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1898.

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THE

LECTRICAL ENGINEER.

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NOTES.

stminster Technical Institute.—The prizes during the past session by the students of the West-r Technical Institute, Vincent-square, S.W., were ted by the Baroness Burdett-Coutts a few evenings

ctrical Exhibition in New York. — An cal exhibition is to be held in Madison-square ns next May, and it is anticipated that it will ogether a much larger show than the one in 1896. eneral manager is Mr. Marcus Nathan, 15, Cortlandt-, New York.

ctric Tramways in Kent.—We are informed the question of introducing electric trams into ster and Chatham is being very warmly debated, but opinion in favour of the scheme is growing. The e is estimated to cost £200,000, and the length of nes will be 14½ miles.

ectric Traction in Queensland.—We learn that ailway Commissioner of Queensland is enquiring into dvisableness of applying electricity as a motive force uburban lines. The substitution of electricity for would, it is thought, mean a far greater number of s being run, at a less cost per mile.

e Telegraph Deficit in France.—For the cial year 1896-7 the expenses in the French Telegraph rtment amounted to £1,708,085 and the income to 08,815, leaving a deficit of £199,270. From the state-s given in the annual report it appears that the more rams there are sent the greater is the loss.

evised Customs Tariff for Brazil.—The Board rade have received through the Foreign Office a tele-from her Majesty's Minister at Rio de Janeiro stating a revised Customs tariff for Brazil is about to be ished, and that it would come into force on Jan. 1 last. ortant changes are said to be made by this tariff mostly e way of reductions of duty.

he Electric Railways of Canada.—There are miles of electric railways in Canada, exclusive of those ritish Columbia. Statistics show that the train mileage in 1896 was 21,917,151, and the number of passengers ied was 73,496,069. The total capital and bonded debt £4,600,000. There were in use 947 motorcars, with 5 motors, 360 trailers, and 62 street sweepers and snow-ghs, while the total number of hands employed was t 3,400.

he Engineering Dispute.—The truce between the ers and men is at an end, and beyond this there is to record. A number of lock-out notices have been d, and now it is a question of finances. A levy upon hole of the trade unions is proposed, and, as a set-off st this, there are indications that in case of need ers also will combine for mutual support. We doubt her the principle of trade unionism is strong enough to sustain a universal war for very long; the instinct of self-preservation is likely to effect what common-sense has failed in.

The Cost of Street Lighting.—From the recently published accounts of the City Commissioners of Sewers for the year ending Sept. 29, 1897, we learn that the amount expended on account of electric supply and sundry works was £11,887, while for gas supply, altering services, etc., the amount was £6,316, and for repairs to gas posts, etc., £852. The salary of electrical engineer, rent, fittings, and expenses at the electrical laboratory and wages of assistants amounted to £640.

Electric Lighting at Singapore.—Some months ago it was announced that the Tanjong Pagar Dock Company, Singapore, had decided to light its wharves, docks, warehouses, and roads by electricity. The installation is now practically completed, and is so far a great success. The installation is of peculiar interest, says *Indian Engineering*, not only because it is one of the largest of its kind in the Far East, but also in view of the unsettled state of the public lighting question in the Straits.

The Post and Telegraph in Spain.—The Government of Spain is notoriously in somewhat straitened financial circumstances, but they have nevertheless decided upon the centralisation of the postal and telegraph offices in Madrid. The new building will be erected on the site of the palace of Medina-Celi in the street of San Jeronimo, and the cost will be defrayed out of the proceeds of the disposal of the various buildings in the city which have up till the present housed the respective departments.

Underground Cables in Calcutta.—The municipal authorities of Calcutta have learned the unwisdom of putting electric light cables underground in a country where the conditions are so favourable to speedy decay. The electric lighting of Harrison-road broke down from this cause, and the wires are now placed overhead and wired in accordance with the regulations of the English Board of Trade. An arrangement has been made with a Calcutta firm to work the plant for a yearly payment of £600. The lighting has been satisfactory under the altered conditions.

A Royal Electric Launch.—We are informed that the Czar of Russia has placed an order for a launch propelled by electricity with a firm of electrical engineers in the United States. The launch is to be only 37ft. long, or 35ft. on the load water-line by 7ft. 3¾in. beam, with a draught of 2ft. 3in. to 2ft. 4in., and a displacement, without passengers, of 5·2 tons. The boat is to have a speed of eight miles an hour for three hours, or seven miles an hour for six hours. Storage batteries will provide the current for the motor driving the propeller, the voltage being 110.

British Columbian Prosperity.—We are pleased to see that the success of electric traction in British Columbia is in the realm of Things Accomplished. From a circular to the shareholders of the British Columbia Electric Railway Company we learn that for the first half-year of

the company's existence a net profit of £2,300 has been earned, after paying working expenses, expenditure in London, interest on £250,000 4½ per cent. debentures, etc. The company are wisely spending money on improving their concern and in carrying out extensions. The gross earnings for the half-year amounted to about £26,000.

The Lighting Concessions of Paris.—A report prepared by Mr. Charles Bos on the petition of six companies for the prolongation of the concessions for supplying electrical energy in Paris, will shortly be discussed by the Paris Municipal Council. The report recommends that the concessions should be prolonged to Dec. 31, 1925, which will, in fact, be a new *modus vivendi* for 28 years, because an important reduction of the price of the electrical energy and a considerable extension of the network of conduits are imposed on each of the companies, as well as various modifications in the conditions of the contracts.

The Blackpool Tramways Question.—The Blackpool Tramways Committee met last week to consider a peculiar position of affairs. Some time ago they applied to the Local Government Board for permission to substitute the overhead trolley system for the conduit system of electric traction on the promenade. Not only has the Board refused this permission, but it has condemned the existing conduit system as well. This has come as a surprise upon the committee, who are going to interview the officials in London on the matter. Meanwhile they have decided to lay a tramway line through Claremont Park, instead of along the lower promenade.

The Willesden Polytechnic. — The prizes and certificates gained by the students of the Willesden Polytechnic and of the Harlesden and Hendon affiliated classes during the session 1896-97 were distributed a few evenings ago, in the hall of the institute at Priory Park-road, Kilburn. Mr. R. D. Littler, C.B., Q.C., chairman of the council, made the presentation. The council reported that the total enrolment for all classes throughout the district was 1,571, and the weekly average attendance 972, showing a substantial increase of 82 entries and 106 in average attendance. With regard to the present session, which commenced in October last, general progress was observable, and the number of students enrolled still showed an increase on that of the previous years.

The Pacific Cable Project.—According to a telegram despatched by Reuter's Agency, Sir Sanford Fleming, in a communication made to the Press, urged the Government of Canada once more to take up the project for a Pacific cable. He argued that the proposal of the Eastern Extension Company, which resulted in the suspension of the Pacific cable project at the last conference, would not adequately fulfil the purpose, what is required being an auxiliary system free from liability to interruption. He declared that the Pacific cable scheme was pronounced impracticable and expensive in the interests of the Eastern Extension Company only. The Australian colonies being politically disunited, Sir Sanford Fleming holds that it behoves Canada to make definite proposals, for which the mother country is waiting.

New Jewellery.—If any manufacturing company has a stock of old telegraph wire on hand, the best thing to do is to ship it out for barter to the dusky inhabitants of the Gold Coast. It will be remembered that the telegraph line was permanently extended to Kumasi last March, and it has proved a great boon to the natives, who steal it in considerable lengths to make armlets. On one occasion 240 yards were carried away, and it seems a pity to use material for such a purpose when there is so large a ...y discarded as being useless. The Gold Coast is not poor in gold dust, and instead of wasting one's energ... in trying to transmute silver into gold, it would be... much more satisfactory process to use old telegraph w... while there is such a strong demand for it. Fashio... change, even in a nigger's scanty apparel.

Wanted, an Examination Code.—We learn fr... the *Elektrotechnischer Anzeiger* that the municipal authoriti... in Koenigshuette have issued an edict that in future wh... any electrical installations are to be connected with the m... of the Corporation, only such contractors shall be recognis... as have proved that they are theoretically and practicall... capable of carrying out the works. This "censorship," ... to speak, rests with the Municipality. The contractor wh... is fortunate enough to pass will undertake the full respo... sibility of the works, machinery, and plant, and, in additi... to this, has to make a written declaration binding hims... to deliver all materials, machinery, etc., without fault, ... accordance with specification. A surety has also to ... deposited of the value of at least £50. It will be interes... ing to see what the standard of examination will be.

Post Office Motorcars.—A great sensation was ma... the other day when it was announced that the Post Offi... had decided to use an oil motorcar for carrying the mai... between London and Brighton, and it was prophesied th... this was only a temporary victory over electricity. ... New York electricity has already conquered, for we re... that Postmaster-General Gary, in his annual report, stat... that the greater expedition to the mails secured throu... transportation on electric cars has created an increasi... demand for the extension of the service. There are mo... applications now pending in the New York Post Offi... Department for the establishment of electric car ma... service than can be met from the appropriation for th... current year. The annual rate of expenditure for th... electric and cable car postal service on June 30, 1897, wa... £36,600. Uniform rates of pay have been adopted, bas... on space and mileage.

Imperial Institute.—The following are the arrang... ments for lectures during this month at the Imperi... Institute. These lectures will be open free to the publi... without tickets, seats being reserved for Fellows of th... Imperial Institute and persons introduced by them... Monday, 10th, 8.30 p.m., "Western Australia, its Grow... and Possibilities," by Mr. H. C. Richards, M.P.; in ... chair, the Hon. Sir Malcolm Fraser, Agent-General ... Western Australia. Monday, 17th, 8.30 p.m., "So... Africa, from the Cape to Ngamiland," by Mr. H. ... Bryden; in the chair, the Hon. Sir David Tennant, Age... General for the Cape of Good Hope. Monday, 2... 8.30 p.m., "New Brunswick, Past and Present," by ... C. A. Duff-Miller, Agent-General for New Brunswick ... the chair, Lieut.-General J. W. Laurie, M.P. Monday, 3... 8.30 p.m., "Through the Goldfields of Alaska to Beh... Straits," by Mr. Harry de Windt, F.R.G.S.

The Magnetic Needle in Russia.—A correspon... to the *Standard* states that the results of the investigat... made by the French *savant* M. Moureau and Ru... scientists into the extraordinary deflection of the mag... needle over an immense area of Central Russia have sti... be published in scientific form. Observations were ... over a strip of country between Moscow and Kharko... extreme points north and south, distant from one an... as the crow flies about 850 miles. The greatest aberr... are found in the province of Kursk, the capital tow... which is some 600 miles almost due south of Moscow. ... the northern part of the province, near Tim, the ne... deflects 20deg.; further south, in the district of O... Oskol, up to 30deg.; while in the South-East Prov... about 150 miles south of Tim, the deflection is over 96d...

the needle standing almost perpendicular and pointing east and west instead of north and south.

"Finance."—This is the title of a weekly journal and review which made its appearance with the New Year "to supply an urgently required need." It is full of information and illustrations, set forth on very excellent paper. It has, however, a somewhat Yankeefied look about it, and it certainly conveys the impression of being backed by an unlimited supply of dollars. An article by Sir Edwin Arnold—of all men—"In Defence of Money," starts the literary part. As he pleads ignorance of the subject, he may be excused in calling a blanket reef a banket reef. Probably he thought that a banquet (the opening one) is often all the unfortunate shareholder gets out of such a mine. J. K. Jerome, I. Zangwill, the Hon. W. P. Reeves (Agent-General for New Zealand), Admiral P. H. Colomb, J. F. Nisbet, and Miss Helena Gingold are amongst the other contributors.

The African Telegraph.—Good progress is being made, says the *Financial News*, with the extension of the transcontinental telegraph to Tete from Umtali. A line already exists from Salisbury to Tete, and messages have been regularly sent by it; but it passes through country where the natives give a good deal of trouble, and it is not intended to repair it. Salisbury and Umtali have for long been connected by wire, and it is now intended to make the Salisbury-Umtali section a link in the transcontinental route, the wire being taken northward from Umtali to Tete. From Tete the line will be taken across the Zambesi, and it is anticipated that it will reach Karonga, on the north-west of Lake Nyassa, about April next, which means that the north end of the lake will be in direct telegraphic communication with London. From Nyassa an excellent road stretches to the southern shore of Lake Tanganyika. Connection with Tete will be established about the end of January, if all goes well.

Municipal Telephony.—It is interesting to see what has been the result, apparently, of the action between the City Commission of Sewers and the National Telephone Company and the Post Office in connection with the granting of additional facilities in return for permission to lay wires underground. The London County Council have the question under consideration, as well as the Glasgow Corporation. The St. James's Vestry have approved of the action which the City authorities are taking, and have circularised the local authorities in London on the subject; Brighton Town Council are considering the advisability of applying for a license to establish a telephone system, and Huddersfield Town Council have already decided to apply for a license. Other towns are also talking of adopting a similar course. The Beckenham Urban District Council called upon the National Telephone Company to remove the overhead posts and wires in the district. The company refused, and a writ has been served on them, and an injunction is to be applied for to restrain them from continuing a trespass with the poles and wires in the Council's district.

Electric Railway for Klondike.—A Californian is said to be negotiating for the erection of an electric elevated single-track railway from Skaguay over the White Pass. The track consists of 12in. by 12in. posts, [illegible] high, and 14ft. apart, on which are strung two timbers, each 6in. by 12in. and 28ft. long. On top of the timbers a 30lb. steel rail. The cars are 15ft. long, 7ft. high, and [illegible] wide, capable of carrying three tons each. Two cars are joined together by heavy beams and run one on either side of the rail, making practically one car. Two heavy car wheels support the load and two 15-h.p. motors are [illegible], one for each wheel. The cars weigh 2,500lb. each, inclusive of the motor. The cars are steadied by wheels at the bottom set with a spiral spring, which takes off the oscillation. They can turn on a radius of 50ft., and with a 15-h.p. motor can climb a 17 per cent. grade. We should think that the first thing to be done is to show the miners that they can be well supplied with provisions, and then to prove that an electric plant driven by turbines can be kept running all the year round, frost and ice notwithstanding.

Electrical Undertakings in Mexico.—An engineer in Mexico has submitted to the *South American Journal* particulars of some enterprises in that country which are of interest. The first scheme is for the installation of turbines and electrical plant for transmitting 2,000 h.p. a distance of 18 miles, to be distributed among users in a great industrial centre. The tunnel and canal for this is nearly complete, and the hydraulic power given to the company at the point where the turbines will be put in. The cost of this plant and putting it down is about £65,000, and with this 2,000 h.p. can be transmitted, as the hydraulic power is over 3,000. This 2,000 h.p. is all provisionally sold. The second scheme is similar, except that 1,000 h.p. will be available and the distance that the electricity will be transmitted is 15 miles. This power is practically all sold. The third enterprise is to put down 3,000 16-candle lamps, to be obtained from a local water power in a State capital. The owner, in this case, offers to pay cost in instalments, and it is a case where the company would hold a mortgage on the whole installation till it was paid, or at once buy all the lot. Another scheme is for the lighting of a State capital which would be guaranteed by the said capital. The water power is only three miles distant.

Manganese Dioxide in Lead Accumulators.—Mr. G. von Knorre, in the *Zeitschrift für Elektrochemie*, gives some interesting facts relating to experiments carried out by him with regard to the use of manganese in accumulators. He states that a freshly-charged positive plate, dipped into sulphuric acid containing manganese sulphate, at once gave the pink colour and the absorption spectrum of permanganate. The same acid is formed when a positive plate on which some manganese dioxide is spread is immersed in sulphuric acid. On the other hand, a permanganate solution is discoloured by a negative plate, and a lead glycerate plate containing manganese dioxide and coupled as cathode with another plate during formation soon made the anode red, although the sulphuric acid and the anode were free of manganese. The author concludes that there is little doubt but that the manganese acts as oxygen carrier from the positive over to the negative plate, and impairs the capacity of the cell; and that the fact that we do not notice the colour reaction in ordinary cells is due to the circumstances that the oxidation and reduction proceed simultaneously. An accumulator which has been prepared with manganese salts is said to become quickly discharged. The author strongly advises that manganese compounds should be avoided in electric accumulators.

Electricity in Agriculture.—It must be at least 12 months since we heard the last of electricity as a fertiliser, but we learn from a St. Louis newspaper that experiments have been continuously made which have resulted very successfully. It is said that the fragrance of flowers is greatly increased by the application of electricity to the soil in which they are grown, and this led up to the discovery of the value of the current in increasing the percentage of sugar in beet. The increase was obtained by a long series of experiments by which the wires and arc lights were tried at all distances from the vegetables, and then nitrogen was added to the soil in abundance, and was converted directly into sugar. This is all very wonderful; and it is even more amazing to read

that an increase of sugar, varying from 20 to 30 per cent., has been obtained, and that this is soon likely to increase to 50 per cent. Of course, unless one has seen the experiments, it is easy to doubt and difficult to criticise. Electricity may be as invigorating to plant growth as it is said to be in this solitary instance, but we should think it would require more than a 50 per cent. increase to make it pay. To lay and maintain a system of wires sufficient to produce that result would mean an enormous expense to a farmer, to say nothing of the cost of generating the current.

Magnets for Lifting Purposes.—We have from time to time recorded interesting experiments which have been made with magnets for lifting purposes, and we now learn from *Cassier's Magazine* that someone has suggested their application to the raising of iron and steel vessels sunk in deep water—too deep to admit of the employment of divers. One proposed scheme has for its object the raising of the ill-fated "Victoria," of the British Navy, which now lies at the bottom of the Mediterranean in 450ft. of water, off the harbour of Tripoli. The weight of the wreck in water is estimated at 7,000 tons, and the suggested method of raising it is as follows: Powerful hydraulic rams and dynamo machines and a series of heavy electromagnets will be arranged on pontoons at the scene of the wreck. A magnet, lowered over the side and coming within reasonable distance of the sunken vessel, would be drawn towards the latter, and, on touching any iron or steel part of it, would immediately stick to it with a power of 100 tons. As each magnet made attachment, which would be indicated by means of an electric dial on the pontoon, a trial pull would be given to the rope to ascertain that a connection had been made to a firm part of the wreck. Should this not be the case, the magnet would come off, its position would be then slightly moved and a fresh attachment made until a firm hold had been taken of the wreck. When all the magnets had been thus fixed, the wreck would be considered ready for raising. Each lifting rope would be attached to the lifting pontoon by means of a sheave on the head of a hydraulic lifting ram having a stroke of 12ft., which would give an effective lift of 24ft. Each hydraulic cylinder on the pontoon would be in connection with all the others, and a balancing accumulator would prevent any rope getting more than a normal strain of 100 tons. When the rams had made their full stroke, the lifting ropes would all be simultaneously held in position by means of special hydraulic lifting blocks. The rams would then be lowered and another lift of 24ft. given to the wreck, and the operation would be repeated until the wreck would be raised sufficiently near to the surface to be towed to shallower water and there beached. It would be extremely interesting to see such an experiment tried, but as the cost is estimated at £25,000, we very much doubt whether it will get any nearer an accomplishment than it is at present.

An Everlasting Problem.—Many brains have been at work for many years trying to devise a scheme to effectively and expeditiously deal with the enormous traffic in the London streets. Mr. C. G. Mott, the chairman of the City and South London Railway, agrees with the now pretty general idea that the remedy is to be found in electric underground railways, but he also goes a little bit further, and says that if these railways are to afford the maximum of convenience to the public they ought to be so arranged as to become one complete network of communication, so that a passenger descending at any one station may be able, by changing from the platforms of one railway to those of another, to proceed to any part of the Metropolis to which he may desire to go without the necessity of coming again to the surface until he has arrived at his destination. If this were done, it would very largely relieve the traffic of the streets, and would enable the transit from one part of the Metropolis to another to be performed with an ease, comfort, and quickness to which London has hitherto been a stranger. "In order to accomplish this result," he says, "it is necessary that a controlling influence should be exerted to determine the best lines of route for these railways, and the points at which the exchange of traffic should take place, as, if this is not done, enormous future public inconvenience will be the result." At present, all these railways have to be constructed under the lines of the existing streets, in order to avoid payment for the use of the subsoil, but it is clear that in many instances it would greatly conduce to the public advantage if the railways could be constructed in more direct lines under private property. This was recognised by a joint committee of both Houses of Parliament, to which the question was referred several years ago, and upon their recommendation powers have since been granted authorising the railways in these cases to take an easement only instead of being compelled to purchase the property on the surface. Considering the great depth at which these railways are constructed (generally from 70ft. to 90ft. below the surface of the ground), the value of this easement is exceedingly small, but the number of separate properties under which the line in such a case would pass is so great that the legal expenses involved in settling the amount to be paid and obtaining a separate conveyance in each case are such that at present the passing under private properties for any distance is not practicable. As the value of the subsoil at that depth is the same all over the Metropolis (as it can never be used in connection with the surface property), could not Parliament fix some uniform sum to be paid for it, and so avoid the enormous legal expenses involved? Mr. Mott also suggests that the Board of Trade should sketch out the main routes desirable for new metropolitan railways as a guide for the parliamentary committees.

Prof. Lodge's Lectures.—Interest is unabated in the lectures given by Prof. Lodge at the Royal Institution on "The Principles of the Electric Telegraph," and there were again good audiences last Saturday and Tuesday. The fifth lecture given last night (Thursday), dealt with the principles of wire and cable signalling. The speaking-tube, bell-wire, rates of transmission, the telephone, the ear as receiver, and the microphonic transmitter, were first enlarged upon, and the lecturer then proceeded to explain that the simplest electric signalling pulse is an advancing electric and magnetic field, travelling together as a wave in ether with the speed of light, and usually followed by a steady state of some duration. A perfectly conducting wire can keep the wave together unaltered, and guide it to a destination, however distant; and in the wire is then an electric current. When the electric and magnetic fields have equal energy, they travel and arrive together, the wave retains its simple form, and the signal it gives is sharp and clear. Resistance in the guiding wire tends to dissipate the current—*i.e.*, the magnetic field—but leaves the total electric field—*i.e.*, the charge—unaltered; her[ice] less of the wave is progressive, the pulse gets flattened o[ut], leaving a tail behind it, and the signal is both smooth and weakened; changes which are called distortion [and] attenuation respectively. Leakage in the insulator red[uces] the electric field to match (more or less), and thus less[ens] the distortion, though it adds to the attenuation. Whe[n a] wire is hung on tall posts its electric field is weak, and [the] distortion insignificant; but when a wire is buried in [the] earth or sea with only a thin insulating covering, [the] electric field is strong, and the distortion caused

idable resistance is considerable, so that a sharp signal iriously washed or smoothed out. The remedy is to then the magnetic energy to match, say, by coiling ire, or by surrounding the core with a number of ngs or washers; or else to reduce the capacity or sistance. Prof. Lodge explained the difficulties of telephony, and the kind of signal which arrives h a long cable. A rising current in a wire has to sh both an electric field from the wire and a magnetic ound it. Both operations require time, and so the t does not rise to its full strength instantaneously. xth and concluding lecture is to be given to-morrow day), and deals with space telegraphy. Mere wire-legraphy, says Prof. Lodge, is very ancient, but : wireless telegraphy depends, like other electric phy, on the emission into space of a wave or pulse ' electric or magnetic. A wire could guide this o a destination, but without a wire it spreads like

Telegraphy by magnetic impulse alone is detected iced currents, and best directed by iron. Telegraphy tric impulse alone is detected by electroscope, and irected by copper. The production of electromag-aves by Henry, Helmholtz, Lord Kelvin, Feddersen, l that a Leyden discharge was oscillatory; Clerk ll, Fitzgerald, and others, and Hertz showed that oscillations emitted waves. The lecturer then s the experiments for the detection of electro-tic waves at a distance, by Hertz, by many other menters, and by Branly, and touches upon the recent ited application of the waves and their detectors to business telegraphy; the meaning of electric nce, or syntony, and absence of it from the practical pts so far made and published, and the mode by it may be attained. Electromagnetic waves and ors for them are also in reality, he says, very ancient. m or candle is an emitter, the eye of a photograph is a detector. In other words, ordinary light consists succession of true waves, with equal electric and etic energies, travelling in the ether at the speed of a nd simple telegraphic signal.

hen is Electricity Dangerous?—Mr. Gisbert , in a leader in the *Elektrotechnische Zeitschrift*, cites a ases to disprove the idea commonly held that an alter-current at 100 volts is totally without danger. He details of four fatal cases which occurred in one chemical ry within 16 months. In three of these cases the voltage not higher than 115; in the fourth it may possibly have 120, but was certainly not higher, and probably it was 115. For reasons which may well be imagined, he not give the name of the place and character of the ry, but he says that the installation was originally pleted in a thoroughly workmanlike way, and that a t enquiry into the condition of the installation showed it is still in perfect order. He goes on to say: "We to deal here with an installation which any expert and scientious engineer would have at once taken over as g ready and safe for immediate working, and yet four cases have happened there within 16 months. The first occurred with an arc lamp which hung on a wooden in the open air. This lamp could be lowered with a amps, a windlass, and an iron crank. The cable was ated from the lamp, and it had, therefore, as long as ything was in good order, no voltage on it. The attendant instructions never to attend to the lamps except when ng on an insulated stool, which he was supposed to with him when he went round. He did take the stool him, but he rested it against the mast while he himself on the ground bare-footed. Under ordinary circum-, even then no immediate danger would exist, because the cable was insulated from the lamp, and certainly the man had frequently attended to the lamps in the same way without accident. But on that fatal day he forced the lamp up too high, so that the support of the lamp was bent and touched the upper pulley on which it was suspended. In consequence of this, the cable, the windlass, and the crank received a voltage of about 115, which proved fatal to the man. In the second case a labourer, in defiance of instructions, seized an alternate-current conductor which was outside a window. He had to lean out considerably to catch hold of it, and therefore could not let go immediately. The potential of this wire to earth could not have been 250 volts, and was probably only 115, because when measured later on all three wires of the three-phase system were found to have nearly the same voltage to earth. In the third case the man did not touch the wire itself, but an iron tube in which the two insulated wires in an electric light conduit were enclosed, and which was held up by an iron hook against the wall. One of the joints of the tube got loosened, and in time cut the insulation of the wire, and so brought the wire and the tube into contact. The voltage conducted to the tube in this case was also fatal. In the fourth case, the man was found lying on his back with one hand holding an extinguished hand-lamp, while the cord lay over his breast. The workman who tried to remove him received shocks, and here again the voltage was only 115. It is worthy of notice that, according to one of the managers of the factory, he, as well as his engineers, very frequently touch the conductors without being hurt, and without getting particularly severe shocks. There is therefore a difference of the physiological effect. This difference may possibly be explained by the way in which current-carrying parts are touched, and through a difference in the manner persons are clothed. It is apparent that the effect must be very different whether one touches an object only cautiously and slightly, expecting to receive a shock; or how one, without thinking of the danger, grips hold of the object firmly. In the first three cases it is undoubted that the victims had got hold firmly, and in the fourth it is highly probable. Of more importance than the manner of the gripping might be the way in which people were clad or the condition of the skin. The transmission resistance of the skin forms the larger part of the total resistance of the human body. It might be conceded that the resistance of the body is diminished by a person staying for any length of time in a damp room, or a room sometimes filled with vapour, and also through the handling of chemicals. In addition to that comes the circumstance that the labourers were not provided with dry boots, but wore either wooden slippers, which got damp quickly, or went about with bare feet. In either case they were rendered more liable to danger than an employé who only went into damp rooms occasionally, and then with dry boots." Prof. Weber, of Zurich, has recently pointed out that from several minute examinations of the physiological effect of the alternating current on his own person, he came to the conclusion that there was a danger in touching two alternate-current wires with both hands—both being dry—as soon as the difference of voltage exceeded 100, and Mr. Kapp refers to this theory in order to show that practical experience confirms it. He says he does not wish to alarm the electrical industry, but he thinks it his duty to point out that one has to reckon with those circumstances and to invent means to prevent the danger. We wish that the particulars of the processes carried on at the factory in question had been published, as they may explain the low resistance offered by the victims to the passage of the current.

FRANCIS HUGHES WEBB.

Every man who mingles in the real work of the world always feels regret when one of the honest workers leaves the sphere of labour he has adorned so long, and the regret is intensified to those who have been the immediate colleagues and fellow-workers. Thus every member of the Institution of Electrical Engineers will regret the resignation of Mr. F. H. Webb, although they will sympathise with his desire for a little rest and leisure. It is about 20 years ago that Mr. Webb was appointed secretary of the then Society of Telegraph Engineers, and it may be well to glance at the progress of the Institution during that period. In the first place, the number of members has about trebled, as might be expected, the year 1878 being on the brink, so to speak, of the new electrical era. Paris was gay in 1878, but so far as electricians are concerned their innings can hardly be held to have started till the Paris Exhibition of 1881.

The English Institution had meetings in Paris in 1881 and again in 1889, in both of which the secretary was necessarily an active participant. As regards the Vienna Exhibition of 1883, Mr. Webb was one of the secretaries to the commission. He also took an active part in the meeting at Edinburgh in 1883, and at the Healtheries in 1884. When, then, we consider the increasing number of members during these early years of his secretaryship, and the arduous labours attached to the management of these various meetings, and find also that the library was opened in 1881, while the throes of incorporation were concluded in 1883, it must be acknowledged that the secretary was fully occupied. But this was not all. The society had during these years under consideration fire rules, issued first in 1883, again in 1888, and again in 1897. The eighties were indeed busy years, for annual premiums were instituted in 1882, students' meetings commenced in 1887, and the title of the society changed in 1889. The work in connection with all these matters needed energy and tact, which the results show were not lacking. The good work of progress did not stop, however, at the end of the eighties, for we find the Salomons's Scholarship founded in 1891, a building fund begun in 1894, and students' visits to works inaugurated in 1896, to say nothing of consultations that would naturally arise between the Board of Trade and the Institution over electrical matters during this period. Perhaps the point that appeals most to business men is the change in the financial position of the society. When Mr. Webb took office the finances were not healthy, the balance was on the wrong side, while now he leaves the financial position healthy, with large balances on the right side. These are a few of the facts concerning the work of the Institution during the secretaryship of the gentleman who has resigned office, and will shortly vacate the position he has so long and so honourably filled. We congratulate him on his achievements in the interests of the Institution, and wish him long life and health to enjoy the well-merited repose he has sought.

THE MIDLAND RAILWAY'S ELECTRIC LIG PLANT AT LEICESTER.

When Mr. W. Langdon in 1895 read his valuabl on "The Employment of the Electric Light for R Purposes," the plant at Leicester had not long running, and hence the figures of cost of working co be given. Now that the plant has been at work fo few years, a *résumé* of the results achieved will interest to our readers. During the intervening many improvements have been made to the various e machines, and other apparatus used, and the plant ge has been subjected to more than the renewals allowed for in central-station work. Thus the figu repairs and wages are higher for the time being than be found if a cheese-paring policy were adopted Langdon believes in having the best machiner treating it in the best possible way, and hence the lighting stations of the Midland Railway Compa models of their kind.

Arrangement of Plant.

The general equipment of the generating plant seen in the plan Fig. 1, while Fig. 2 shows the ext the works. The site available for the station was in extent, and this influenced the arrangements. due to the increase of the incandescent lighting, a of the space which was to be used for the quarters had at the last moment to be thrown i engine-room. The photograph reproduced in Fig. a general view of this engine-room, but owing numerous belts and belt fences and the lack of spa not easy to get a good representative photograph lights supplied from the station include the foll 113 series arc lamps, taking 10 amperes each; 28 arc supplied in parallel circuits of two lamps in seri 32-c.p. incandescent lamps, 189 16-c.p. lamps, an 8-c.p. Thus the series lighting corresponds to a 57 kw. and the parallel lighting to about 30 kw.

The series arc lighting is supplied from three Br lighters of the old open-coil type. The regulation voltage of these machines, each of which is cap taking 50 arc lamps, is effected in the usual way by rheostats and relays. The most noticeable part of lighting gear is the switchboard, which was desig Mr. Langdon's staff and manufactured in the M Company's shop. With this board the use of flexibl and plugs is avoided, and the face of the board at a indicates in diagram the circuit arrangements. Th circuits are so arranged that whole platforms can be sw on or off from the engine-room. In this way the la run on some seven different circuits, having from thirty lamps each, which are grouped together at th as may be required.

Fig. 4 gives a front elevation of this board, w composed of 12 panels. The panels are of slate, m in a wooden frame. There is in the centre of each horizontal metallic axis, on which swivel eight all connected together. Into these sockets, loose bars, with handles, are placed, which make con with either jaw in the two rows of eight jaws at and bottom of the panel. Seven of the panels ha central axis connected to circuit positives, three a nected to dynamo negatives, and the other two wi meter terminals. The contact jaws at the top of the are positives, and the lower jaws are circuit ne Thus in building up a number of circuits on to one m a switch bar is inserted in the swivel plug of, say, positive No. 1, which is opposite to the jaw conne say, dynamo positive No. 2. Then if No. 3 arc ci wanted next in the series, its positive is switched the negative of No. 1 at the third panel. Finall perhaps another circuit has been added, the negativ of dynamo No. 2 is used to switch on to the nega the last circuit. With this system of connection it to cut out any arc circuit from a series by short-ci it, and it does not matter at which part of the ser circuit happens to be. Over these switch panels ar circuit current indicators, to show automatically

he current is flowing. Over these, again, come the ammeters, placed in the dynamo circuits. The of the metal parts of this switchboard are encased bonite, except at the contact surfaces, so that it is not rous to the operators.

generator and motor mounted on the same shaft, but on separate cores, to allow of the fields being separately excited. The motor is shunt wound for running at constant speed on the 110-volt circuit, while the generator is series wound. The design of this latter machine is so arranged

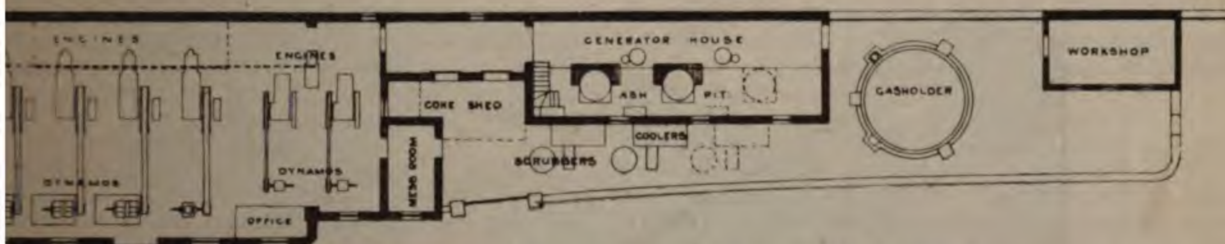


FIG. 1.—General Plan of the Midland Railway Company's Electric Lighting Works at Leicester.

parallel lighting plant consists of a Brush two-pole current dynamo giving 290 amperes at 115 volts running at 800 revolutions per minute. This is from the same sized gas-engine as is used to drive the

FIG. 2.—Exterior of the Leicester Works.

ghters. Besides this machine, there are two Siemens nos, each capable of giving 125 amperes at 115 volts driven at 600 revolutions. Two smaller gas-engines are to drive these two machines. There is nothing special

that the voltage is increased in direct proportion to the current flowing in the circuit. This little dynamo is wound for a maximum of 150 amperes, and then generates 10 volts. It runs at a speed of about 1,080 revolutions per minute. This compensator is also to be seen in Fig. 8. Previous to its use trouble was found with the arc lamps used in parallel off the low-tension mains, as they were apt to hunt. Now the voltage at the further end of the line is kept constant independent of the load.

THE ENGINES.

These were all supplied by Messrs. Crossley Bros., and are of their special high-speed electric lighting type. The engines driving the arc lighters and the larger low-tension dynamos are each capable of developing 50 b.h.p., using Dowson gas, and running at 200 revolutions per minute. The engines have cylinders 16in. in diameter and a 21in. stroke. As there are no batteries as a stand-by, it is essential that the engines shall be capable of running continuously. Hence an efficient arrangement of oiling has been devised, and added to the engines since their erection. The crank pin is oiled by means of a centrifugal oil shield attached to the crank. A sight-feed lubricator drops oil into this, which then flows up into the crank-pin bearing. In this way very prolonged runs in time of fog have been made. The system of oil catching has also received special attention. The first foundations of the engines suffered

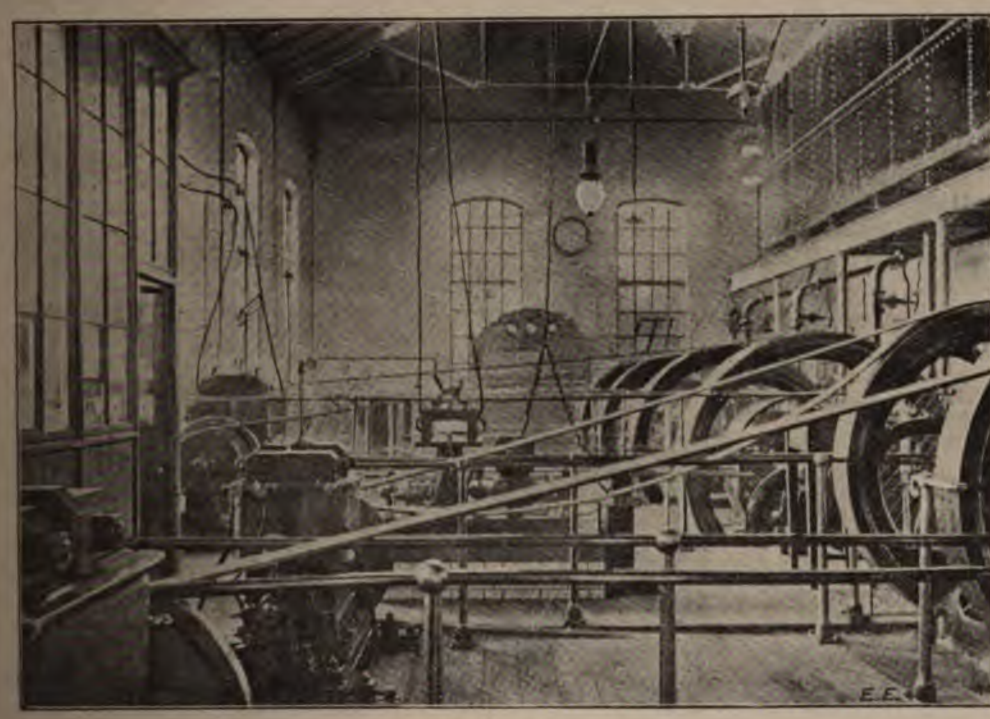


FIG. 3.—General View of the Engine-Room.

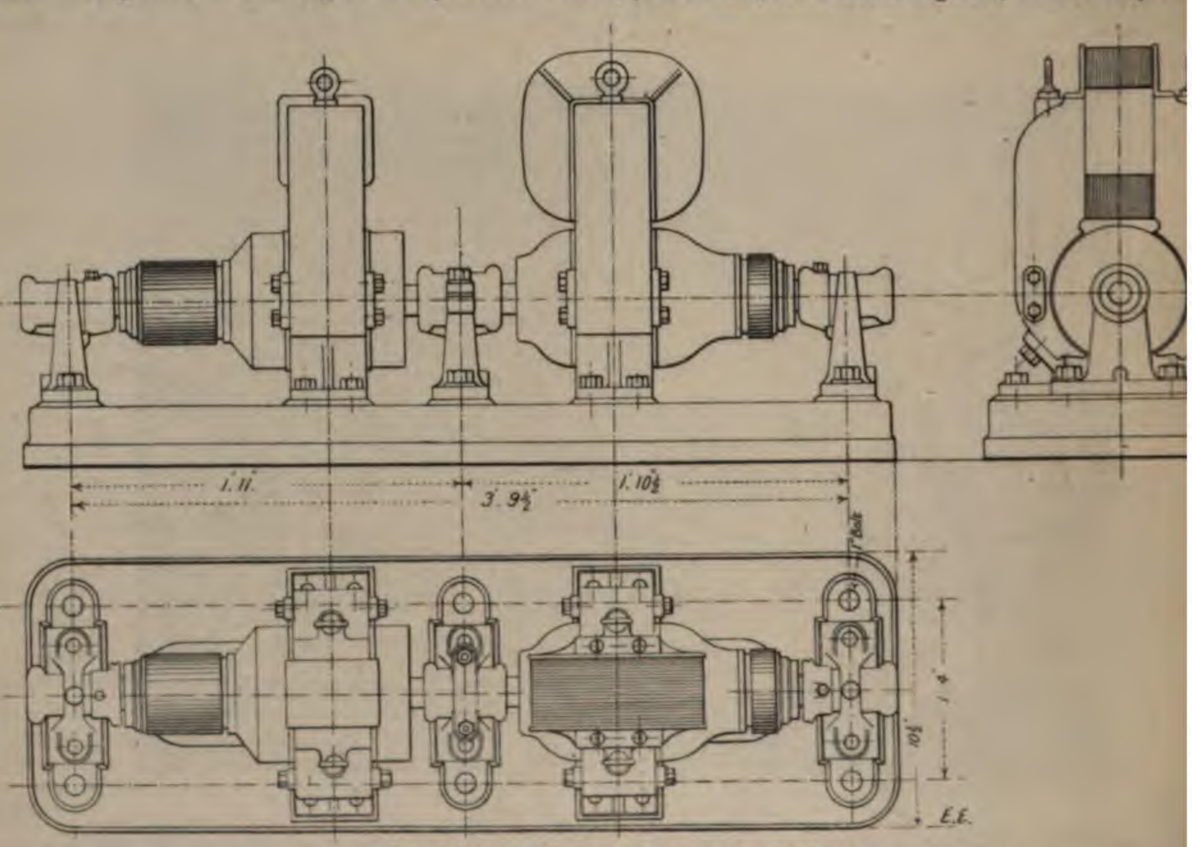
ble in the switchboard for this part of the station, the compensator placed in the feeders needs special ance. This compensator (shown in Figs. 5, 6, and 7) designed by Mr. W. B. Sayers, and manufactured by rs Mavor and Coulson, of Glasgow. It consists of a

from the oil running down and rotting the concrete. This necessitated the renewal of the foundations, which are now covered with sheets of lead, in which channels are arranged to conduct the waste oil away into suitable receptacles.

Since the engines were first laid down, counter-weights on the cranks have been added by the Midland Railway Company, which have much improved the steadiness of the running of the engines. These counter-weights were

FIG. 4.—The Arc-Lighting Switchboard.

fixed on in the company's shops, and the method of strapping them on by rectangular iron bands is particularly neat. The ignition in these engines is by means of tubes,



FIGS. 5, 6, AND 7.—The Sayers Compensator used at Leicester.

both iron and porcelain having been tried. We understand that the porcelain tubes are found to give satisfaction if due care is taken of them. The heating of these ignition tubes is done by town gas. The engines can be run by either Dowson or town gas, and the admission v pipes are so arranged that the change over from other can be quickly made. This would seem at to be a great essential, as the gasholder used for gas would not run the full load for many mi breakdown in the generators occurred. Mr. Goodchild, the resident engineer, informs us, how such breakdowns do not occur in practice. The stand-by is hence rather an expensive luxury, as a consumption of 1,500,000 cubic feet of gas per a to be guaranteed before the Corporation laid

ry mains. Before leaving this part of our subject, not help referring to the painting of the engines. as been done again, and each engine is ornamented coat-of-arms of the Midland Railway Company.

THE GAS GENERATING PLANT.

Leicester there are now installed two complete sets of n generators and boilers, each capable of developing

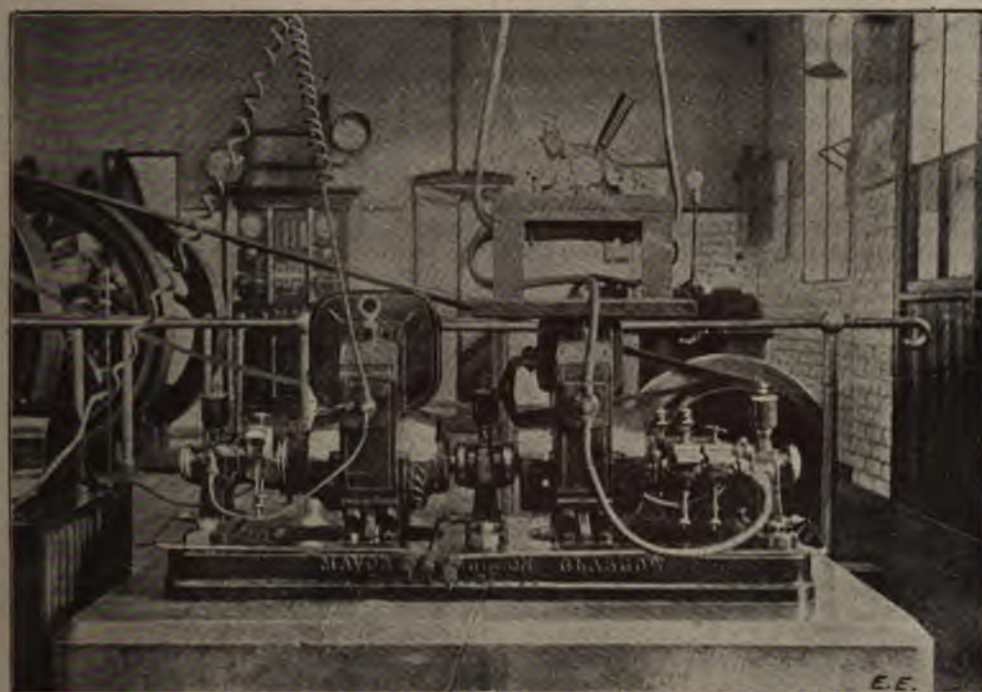


FIG. 8.—General View of Compensator.

or 100 h.p. at the engine. Each set has its own gas-r, hydraulic box, coke-scrubber, and sawdust-scrubber. elevation of this plant is shown in Fig. 9. The boilers not both used at the same time, as one will supply ient steam for both generators. As regards the ing of the apparatus, we may state briefly, for the

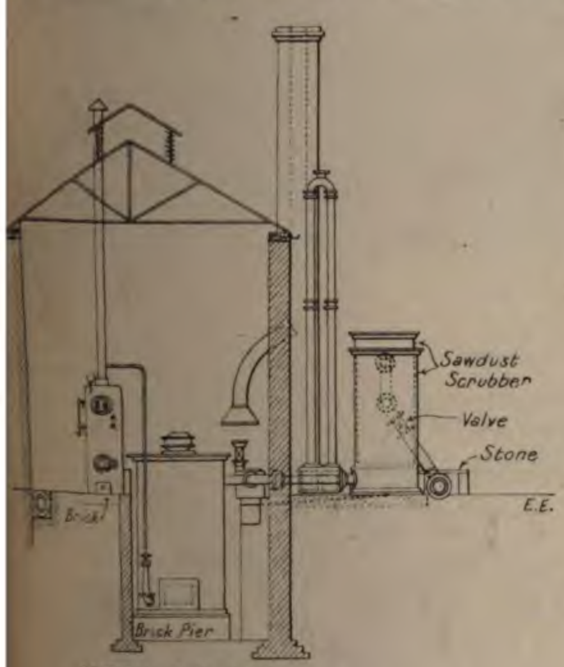


FIG. 9.—Dowson Gas Generator Plant.

of our younger readers, that the generators consist closed cylinder with firebars a few inches from the The fire is of anthracite coal, and the jet of steam air under the bars regulates the production of power The partial combustion only and the decomposition steam results in the generation of a considerable proportion of carbon monoxide, from which power is obtained in the explosion. This is the rough idea, but in the detailed working of such a plant great care is needed to ascertain the best method of working to produce uniform and good gas.

It is to the determination of the best method of working these generators that Mr. Goodchild, the resident engineer, has devoted special attention. The results he has achieved can be best seen from the following figures. The total cost per unit for the half-year ending December, 1895, was 3·30d., and in this period 4·6lb. of coal were consumed in the generator for every Board of Trade unit developed by the dynamos. For the first half-year of 1896 the cost per unit was 3·09d., and the pounds of coal per unit 3·66. Finally, for the first half of 1897 the cost per unit was further reduced to 2·8d., and the coal per unit to 3·03lb. From these figures it will be seen that the coal required has been reduced from 4·6lb. to 3·03lb., or by 34 per cent. This reduction has largely been effected by the use of a cheaper class of coal. Up to July, 1896, both the generators were worked with ordinary anthracite coal. At that date one of the generators was altered to use machine-washed anthracite peas, which cost 5s. to 9s. at the pit's mouth. After adjusting the working arrangements, it was found that 25 per cent. better gas could be obtained with the small coal. With the ordinary anthracite a fire about 4ft. deep was used in the generator, whereas with the machine-washed peas 18in. of fire gave best results.

The better results obtained are said to be due to a greater uniformity in the fire itself. With the large coal and the cup and cone method of charging, the larger pieces get to the outside and allow a certain proportion of steam and air to get through unaffected. With the small coal the grate area has been reduced to 2ft. 6in., while the lining of the generator is 3ft. The second generator was converted to use the peas soon after the improvements in the quality of gas had been established. The advantages of the small coal may be summed up as follows: first, 25 per cent. better gas, enabling the 100-h.p. furnace to develop 120 h.p. to 130 h.p.; second, a more even quality of gas; third, the reduction in the cost of fuel; and lastly, the fact that the generator can be started up in much less time. It is usually found that in 10 minutes good gas is obtained.

The complete figures as to the cost of working at Leicester for the half-year ending June 30, 1897, are as follows. The second column, headed 1896, gives the corresponding figures for the first half of that year:

	1896.		1897.
Arc lamps in use	137	...	141
Incandescents	288	...	320
Total units	126,514	...	137,070
Total cost	£1,631 9 1	...	£1,604 15 9
Total cost per unit	3·09d.	...	2·8d.
Labour per unit	1·42d.	...	1·49d.
Stores and carbons	1·19d.	...	·86d.
Repairs	·13d.	...	·16d.
Coal	·32d.	...	·18d.

For the same half-year in 1897 the cost per unit generated by town gas was 1·42d. For comparison with a steam plant the figures obtained from Derby for the same half-year are as follows: total cost, 2·7d. per unit; coal, ·38d. At Derby, however, there are no arc lamps to be trimmed, which saves considerably in the labour item. At Sheffield the figures are 2·64d. per unit for total cost and ·54d. for coal.

It is interesting to note that if the Leicester installation had been worked without any town gas being used, the average cost per unit would be reduced to 2·67d. This figure is easily ascertained from the quantity of town gas actually burned during the half-year, and the corresponding cost of anthracite peas to produce the same power.

In conclusion, we have to express our thanks to Mr. W. Langdon for his courtesy in placing these figures at our disposal, and for kindly allowing us to inspect the works. We also have to thank Mr. Goodchild for explaining the various steps which have been made in perfecting the plant.

The New Glasgow Engineer.—The notices in all the daily papers that Mr. W. A. Chamen had been appointed to the position of chief electrical engineer to Glasgow was somewhat premature. It was true that the Electricity Committee had recommended his appointment, but a committee's recommendation is not always adopted. We are pleased, however, to note that in this case there has been no hitch, and that at the meeting of the full Council, held yesterday (the 6th inst.), the appointment of Mr. Chamen was confirmed.

ELECTRIC LIGHT INSTALLATION AT THE WESTERN INFIRMARY, GLASGOW.

Early last year the governors of the Western Infirmary, Glasgow, which, with the Royal and Victoria Infirmaries, supply the bulk of the hospital requirements of the second city of the empire, decided finally upon the introduction of the electric light, although the question had been under consideration for some considerable time past. In fact, the requisite engine and boiler rooms had been built at the same time as the new laundry buildings were put up some three or four years ago.

The governors instructed their consulting engineer, Mr. Thomas Young, of Glasgow, to draw up a specification, and having already fitted the Victoria Infirmary and several other hospitals, he was well acquainted with hospital requirements. The specification was issued to contractors early in June, and they were asked to submit

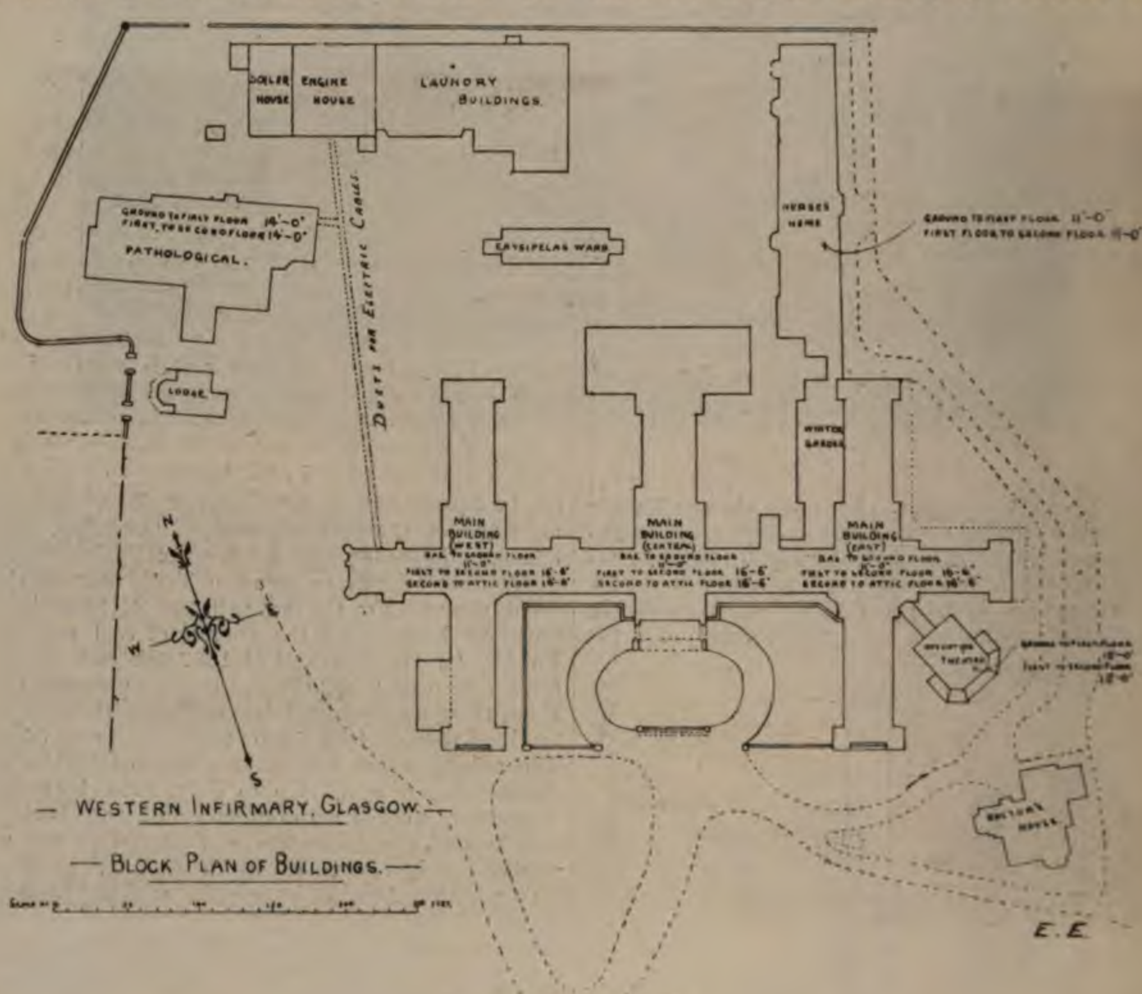


Fig. 1.—Block Plan of Building.

alternative tenders (1) for three 60-b.h.p. and one 30-b.h. direct-coupled plants, and (2) for two 110-b.h.p. slow-spe horizontal engines driving on to a countershaft by me of a belt from which the dynamo would have been driv as required, and one 30-b.h.p. direct-coupled plant. Aft careful consideration it was decided to adopt the dir coupled scheme. Apart from this decision, it might mentioned that the direct-driven plant came out betw £5,500 and £6,000, while the belt-driven plant would h cost some £200 more than this amount. The govern eventually placed the work in the hands of Messrs. Ma and Coulson, of Glasgow, last autumn, and the wh installation was completed and put into working order the time it was needed for the present winter lighting.

As will be seen from the block plan (Fig. 1), the engi and boiler house are placed on the north side of the m buildings at a distance of about 100 yards. The steam supplied by three large Lancashire boilers, which also su steam for various other purposes about the buildings. boilers were built by Messrs. Penman and Co., Glasgo

engines selected were Messrs. G. E. Belliss and Co.'s known make of enclosed self-lubricating quick-revolu- engines, fitted with their patent system of forced lubri- n. In this system the oil is supplied to all the bearings means of a simple pump without valves or packing, arging at a pressure of 10lb. to 20lb. per square inch ugh a specially-arranged system of oil channels. oil escaping from the bearings drains into the k pit, to be used over again. The type of engine ted for both the three 60-b.h.p. sets, and also for the l 30-b.h.p. set, was the two-crank single-eccentric com- d type, as will be seen in Fig. 2, showing a general of the engine-room. The engines are fitted with the ttle type of governor, and in the case of the three er sets it will be noticed that this is carried on the end he crankshaft outside the casing, while in the small set whole of the governing arrangement is enclosed inside casing. With the engine being double acting, the film il at the pressure mentioned above is thoroughly worked ween the moving parts, and lessens friction or jar, no and this is automatically drained by means of one of Heintz's steam-traps. This trap is one of those depending for their action upon the expansion and contraction of metals; the requisite movement is obtained by the expansion and contraction of a metallic tube. As long as the temperature in the outer case is below 212deg. the valve is open, but when this temperature is reached and steam appears the valve closes itself, but the moment it falls again and condensation is set up, and the valve opens and the condensation water is blown off. The steam and exhaust pipes are of cast iron with copper bends down to the engine; the former are carried overhead and the latter below the floor level. They are all neatly lagged, and are fitted with all necessary valves, etc., for shutting off any required section.

The dynamos are of Messrs. Mavor and Coulson's well-known make. They are of the horizontal type, for which this firm always show a preference in all but their very small machines. The magnets and pole-pieces are of wrought iron, and are compound wound. The armature is wound

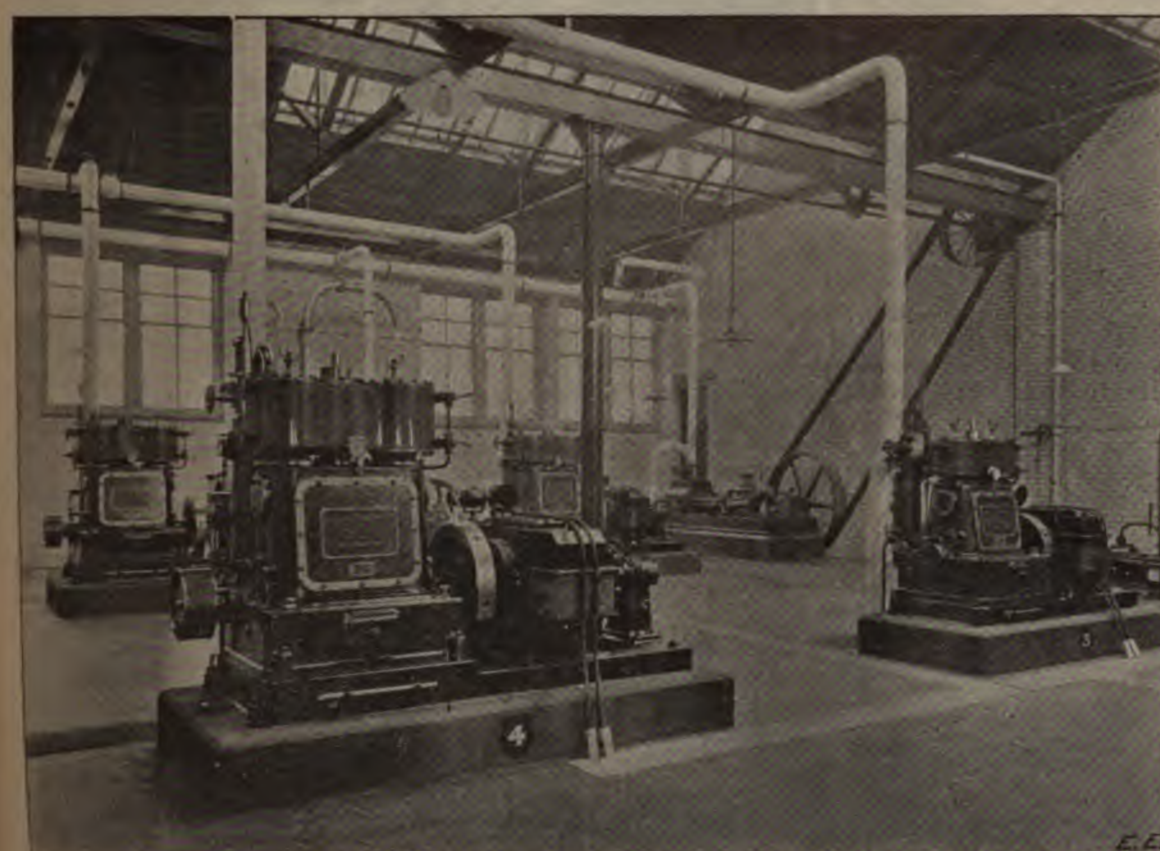


FIG. 2.—General View of the Engine-Room.

matter how the load varies. Dirt is excluded from the bearings by the working parts being closed in, but this is no hindrance to cleaning or overhauling, as the casing is fitted with a hinged door at the back, and, if necessary, the whole front of the casing can be easily removed for examination or repairs. There is no splash, as in most types of high-speed engines, as the cranks are never immersed in oil. It will be at once seen from these remarks that the lubrication must be far more effectively done than in the case of a single-acting engine, as in this latter case, the strain being all in one direction, the film of oil has no opportunity of being forced between the surfaces, but in the double-acting engine the oil takes an appreciable time to squeeze out, and the film is sufficient to last until the strain is reversed and the oil on the other brass comes into action. This system of oiling is said to be so efficient that engines, when taken apart after a couple of years' full work have shown hardly any signs of wear. We must say that when we saw these four engines running at the Western Infirmary it was almost impossible to tell, without closely examining them, which were running and which were stationary.

Each engine has a separator fitted on to its own bedplate, on the Sayers system. The output of the three larger machines is 300 amperes at 116 volts when running at 450 revolutions per minute; and of the small machine, 150 amperes at 116 volts when running at 550 revolutions per minute.

From the photograph of engine-room (Fig. 2), it will doubtless be noticed that the plant appears to be very much scattered, but the reason for this was to admit of further plant being added between each of the present sets, when extensions are required. By arranging the plant in this manner, it prevents the engine-room looking one-sided in the meantime.

The main switchboard is arranged on the south wall of the engine-room, and the dynamos are connected to it by means of cables laid underground in culverts. The switchboard consists of eight slate tablets, as shown in Fig. 3, which are mounted on a teak frame and attached to a wooden screw fitted some 4ft. from the wall, and over the duct carrying the cables to the main buildings. The switchboard is arranged for five dynamo circuits, although only four are at present installed, and 14 distributing circuits. The negative leads are all carried to the three long tablets at the bottom of the board, on which fusible cut-outs are

fitted. The three centre panels carry the regulating gear for the five dynamo circuits as shown, each circuit being exactly similar, and consisting of the following fittings: a fusible cut-out, to which is immediately connected the dynamo lead; the current then passes through an automatic switch, which cuts the dynamo out of circuit when its current falls below a given point; and after passing through one of Lord Kelvin's latest pattern of ampere-

FIG. 3.—Main Switchboard.

gauges, is connected to a common 'bus bar. These automatic switches, or minimum cut-outs, are of a very simple and substantial make, and are manufactured by the contractors themselves. The general appearance will be gathered by a reference to Fig. 3; the coil at the top of the cut-out being a spiral of polished copper strip surrounding a soft-iron core with pole-pieces at either end. The lower portion of the cut-out consists of

FIG. 4.—General View of the Infirmary, looking south (from a photograph by Valentine).

a simple switch mechanism, making contact by means of a horseshoe-shaped contact piece between two blocks; an arm carrying an armature is hinged at the back of this, and in such a manner that when held up by the solenoid the switch will remain in contact, but when relieved, the jar, striking the horseshoe-shaped contact piece, knocks it from between the contact pieces, thus breaking the circuit. The 14 distributing switches are arranged on the two side

panels, seven on either side. Besides containing on the main dynamo circuits, the middle panel also ca one of Lord Kelvin's multicellular voltmeters with a way switch to put it on to either dynamo, and als ampere-gauge similar to the others, with a flexible att ment and plug arranged for taking the current th being taken by any of the 14 distributing circuits; th effected by one pole of the instrument being permane

connected to the main 'bus bar, and the other to flexible connection, which can be attached by means plug to either of the circuits on the lamps' side of switch, so that by thus opening the switch the whole of current of that circuit is passed through the ampere-m It will be observed that a shunt regulating resistanc fitted for each dynamo circuit.

The following nine circuits at present leave the m switchboard: (1) doctor's house, (2) operating theatre, nurses' home and winter garden, (4) erysipelas w (5) main building—east, (6) main building—central, main building—west, (8) laundry buildings, (9) patholog laboratory, with some spare circuits left for future ex sions. One pair of mains is carried from the main boar each of the above-mentioned points, and those going in direction of the main building of the infirmary run in

main duct, carried on insulators, mounted on galvanised iron brackets, spaced about 12ft. apart. Extra insulators are fitted for spare circuits when required. This duct is entered from the back of the switchboard, by means of an iron ladder. The mains going to the nurses' home and winter garden, erysipelas ward, etc., are carried in cast-iron pipes. All the mains from the main switchboard terminate in double-pole fuse distribution boards, fitted on the ground floor of each part of the building. From these boards a pair of mains is carried to each floor, and terminate in a branch distribution board, with a double-pole fuse for each circuit.

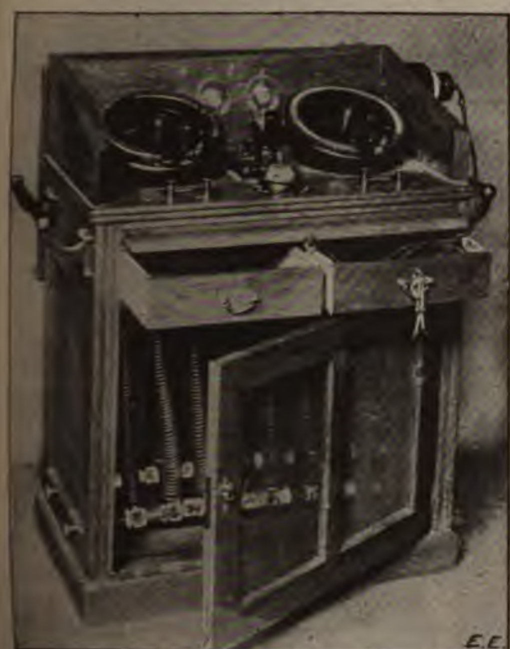


FIG. 5.—Surgical Lamp and Cautery Apparatus.

Wherever possible, the conductors are carried on the surface of the walls and ceilings in best pine casing, but when it is unavoidable, and they have to be placed under floors or out of sight, they are run in solid copper pipe, with suitable junction boxes, etc. The fuse boxes consist of polished [illegible] boxes, mounted in teak cases. Fuses are placed on each branch switch, but there are no fuses on the ceiling [illegible].

In the nurses' home, the lights, besides being provided with their own switch, have a main switch on each circuit fixed near the matron's room. All the corridor lights and [illegible] lights are on circuits by themselves. In the [illegible] the lights are in guarded bulkhead fittings, and are fitted with two-way switches, so that the lights may be turned on or off from either end of the duct. The lights on all the stairs are similarly wired with two switches. The hoists are fitted with lights connected to the circuit by means of strong flexible cords. There are eight-ampere sockets placed about the various 20 wards where required for the use of cautery instruments and other medical uses, and three similar ones fitted in the theatres for the same purpose. The total number of lights at present installed in the whole of the buildings consist of 1,181 16-c.p. lamps, 107 32-c.p. lamps, and 34 50-c.p. lamps. These all consist of plain brackets, plain pendants, or wall sockets with plain portable lamps, with the exception of principal entrance and rooms and doctor's house, and three watertight raising and lowering seven-light fittings in the operating theatre.

Special mention must be made of the manner in which the work in this last-mentioned department has been carried out. The needs of an up to-date operating theatre are chiefly that it should be quite incapable of harbouring microbes or germs of any kind, and for this result it must be able to be readily cleansed out with disinfectant in every hole and corner. It is thus evident that the whole system must be watertight, and not only the wiring, but the fittings also must be perfectly watertight. Furthermore, both wiring and fittings must be so arranged that no chinks or crevices are left for the accumulation of dirt. This at once prohibits the use of any method of pipes carried on the surface of the walls, and the spaces at the back of pipes are veritable dust-traps. On the other hand, any system of tubing beneath the surface would have to be so arranged as not to deteriorate, and also to be readily accessible for drawing in new wires if necessary. To meet these requirements, the consulting engineer decided to use heavy drawn copper tube, buried in the cement floors and behind the glazed brick walls. Suitable junction boxes are also provided for getting at the wires if necessary. This copper pipe ends in a metal wall box fixed flush to the wall, and a heavy brass bracket screws on to this by means of a kind of hose union. The wires throughout are $^{7}/_{22}$ S.W.G., and they are all carried direct into the lamp-holder terminals without joints of any kind. It is claimed that a jet of water could be played over any part of the building without doing any damage.

The pathological laboratory is also fitted throughout with the electric light, but as this is used in connection with the Glasgow University (which is adjoining the infirmary), the senate of this latter institution is charged for the energy used by meter.

FIG. 6.—Faradisation and Galvanisation Apparatus.

In connection with the operating theatre we must not forget to mention the medical apparatus, which has been especially designed by Mr. John Trotter, of Gordon-street, Glasgow, and manufactured by him in his own workshops for the university authorities. The accompanying photographs will doubtless prove of interest, as this branch of electrical work has not received much attention, and this

particular apparatus presents several features of interest, it being the first occasion, we believe, in which this class of apparatus has been arranged for working off the lighting circuit. Fig. 5 shows the resistance table for surgical lamps and cautery apparatus. The cases are of polished teak, panelled with strong brass-wire gauze, and contains a large resistance of manganese wire. Two-volt to 50-volt surgical lamps can be attached to the terminals on the left-hand side, and by means of the adjustable resistance lighted to any degree of incandescence required. Current for the cautery is taken from the right-hand terminals, instead of altering the resistance in series with the instrument, as in the case of the surgical lamps. A fixed resistance in the base passing 20 amperes is introduced into the circuit, and a small adjustable rheostat shown behind is put across the terminals, acting as a shunt to the cautery instrument. By adjusting in this way, not only is the current more readily controlled, but the surgeon, by means of the small switches on the handle of the cautery, can put the current on and off as required. Although these switches have barely $\frac{1}{32}$in. of a break, even with 20 amperes there is no tendency to arc. A switch is provided to cut off the current from the cautery circuit when not in use, and as when this switch is closed 20 amperes pass through the main resistance, whether the cautery is in use or not, a red warning lamp is provided to prevent waste.

The photograph Fig. 6 represents the apparatus for faradisation, galvanisation, and electrolysis. It can be attached by a flexible to any of the five-ampere sockets provided throughout the building. By means of the resistance seen on either side, the current for electrolysis or galvanisation can be regulated as required. The quantity is indicated by the milliampere-meter reading from 115 to 250 milliamperes. Switches are provided for reversing the current or for combining it with the faradaic circuit from the medical coil. The instruments are mounted on polished teak and are being provided with large rubber-tyred castors. A set of the instruments is being provided for each of the theatres.

Throughout the building all the work appears to have been carried out in a most substantial manner, and it reflects great credit upon Messrs. Mavor and Coulson for their execution of it, and Mr. Young's general arrangements show that he is well accustomed to the special needs of hospital work.

NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

[*Copyright.*]

LI.

These notes are written for practical men having a scientific foundation of elementary physics and chemistry, with a view to aid them to design and make reversible lead batteries, or accumulators, not as they have been, but as they should be, constructed. They are not intended to be theoretical beyond the point at which theory can be utilised in, or bears upon, practical work. A question arises as to where that point may be considered to be located. Certainly it is not necessary to consider and weigh the various theories which have been put forward to explain, in accordance with fundamental laws, the action of the reversible lead couple. Nor should we assume that it is possible at the present time to advance a theory perfect and accurate at every point. But I hold that the man who is practical, in the higher sense of the word, cannot work contentedly and satisfactorily to himself without having some clear conceptions of the causes involved in his results. *Felix qui potuit rerum cognoscere causas* is a maxim peculiarly applicable in his case. If he cannot find an accordant explanation, he likes to know, at least, why that should be the case—where the mistakes have been made and where the difficulties exist. When I tell such a man that I do not know the gaseous heat of oxygen—which is involved in some of our thermodynamic equations—and that, in spite of the fact that oxygen has been liquefied and solidified, I do not know that anybody knows it, his mind may be relieved and enlightened: he at least sees one of the h
have to be jumped before he can reach the g
you diminish a glaring discrepancy by making
a calorific value has been added where it shoul
subtracted, he is pleased to find himself sud
to a required explanation. So long as th
abstract, it is better to offer the practical m
rather than too little; for it can be *skippe*
place and be taken up afterwards at leisure.

LII.

A forcible illustration of the difference
thermic and endothermic compounds may be o
I have in this gasometer 3 dyad gramme e
132 grammes = 70·325 litres of carbonic anhyd
i.e., nearly $2\frac{1}{2}$ cubic feet of the gas. Also, i
have 2 dyad gramme equivalents = 36 gramm
I add the water to the contents of the gasome
with 42 grammes (3 gramme atoms) of nitrogen
(1 gramme atom) of oxygen, and 1 gramme
atom) of hydrogen. The total weight of
mixture is thus 227 grammes, or half a pound
Now if it were not for the presence of the 1 g
1 *crith* (11·19 litres)—of hydrogen, which tend
with one-half the quantity of oxygen also pr
free state, the contents of the gasometer woul
most inert and innocent character; the solution
of the carbonic anhydride in the water, with th
of carbonic acid (H_2CO_3), and a very slight
temperature, being the only actions occurring
exceptions mentioned, including the addition
of oxygen, the affinities are satisfied; the mol
compounds present having at some period *fal*
virtue of the affinities or attractive forces be
In regard to the uncombined hydrogen, we c
if it were required, bring about its comb
oxygen to form 9 grammes of water. What
to note, is that by so doing we should produ
of heat sufficient to raise 34,180 grammes, o
grammes of water from the temperature of 4d
of 5deg. C.—*i.e.*, 34,180 calories of Dulon
"grandes calories" (kilocalories), termed simp
by Continental engineers. Now, in cases wh
accuracy is out of the question (as in m
"calorific equivalents" arrived at indirectly
so small a unit as the calorie of Dulong is som
as well as inconvenient, and I propose theref
in these notes the *kilocalorie*. Referring to Sec
it will be seen that the foot-pound of work
open to objection than the small calorie, and I
be convenient, generally, to substitute for thi
as a mechanical unit of work, retaining also t
metre as the metrical unit of work. As the uni
work, the watt-hour $= \frac{1}{746}$ horse-power hour
neither too small nor too large. Thus we hav

$$\text{One watt-hour} = \begin{cases} \cdot 867 \text{ kilocalorie.} \\ 1\cdot 184 \text{ foot-ton} = \frac{1}{746} \text{ hors} \\ 367\cdot \text{ kilogrammetres.} \end{cases}$$

$$\text{One kilocalorie} = \begin{cases} 1\cdot 153 \text{ watt-hour.} \\ 1\cdot 361 \text{ foot-ton} = 0\cdot 00153 \\ \quad \text{hour.} \\ 423\cdot 3 \text{ kilogrammetres.} \end{cases}$$

To continue, if 1 gramme of H combining wi
of O evolves 34·18 kilocalories, what work
would it take to decompose our 36 grammes
the gasometer?

$34\cdot 18 \times 4 \times 1\cdot 361 = 185$ foot-tons (·209 horse-

Now, how many foot-tons of work woul
decompose our 132 grammes of CO_2 into
oxygen, and how should we set about
analysis? The sun—the great purveyor of e
ing that which it pleases us to say *we* exert
action of its chemical rays upon the leaf o
ing plant, readily effect the decomposition
anhydride; but to us, with all the resources of

difficulty. The only way I know is to pass the ated potassium or sodium, either of these metals with the oxygen and liberating the carbon. e may take it from a good authority (Thomsen) yad gramme equivalent of C, in combining lyad equivalents of gaseous O, evolves about ries; and thus it would theoretically require l of the same calories, or 397·5 foot-tons of lecompose our three dyad equivalents in the The remaining constituents of our mixture dy in the uncombined condition, the work we ire to expend in completing the decomposition ure is 186·6 + 397·5 = 584 foot-tons of work = power hour. (Note that the *compounds* contained meter are all exothermic, since they evolve heat mation and absorb heat in their decomposition.) ave in this porcelain dish nearly 5 (4·8) fluid a colourless, oily fluid resembling glycerine rom which compound, in fact, it has been probe following reaction:

$H_8O_3 + 3HNO_3 = C_3H_5(NO_2)_3O_3 + 3H_2O$.

e, from your sudden withdrawal to a respectful at you know what this compound is. Yes, it is ered by Sobrero in 1847, and termed by him ine ($C_3H_5(NO_2)_3O_3$). But pray come back; sure as this is, and if you understand its "little compound is by no means so dangerous as you ik. Indeed, I believe you could not readily explode ed. I assure you that, if you will let me apply ed match, this will be quenched in it; and the urn with a smoky flame, without explosion. heat it on an iron plate at a temperature below it will slowly evaporate, and ultimately take g rapidly, but not exploding. Well, if you fficient confidence in me, I will not try any with it; but merely remark that, if we did any portion of it, above 360deg. F., or if we lode by friction a minute portion of mercuric $HgC_2N_2O_2xH_2O$) in proximity to it, it would low a big hole through the table, render the and its contents quite unrecognisable, and r glass in the neighbourhood, but might cause r—as Henry Byron used to say he often did—pieces."

have to note is that the weight of this nitro- nd that of the several elements composing it, the same as in the mixture contained in the Thus: $C_3H_5(NO_2)_3O_3 = 3CO_2 + 2H_2O + 3N +$ e components of the mixture, as we have seen, r their decomposition a horse-power exerted re than 39 minutes; what amount of work is decompose the former? Well may you smile! and of nitro-glycerine certainly does not *absorb* its decomposition; for, if placed on the top of a ing between two and three tons, it will, if its ion be brought about by firing a fuse, explode port of a heavy gun, shattering the rock into a ieces. The compound is endothermic; it absorbs the various steps of its formation, and evolves its decomposition.

LIII.

e speak of the decomposition of a compound, we lose sight of the fact that this is ordinarily a ent of the molecules, in which more stable com- n those originally present are composed. Thus, mposition of organic compounds, albumen, fibrin, sein, gluten, etc., which are all endothermic, oken up, and H_2O, CO_2, HNO_3, H_2S, etc., which rmic, become formed with production of heat. compounds are there which, like the oxides of D and Au_2O_3) and the oxides of platinum (PtO , become decomposed into their ultimate elements. ards, the decomposition of a compound seldom nalysis; it cannot be said to occur by *synthesis*, hose about to combine are not free; it takes tathesis or interchange. Even in the case of which the dyad metal is combined with two dyad ing four combining links free in the double molecule, the decomposition which is brought about by a comparatively slight elevation of temperature results in the formation of a compound (Pb_2O_3) of greater stability, having but two free links. When by the action of some determining cause, such as a rise of temperature, the actinism of the solar rays or a vibratory shock, metathesis occurs, the energy developed must obviously be proportionate to the difference between the active and resisting affinities in play. In the case of nitro-glycerine, a compound produced by the reaction between two endothermic bodies, the constituent affinities, which become the resisting affinities, are feeble; whilst the active affinities brought into play by the cause determining metathesis, and resulting in the formation of CO_2 and H_2O, are, as we perceive from the heat attending such formation, of the most energetic character. Thus the energy which would be rendered kinetic by the *decomposition* of our 227 grammes of nitro-glycerine can scarcely be much less than the 584 foot-tons of which the heat value is evolved in the *composition* of 3 dyad gramme equivalents of CO_2 and 2 of H_2O.

LIV.

Stored energy—potential ($f\,s$) or kinetic ($m\,\frac{v^2}{2}$, in absolute measure)—is, in ordinary parlance, *expended* in the production of work ($f\,l$). But all work is necessarily a storage of energy. Work, then, is the conversion of one form of stored energy into another; although we measure work by the quantity of energy converted. Energy is rendered potential by the separation of (*a*) masses, or (*b*) molecules and atoms. Potential energy is rendered kinetic by the falling together (accessus) of (*a*) masses, or (*b*) molecules and atoms. In our solar system, the sun (LII.) is, so far as I know, the sole agent, with one exception, which, directly or indirectly, effects the storage of energy by the separation of masses or of molecules and atoms. The exception is the moon, which aids in storing the energy developed in the tidal ebb and flow.

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week:

SATURDAY, JAN. 8.—Royal Institution, Albemarle-street, 3 p.m., Prof. Oliver Lodge's last lecture on "The Principles of the Electric Telegraph."

MONDAY, JAN. 10.—Institution of Civil Engineers (Glasgow Association of Students), second annual general meeting, Institution Rooms, 207, Bath-street, Glasgow, 7.45 p.m.; "The Present and Prospective Uses of Electricity on Board Ship," by Mr. E George Tidd, A.M.I.C.E., A.I.E.E., etc.

TUESDAY, JAN. 11.—Röntgen Society, 11, Chandos-street, Cavendish-square, W., general meeting, 8.30 p.m.; "Practical Work with the X-Rays," by Mr. W. Webster, F.C.S.—Institution of Civil Engineers, Great George-street, Westminster, S.W., ordinary meeting, 8 p.m., "The Machinery Used in the Manufacture of Cordite," by Mr. E. W. Anderson, A.M.I.C.E.—Royal Colonial Institute. Northumberland-avenue, meeting at the Whitehall Rooms, Hôtel Métropole, 8 p.m., "The Goldfields of Ontario and British Columbia" (with lantern illustrations), by Mr. Edgar P. Rathbone, M.I.E.E., A M.I.C.E, etc.

WEDNESDAY, JAN. 12.—Society of Arts, John-street, Adelphi, juvenile lecture (No. 2), 7 p.m., "Fire," by Prof. W. Ramsay, Ph.D., F.R.S.

THURSDAY, JAN. 13.—Institution of Electrical Engineers, ordinary general meeting at Institution of Civil Engineers, Westminster, 8 p.m., presentation of premiums and inaugural address of the President (Mr. Joseph W. Swan, F.R.S.).

FRIDAY, JAN. 14.—Institution of Civil Engineers, Westminster, students' meeting, 8 p.m., "Mechanical Draught," by Mr. R. Gordon Mackay, Stud.Inst.C.E.

The X-Rays in Warfare.—A mail letter in the *Daily News* says that the Röntgen rays have been of the greatest service to the medical officers with the Indian frontier force. Bullets have been extracted and limbs set which would have presented great difficulties but for the rays, and the negative results obtained have been of great use, too, in showing that a bullet is not embedded or a limb broken. Where there have been severe contusions—considering that the total casualties in this campaign already amount to something like 700—the Röntgen rays have had a most extensive trial, and the results have been most satisfactory.

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TO CORRESPONDENTS.

 Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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Vol. XIX. of new series of "THE ELECTRICAL ENGINEER" *can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.*

FINANCE AND TRACTION.

It is now nearing a couple of years since, in to some remarks of ours hinting that tracti would hardly develop at the rapid rate som advocates imagined, we were assured the c would be the case. Time has proved our tion. But we are glad to say that at last ther to be a better indication that progress will rapid. Progress, however, is not spontan has be assisted. So far as municipalities cerned, our remarks will not apply. A few y the tramway companies in the United Kingd generally in a moribund condition. Here an were some flourishing concerns, but these w and far between. The value of electric was urged. It was shown to be taking rapid in America, but there the conditions differed from those holding here. Even the promises of electric traction exploiter been fulfilled, very, very few of the comp Great Britain were in a position to take these advantages. They had no mone could not get money. The manufacturin panies of America and Germany were the solve the problem. They obtained a con influence of suitable tramway concerns, gested new lines, found the money for the from one form of traction to the other, and out that change. When a close examination into the various concerns, it will be found say, the initiative has been from witho the money has come from without. His but repeating itself in all this, for the devel of central-station work arose much in the sa Elsewhere in this issue we give a diagram what we may term the appreciation of share in various central stations that are in the of private companies. Of course we cannot p nor would it do to prophesy, that t undertakings under similar management w similarly remunerative. There are electri companies and electric light companies, there are tramway concerns and tramway co Some businesses will never prove satisfact we may venture to say that, in our opinio chosen, well-managed, and well-equipped tr schemes will succeed as well as purely schemes. The ideal state would perhaps be bination of the two, and it is only this consid that renders us favourable to the view of mu isation of tramways. It is now an open secr the system here described—namely, the ob a controlling interest in existing tramway and the energetic exploitation of new sche being actively carried on around us, and in t future some of these schemes will be ripe fo to be commenced.

SECRECY.

The daily papers informed us a few day that during the whole period of the imbroglio, cypher messages had been passin stantly between the Government here a representatives of this country in China.

information also said that though endeavours had been made by interested parties to read the cypher, the attempt had hitherto failed. There are some experts who contend that, given time and patience, any cypher message can be read, but Mr. Rice claims to have devised a system by which absolute secrecy is attainable. Be that as it may, our question is the old one—Why is this country so lax as regards strategical cables as to be unable to send messages that do not come into the hands and under the eyes of possible rivals? We have had sent us a map on Mercator's projection of the world's telegraphic system, 1897, by Charles Bright, which shows clearly that under any ordinary circumstances all our messages, important from an Imperial point of view or not, do pass through places over which possible rivals have control. Our patriotism seems to lie in the direction of telling everybody what you are doing, and taking the chance of the chapter of accidents to come out ahead. We rely on the secrecy of our cypher, but surely it would be better to have a double check such as would obtain if the communicating lines passed through none but our own possessions. What is the position of affairs with regard to that Pacific cable, which ought to be the connecting link in the chain of telegraphic communication we desire?

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

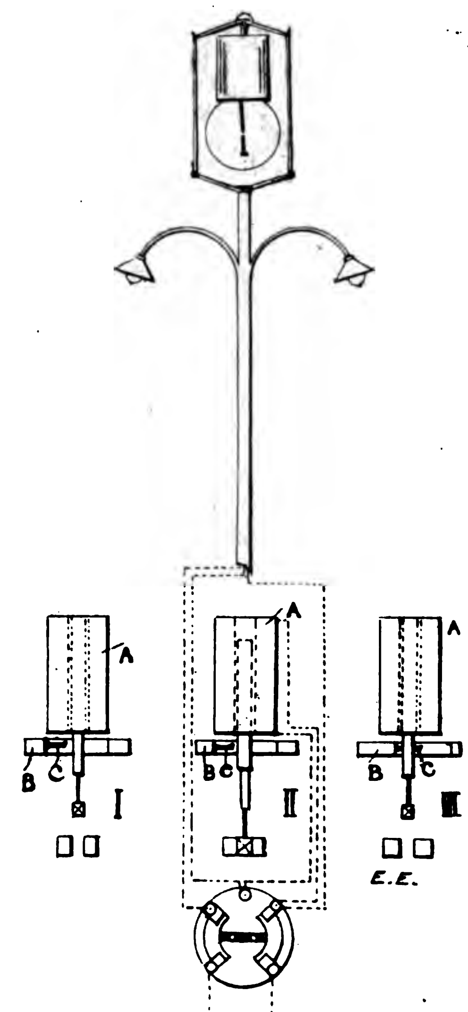
EDMUND'S AUTOMATIC SWITCH.

SIR,—The following diagram may help your last week's enquirer to understand the working of the Edmund's automatic public lighting switch. My previous explanation was, perhaps, too briefly put to be intelligible.

The objects of this switch, apart from the usual and obvious one, seem to be: (1) The substitution of incandescents for arcs, and *vice versâ*, for the public lighting, controlled from the lighting works. In respectable communities there is not much need of a blaze of light all night long, and it is no saving to send men round to switch out arcs and switch in incandescents by hand. The substitution effects an economy in current and also in trimming labour and material. (2) The replacing of individual arcs by incandescents, in the event of the lamp mechanism failing to act, which is not uncommon with continuous-current lamps. (3) The extinguishing of the incandescents. The arcs are taken off the usual series circuits, and the incandescents come off the private lighting circuits.

The solenoid, A, is in series with the arc, so that when current flows, the core, to which the switch lever is attached, is sucked up, as in I., out of the incandescent contacts. When the arc current is switched off the cores drop, as in II., thus putting in the incandescents. So far, the continuous-current and alternating-current types are somewhat similar in working; but when it comes to switching out the incandescents the continuous-current switch utilises a pivoted permanent magnet, B, placed with the poles near the end of the solenoid. This permanent magnet has a catch, C, which on a reverse current being sent through the arc circuit hooks under the sucked-up core, and prevents it falling down when this momentary current ceases. This keeps the core up during the day. When lighting-up time comes again the ordinary arc current attracts the magnet to its disengagement position, and all is ready for the incandescents to come on at, say, midnight.

Where alternating current is used a magnet would be no good, not to mention a reversed current, so a cam action combined with a halved current impulse replaces it. Before lighting up, the core is held in the off position by a pin (which had been brought into action by the halved current), and when the arc current comes on it disengages the pin, so that when the arcs are cut off at, say, midnight the core drops by gravity to position II. (incandescents in). A switching on of *half* the arc current then cuts off the incandescents and pins the core up to position III., where it stays the rest of the day.



EDMUNDS AUTOMATIC PUBLIC LIGHTING SWITCH
CONTINUOUS CURRENT TYPE
DETAILS of WORKING.

Trusting this may be a sufficiently explicit description of an apparatus that is now working successfully in several English towns—Yours, etc., J. H. C. B.

REVIEWS.

Electrical Traction. By ERNEST WILSON, Whit.Sch., M.I.E.E. Edwin Arnold, London. Price 5s.

This book bears too close a resemblance in title to that entitled "Electric Traction," by the late A. Reckenzaun, otherwise these two books have not much in common. The work consists of ten chapters and an appendix, the latter giving the text of the Board of Trade regulations for Blackpool, South Dublin, etc. There is also a good index, the lack of which detracts so much from Dr. Louis Bell's otherwise admirable work. As might be expected, Mr. Wilson deals more fully with some of the details of Prof. John Hopkinson's work than do previous writers. The introductory chapter touches briefly on the tractive agents used on street railways or tramways—these are horse, steam, cable, and electricity. In a short table we are told "the following figures represent roughly the average results obtained in practice: horse, 9d. to 12d.; steam, 12d.;

cable, 9d.; electricity, 5d." That is, these figures give the "cost of driving a tramcar one mile under the different systems." It may be doubted whether electricity is not a little too favourably treated in this comparison, and, further, it may be asked to which of the electrical systems does this figure apply. The question of adhesion and tractive force is treated at some length, and it is stated that the tractive effort required by a South London Railway train is "about 216lb. per ton of locomotive, or 73lb. per ton of train, the weight of the locomotive being taken as 13·5 tons, and the complete train as 40 tons." It is pointed out that the conditions in the subway differ from those in the open, and thus the suggestion is given, "if 200lb. per ton on the driving wheels be taken as the basis for the lowest limit of adhesion, it will not be far wrong."

The second chapter deals with the direct-current motor and its control, noticing first the classification of armatures into slotted and smooth core, the former type being preferred in America, the latter in Europe. Their advantages and disadvantages are discussed, but no very definite verdict is given for either. The general theory is discussed, with special practical illustrations of the motors on the Siemens locomotives described by Mr. Greathead in his paper at the Civil Engineers. Methods of control and various types of motor are described. It is exceedingly difficult to arrange the information in any book so that the minimum trouble arises in consultation, and perhaps it was impossible to have all the information about motor tests at one place; hence we get on p. 44 the results of a test of a Westinghouse motor, on p. 88 the Leeds tramcar test, while the results of other tests are given by means of curves and tabulations in what may really be termed the natural position of such information. We now come to the chapter on overhead and overground conductor systems. Here the usual method is followed, giving a brief reference to the systems—their advantages and disadvantages; then pointing out certain information necessary before commencing the design of any scheme, and showing by means of figures how the information is used. The discussion on feeders is clear and to the point, and a suggestion is made for an alteration of the Board of Trade regulations. The author would prefer a regulation to the effect "that the maximum potential difference between any two points of the rails shall not exceed such a potential difference as it can be demonstrated will not be injurious." A regulation such as the suggested one would be all very well when capable engineers were employed in the design, construction, and working of lines, but we should hesitate to trust the knowledge of some engineers. It is better, at present, to be on the safe side and to have stringent regulations rather than to err on the side of laxity. There is a good deal of exceedingly useful information in this chapter; not only on the points we have mentioned, but as regards conductors and details of construction generally. Having referred to several chapters at some length, we must restrict our further remarks to generalities. The author seems to have but a scant idea of the literature of his subject. One technical paper alone seems to possess his confidence, and some of his references are a little old. We should have thought, for example, that Dr. Bell's discussion on joints merited consideration, and might have been cited as authoritative if the author could not or did not care to give personally-obtained figures on the subject. Surely bonding is not uncommon, and there could be little difficulty in giving actual figures obtained in practice. Perhaps, as this is almost the only adverse criticism we have to make, we are making too much of it, yet we think in this so important a matter an ounce of practice is worth a ton of theory. These remarks hold good not only to the question of bonding, but also to tractive resistance. Surely the old figures could have been replaced by those from more modern experiments. The succinct descriptions of the various conduit systems and the suggestions for a surface-contact system are very good; and the chapter on storage cells contains much that will prove interesting, especially as to the details of the Leeds installation. The chapter treating of alternate and direct currents touches a good many delicate and as yet unsolved questions in an admirable manner, giving credit when it is due for opinions held; and the author has caught well hold of *the* question involved in all kinds of work, not only electrical, in that the purpose is "to carry out the scheme with maximum efficiency, having due regard to expenditure of money." This really is the text of the chapter on efficiency, and the points are again put clearly and temperately, and illustrated by reference to installations at work. A chapter on the power-house finishes the book proper, and is followed, as previously stated, by an appendix and index. Altogether, the author has compressed into a very handy volume considerable information of an intensely practical character.

Catalogo delle Opere di Elettricita e Magnetismo pubblicate in Italia ed all 'Estero negli Anni 1885 1897. By CARLO CLAUSEN, bookseller to the King and Queen of Italy, etc. Via Po 19, Turin. 1 bimestre, 1898.

This catalogue of works on electricity and magnetism (172 pages) which have been published during the last 13 years in all countries is splendidly arranged, and the price (1 lira, or 10d.) should not deter anyone desirous of possessing a complete bibliography of the literature dealing with these branches. After enumerating the works under an alphabetical list of authors, giving the full titles of the works in their original language, a classified index is given, and also a list of English, Italian, German, French, Belgian, American, Spanish, Dutch, and Danish periodicals dealing with electricity and magnetism.

THE ELECTROTHERM.

The name "Electrotherm" has been given to an electric heating pad now being put on the market by the Edison and Swan Company. The illustration herewith gives a general idea of the pad, but the following few lines will serve to explain the purpose and uses of this new appliance. The pad consists of insulated resistance wire protected by asbestos, and woven into a pad about ¼in. thick. The resistance is then connected by an ordinary flexible cord and plug to any lamp socket on an electric light circuit. The electrotherms are now made for any voltage from 5 up to 125 volts. The manufacturers recommend that when they are required for 200-volt circuits the 100-volt pad

should be used in series with a 16-c.p. lamp. From this, some idea of the current taken may be gathered. As to the uses of the pad, the following quotation gives an outline of its applications: "The Electrotherm heating pad will be found a great convenience in the relief of general chilliness, cold feet, cramps, and other local pains. Its value and efficiency will be greatly appreciated in cases of rheumatism, neuralgia, pneumonia, bronchial affections, croup, bowel complaints, sluggish circulation, etc., and wherever the application of artificial heat is desired. By its use the risk and discomfort of frequent changes of temperature incident to the renewal of ordinary hot applications are entirely obviated. When the effect of a poultice or moist heat is desired, it should be applied over one or two thicknesses of damp flannel. The pad can be safely used by anyone." The simplicity and cheapness of operation, its cleanliness and convenience, and the great relief and comfort afforded by the Electrotherm will be another incentive to the adoption of electric lighting in private houses.

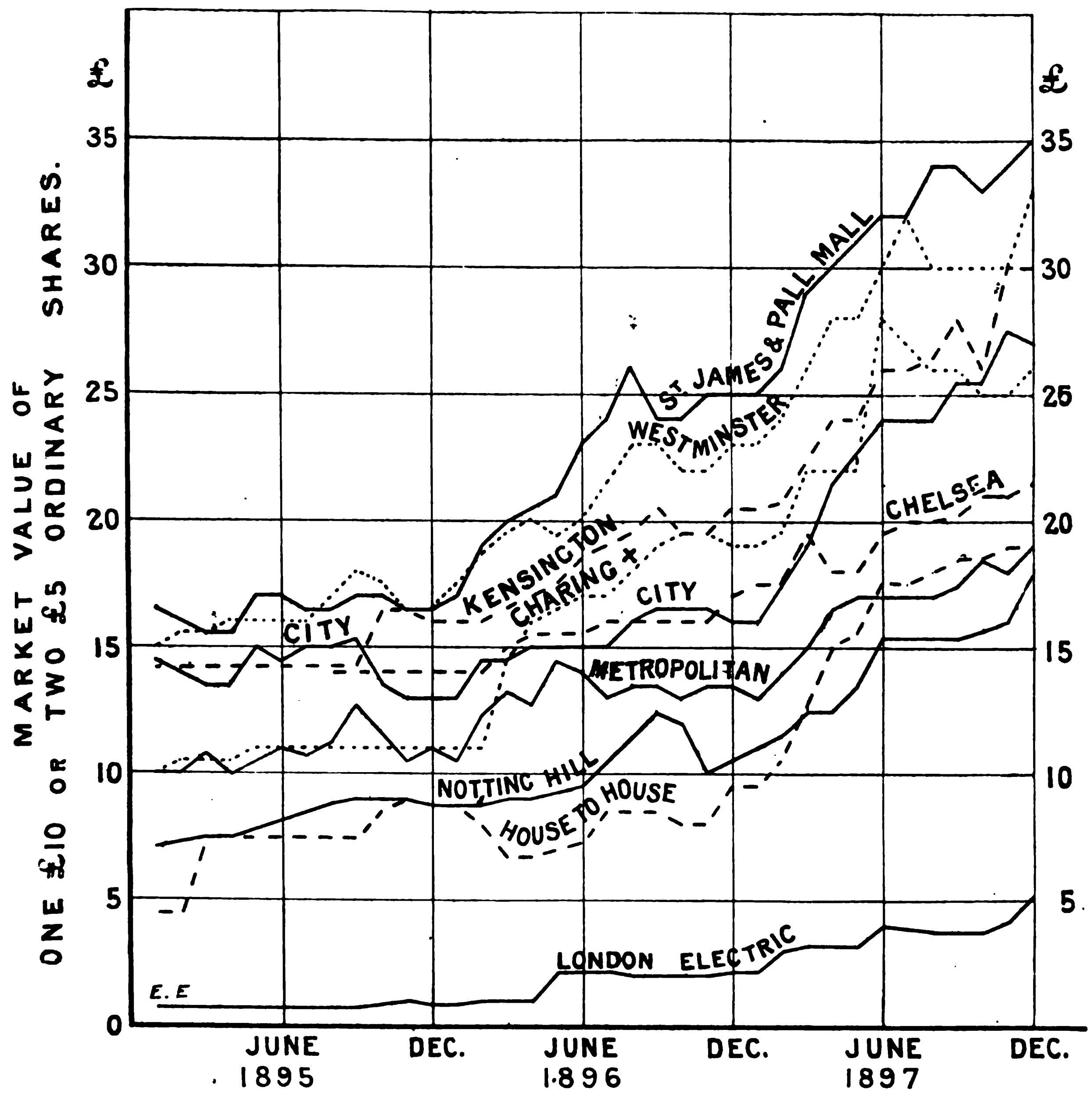
The problem of maintaining an even temperature by the Electrotherm is, however, not so easy as at first sight appears.

This is so because the coverings placed over the apparatus vary the resistance to the transmission of heat, and hence the final temperature with a given expenditure of electric energy. To regulate this final temperature, the makers supply a regulating switch, by which extra resistance is placed in the circuit. There are three steps in this switch, corresponding roughly to temperatures of 130deg., 160deg., and 200deg. F. respectively. Over and above this a thermostat can be supplied if desired, which will regulate the temperature absolutely by cutting off the current when the desired temperature has been reached.

With these accessions we think the Electrotherm the most useful piece of electric heating apparatus that has yet been devised, as it produces results which cannot be obtained by other means.

ELECTRIC LIGHTING COMPANIES' SHARES.

The past year has seen an unprecedented rise in the value of the shares of electric lighting companies, and we are glad to note that the increased value is warranted. For the purpose of showing clearly what the increase in the value of the ordinary shares of the 10 London electric lighting companies has been, we have had the following diagram prepared. The period selected goes back to the beginning of 1895, so that the variation in the value of the shares for the last three years can be seen. In 1895 all the companies had been at work for some time, and had experiences common to the pioneers of all new undertakings. It is worthy of note, therefore, that at that date only three had their ordinary shares below par. In 1895, the curves show fluctuations, but no considerable rises. In the next year, 1896, it will be noticed that the majority of the shares rose rapidly, and during 1897 the increase has been even more marked. The monetary value of the increase in these shares during the past 12 months we have calculated on the number of ordinary shares issued in January, 1896. The increase reaches the enormous sum of £1,900,000. This sum is the rise in value of the



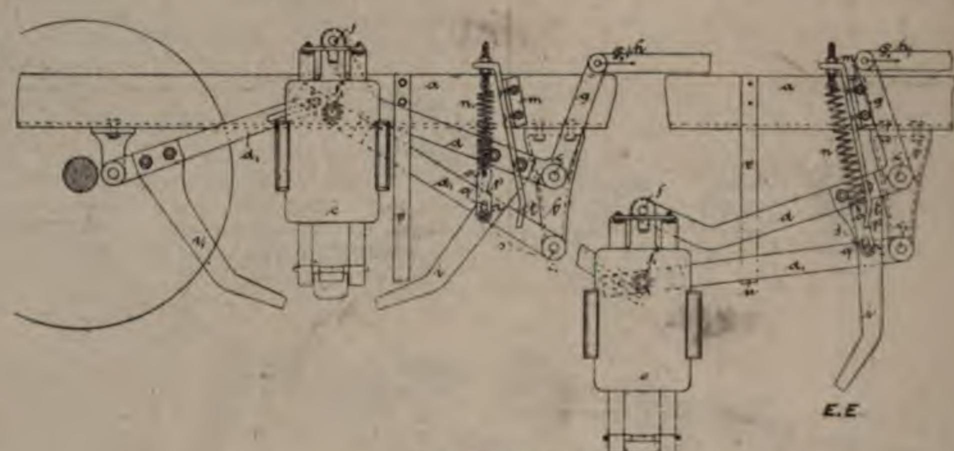
ordinary shares alone. The preference shares in certain cases show a considerable rise in their market value, which should be added to the above to get the total increase. During the year the Westminster Company have redeemed its founders' shares. It was agreed to give 120 ordinary shares for each of these founders' shares, and as the ordinary shares at the time stood at £15, this represented a total of £1,800 per share. We are glad to note that the London Electric Company's shares are rising with the rest, and that the shareholders who have kept their scrip through the dark days of the company have now a chance of a return.

This winter so far has been a good one for the electric lighting on account of the foggy weather experienced. As the actual value of the fog to the companies is of interest, we have obtained the actual figures for Dec. 23. Some of the companies do not wish their detailed figures published, and hence the following totals must be given without their components. The actual increase in output for the day in question was 46,000 units, and from the average charges

for current, the total cost of the fog to the consumers amounted to about £1,200. It must be remembered that a foggy day in October, when the evenings are lighter, will cause more extra expense than a fog in December. A few detailed figures will be of interest. Thus the House-to-House Company delivered 8,200 units that day, of which 2,700 were estimated to be demanded on account of the fog. This shows an increase of 49 per cent. on what the demand would have been on a clear day. In the City of London, where so much basement lighting is required, the increase due to the fog was, roughly, 28 per cent. Again, the minimum load on the 23rd at the House-to-House Company's station was 781 kw., so that the output represented a 10½ hours' run at the load. The Pall Mall Company had a maximum load of 2,460 kw., with an output of about 20,000 units, of which about 5,000 units were due to fog.

A NEW CONTACT PLOUGH FOR CONDUIT LINES.

The illustrations herewith show the details of a new contact plough recently patented by the Union Elektricitäts Gesellschaft, of Berlin. The plough is so constructed that it is automatically lifted out of the conduit in the event of the slot being obstructed by any foreign substance. The bracket, *b c* (Figs. 1 and 2), is bolted on to the longitudinal frame of the car. On this bracket the two levers, *d* and *d'*, are pivoted by the bolts *c* and *c'*. The contact plough, *e*, is suspended on these levers by the bolts *f* and *f'* in such a way that the plough is free to turn on the bolts, and that the lines between these bolts or pivots, *f f'*, *c c'*, form a parallelogram. This ensures that the plough is always held in a vertical position. The lever arms, *d* and *g*, are in one piece, and to the end of *g* is attached the rod, *h*, which extends to the platform of the car. This bar is used by the con ductor to lift the plough out of the slot when required. The lever *d* also carries the small link, *o*, to which the spring, *m*, is attached. The notch, *p*, in this link engages when the plough is down with the stop, *t*. This stop is bolted to the car frame at *m*. The path of motion of the pivot, *r*, is shown in the drawing. Thus the plough cannot be lifted by the spring while the stop is engaged in the notch, *p*. As the car moves, however, if the lever, *i*, which is in the slot, meets with an obstacle, the lever *d* begins to revolve round *c*. In this way, after a small movement, the catch is released, and the spring then raises the plough completely out of the slot. A second lever, i_1 d_2, on the other side of the plough gives the release in a similar way if the car is travelling in the opposite direction. The arrangements of the current collectors on the plough were described in a recent issue of our paper. The collectors are so arranged that they do not prevent the plough being withdrawn at any part of the line. The above arrangement tends not only to lift the plough when an obstacle is met, but the levers *i* and i_1 also prevent the plough itself from receiving the shocks caused by meeting such obstacles.



Figs. 1 and 2.

GUTTAPERCHA.*

BY DR. EUGENE F. A. OBACH, F.I.C., F.C.S., M.I.E.E.

Lecture I.

The Raw Material.—The year 1847—Early history and the Society of Arts—General properties and distinction from caoutchouc—Botanical derivation—Geographical distribution—Expeditions in search of gutta trees—Experimental cultivation—Analysis of particular specimens—Analysis of various commercial brands—Exports from Singapore—Imports into the United Kingdom—Fluctuation of prices.

The Year 1847.

The year 1847 will ever remain a memorable one in the annals of the guttapercha industry. It was in that year that the plant from which this valuable economic product is derived was first named and illustrated by Sir William Jackson Hooker, the famous director of the Royal Gardens at Kew, and during the same year that Dr. Ernst Werner von Siemens, then a lieutenant of artillery in the Prussian army, employed guttapercha for the electric insulation of subterranean telegraph lines, and designed a machine by means of which wire could be continuously covered with this material. This, with but slight modifications, is still in use at the present day.

The Society of Arts having from the very first taken a keen interest in the welfare of the guttapercha industry, it was considered opportune to devote the opening course of Cantor lectures of the present session to a consideration of this subject, and to survey the progress made during the 50 years of existence of this industry.

It is not, however, the first time that guttapercha forms the subject of a Cantor lecture. In February and March, 1880, Mr. Thomas Bolas delivered a course of six lectures on "The Indiarubber and Guttapercha Industries" before this society, which, I well remember, were greatly appreciated by those who had the privilege of hearing them. Mr. Bolas, however, was only able to devote a single evening to guttapercha, and considering the far greater importance and complexity of the rubber industry, this was perfectly justifiable, but I imagine he must have felt a little embarrassed in having to compress the whole subject into so small a compass. For this reason, and owing to the liberality of our esteemed chairman to-night, Mr. Alexander Siemens, in allowing me to lay before you the results of various experimental researches carried out by me in the laboratory of Messrs. Siemens Bros. and Co. during the last 20 years, which have not hitherto been described, I was emboldened to recur to this subject and to devote three entire evenings to its consideration. In doing so, I am fully aware that the exaggerated expectations which were held when guttapercha was first brought to the notice of the technical world were not fully realised, yet there are even at the present day certain important applications of this material from which it is well-nigh indispensable, and in which no other hitherto known substance, not even the closely related caoutchouc, can take its place. Amongst these, let me now only remind you of the most important one—viz., the manufacture of submarine telegraph cables, without which the immense progress of the last 45 years would have been quite impossible.

In preparing these lectures, I endeavoured to do equal justice to the various aspects of the subject, and to amalgamate the results of scientific research with those of practical experience, since it is my firm belief that no industry can continue to prosper without the aid of scientific research.

Early History and the Society of Arts.

The early history of our subject is not without its charm; and, although I may not perhaps be able to contribute much towards it which is entirely novel, yet I venture to hope that

* Cantor Lectures delivered before the Society of Arts.

the brief historical account I am able to give you to-night will be of some interest, inasmuch as I obtained my information first-hand from original sources, which, as you all know, are sometimes difficult to procure.

It appears that the first specimen of guttapercha was brought to Europe by those indefatigable travellers and curiosity-hunters, the Tradescants, father and son, about the middle of the seventeenth century. In a little book by John Tradescant, the younger, entitled "Musaeum Tradescantianum, or a Collection of Rarities preserved at South Lambeth, neer London," published in 1656, which I hold in my hand, there occurs (p. 44), amongst a list of various "rarities," such as an "Indian fiddle," "birds' nests from China," "blood that rained in the Isle of Wight," etc., the following interesting object—viz., "The plyable Mazer wood, being warmed in water, will work to any form." This is considered to apply to guttapercha, since we know of no other material suitable for mazers or goblets which possesses the remarkable property of softening in warm water, so that it can be worked into any desired shape or form as here stated. At first it may perhaps appear strange that this material should be described as "wood," but, after all, it is not so very surprising, if it be considered that guttapercha, as formerly prepared by the natives, was of a light yellowish-brown colour, much resembling that of many varieties of wood, and also showed a decidedly fibrous texture, so that even an experienced observer has been led astray, as I shall be able to prove to you later on.

On the death of the younger Tradescant, in 1662, the "Collection of Rarities" came into the possession of the famous Elias Ashmole, who transferred it to Oxford, where it formed the nucleus of the Ashmolean Museum, opened in 1683. I thought it might perhaps be possible to ascertain what finally became of the specimen of mazer wood there, but I am informed by the assistant keeper of the Ashmolean Museum that it is now neither at that museum nor at the botanic garden at Oxford.

Throught the courtesy of a friend at the British Museum, I am able to show you on the screen to-night the portraits of the two Tradescants, which were taken from engravings by their celebrated contemporary and friend Wentzel Hollar, and contained in the little book I mentioned. My own copy has unfortunately been deprived of these valuable engravings by one of the "Hollar" collectors—indeed, almost every copy of this rare book had been plundered of them already in the middle of the last century.

Although the "Tradescants' Ark," as the museum was popularly called, "attracted the curiosity of the age, and was much frequented by the great," including amongst its benefactors even King Charles and the Queen, yet it appears that the remarkable properties of the "mazer wood" passed quite unnoticed by practical men, and the specimen was considered merely a "rarity," as was the wont of the age. It was reserved for our own century, so prominent by its practical application of every available product, to rediscover the valuable substance, and to apply it in the arts and manufactures under the name of guttapercha. Curiously enough, in the year 1843 there appeared two rival claimants for the honour of reintroducing this material into Europe, both residents of Singapore and both belonging to the medical profession. The one, evidently of Spanish descent, Dr. José D'Almeida, brought specimens with him to London in the spring of that year and presented them to the Royal Asiatic Society; the other of Scottish descent, Dr. William Montgomerie, sent samples to the Society of Arts, through his brother-in-law, Mr. H. Gouger, during the summer of that year. Dr. D'Almeida's specimens are described as consisting of "a ridi g whip, made of the concrete milk of a tree indigenous in Singapore, called guttapercha by the Malays, also a specimen of the concrete milk in the lump," the remark being made that "it becomes ductile by being placed in hot water." Dr. Montgomerie's specimens consisted of the following: "One bottle of the juice; specimens of thin sheets, resembling scraps of leather; specimens in a spongy mass as it concretes in a vessel; specimens of the substance formed into a mass by agglutinating the thin sheets by means of hot water." The secretary of the Royal Asiatic Society acknowledged the receipt of the specimens in a letter dated April 8, 1843, and handed a portion of the raw material to Dr. J. F. Royle for analysis, D'Almeida himself having previously given a piece of it to Mr. W. C. Crane for the same purpose. It appears, however, that neither of these gentlemen made any experiments with the material, and no immediate practical result followed from submitting the specimens to the Asiatic Society. Luckily such was not the case with the specimens sent to the Society of Arts. In a meeting held on Nov. 30, 1843, and, therefore, just 54 years ago to-morrow, the Joint Committee of Chemistry, Colonies, and Trade "took into consideration specimens of a substance called 'guttapercha,' from Singapore, sent to the Society by Dr. Montgomerie," and at a subsequent committee meeting, held on Jan. 23, 1845, with Prof. E. Solly in the chair, it was resolved "that this substance appears to be a very valuable article, and might be employed with great advantage in many of the arts and manufactures of the country." At an ordinary weekly meeting on March 19, 1845, the secretary, Mr. Francis Whishaw, described the specimens, and showed a piece of pipe and a lathe band of guttapercha, made by him, which were afterwards exhibited at the Great Exhibition of 1851; he also covered the bottle, which originally contained the "milky juice," with guttapercha softened in hot water, and produced some good impressions of medals. It was at this meeting that Mr. Christopher Nickols first became acquainted with guttapercha, and was so impressed with its valuable properties that he induced Messrs. Wilkinson and Jewesbury, a firm doing business with Singapore, to import a small quantity for experimental purposes. It was also evidently at that same meeting that Mr. (afterwards Sir) William Siemens, became acquainted with the new material, and obtained the sample which he subsequently sent to his brother Werner in Berlin, to try whether it was suitable for insulating telegraph wires, a proposal which has had such far-reaching consequences.

The Society of Arts having thus early recognised the great practical importance of Dr. Montgomerie's discovery, it was not surprising that on June 2, 1845, it awarded him its gold medal. This act on the part of our society has been severely criticised, and it was blamed for rewarding Montgomerie and passing over D'Almeida, whose services in rediscovering guttapercha were said to be equally great; but not only did the last-named gentleman address his specimens to a totally different society, he was also behind his rival in point of time, inasmuch as Dr. Montgomerie had already submitted samples of guttapercha to the Bengal Medical Board previous to those forwarded to London. These specimens were accompanied by a letter, dated March 1, 1843, which shows without a doubt that Montgomerie had already then personally acquainted himself with the principal properties of the new material and ascertained its suitability for surgical instruments, and its superiority over caoutchouc for that purpose in tropical climates. This letter, together with some of the specimens, was sent to the Agricultural and Horticultural Society of India for publication by Dr. Fred. Mouat, chemical examiner to the Government at Calcutta, and, as it forms the first published record referring to guttapercha, after the more or less apocryphal quotation in the Tradescant catalogue, it is of great historical interest, and will be reprinted in an appendix to these lectures.

The specimens submitted to our society were likewise accompanied by a memorandum from Dr. Montgomerie, in which he makes similar remarks, and on Oct. 26, 1846, he wrote to the editor of the *Mechanics' Magazine*, entering more fully into the early history of the subject. He states that he first became acquainted with guttapercha in 1822, when he acted as assistant surgeon to the Presidency in Singapore, but lost sight of it until in 1842 he noticed in the hands of a Malay woodman a parang (wood-chopper) the handle of which consisted of a substance which appeared new to him. His curiosity was still further aroused when he learnt that the material had the remarkable property of becoming soft and plastic like clay in boiling water, and he at once possessed himself of the article and asked the Malay to procure as much of the substance as he possibly could. Dr. Montgomerie's communication to the *Mechanics' Magazine* was followed by an able contribution from the pen of his successor in office, Senior Surgeon Dr. Thomas Oxley, to the first number of the *Journal of the Indian Archipelago and Eastern Asia*, which appeared in July, 1847. In this article Dr. Oxley gives an interesting general description of the guttapercha tree, its leaves, blossoms, etc.—the fruit he had not seen—and describes the way in which the guttapercha is obtained from it. He also recommends the use of this substance for surgical appliances, such as bandages, splints, syringes, capsules for vaccine virus, etc.; but I must not go any further into details, as I shall have occasion later on to recur to this interesting article in connection with other subjects, and I will now say a few more words about the connection of the Society of Arts with the development of the guttapercha industry.

The interest taken by the society in this matter by no means ended after rewarding the gentleman who first introduced the material to its notice, and we find that in October, 1854, a premium was offered for the discovery and production to the society of any new substance which could be successfully employed as a substitute for guttapercha, and in November, 1863, the society's medal was again offered "for any new substance or compound which may be employed as a substitute for indiarubber or guttapercha in the arts and manufactures."

On Feb. 24, 1858, the council of the society appointed a committee "to direct the institution of a series of experiments on guttapercha, and to report from time to time such observations as may appear to elucidate the nature and cause of its decay, the different qualities of the substance, modes of detecting adulterations, or any points valuable to the manufacturer or to those who use it.' This committee included amongst its members such well-known scientific men and technical experts as Prof. Edward Solly, Prof. John Lindley, Sir William

Siemens, Mr. Latimer Clark, Mr. Edward Highton, and others. After the committee had met several times, a circular was issued containing a number of questions, with a view of obtaining as much information as possible from those able to give it outside the society. Some of these questions have since been answered satisfactorily, but others remain unanswered up to the present day.

It is interesting to learn that already at that early period sad experiences must have been had with guttapercha, since almost half the number of questions referred to the decay of this substance and its probable causes.

The committee was adjourned on Jan. 16, 1860, on account of a Government commission being appointed to investigate the subject of insulators for telegraph cables.

The society's *Journal* contains numerous articles and notes referring to guttapercha and its substitutes from the commencement in 1852 up to the present time, some of them being contributed by such authorities as Prof. Bleekrode, Mr. Murton, Mr. James Collins, Mr. John R. Jackson, and others.

Out of these 40 references, nearly half appertain to substitutes, mostly to Balata, and one-fifth to the botanical origin of guttapercha, the remainder to application, import, decay, etc.

I must, however, bring this part of my subject to a close, although it is by no means exhausted, and I will now say a few words about the general properties of guttapercha in the state in which it is obtained from the native collectors; it should, however, be understood that my present remarks refer only to materials of the best description now obtainable in commerce, which are practically identical with those produced on the first introduction of guttapercha 50 years ago.

General Properties and Distinction from Caoutchouc.

By far the most conspicuous property of guttapercha and the one which at once distinguishes it from caoutchouc, with which it is so commonly confounded, is undoubtedly that already mentioned by Tradescant, and again insisted upon by D'Almeida as well as Montgomerie—viz., its becoming soft and plastic on immersion in hot water, retaining any shape then given to it on cooling, whereupon it becomes hard, but not brittle like other gums. Caoutchouc, on the other hand, does not soften in hot water, and retains its original elasticity and strength almost unimpaired. However, I wish you to understand that the water, as such, exercises no softening action on the material, the effect being purely one of temperature, which may equally well be produced by hot air, only somewhat more slowly.

The exact temperature at which guttapercha softens depends upon the quality of the material, but even the hardest kinds become plastic above 150deg. F. (65½deg. C.).

When guttapercha is heated in air considerably above the boiling point of water, it decomposes and finally ignites, burning with a luminous smoky flame and emitting a characteristic pungent odour resembling that of burning caoutchouc. If the heating takes place in the absence of air—in a retort, for instance—gaseous and liquid products are obtained similar to those resulting from the destructive distillation of caoutchouc, which were examined as long ago as 1835 by Prof. Himly, brother-in-law of Sir William Siemens.

The oily liquid which distils over consists chiefly of hydrocarbons of the terpene series, which form an excellent solvent for caoutchouc. The two most important components are isoprene (C_5H_8) having a specific gravity of 0·682 and a boiling point of 37deg. C., and caoutchine ($C_{10}H_{16}$), specific gravity 0·842 and boiling point 171deg. C. The identity of isoprene and caoutchine from guttapercha, with that from caoutchouc, was proved by Mr. Greville Williams in 1860.

(To be continued.)

ELECTRICITY IN ENTERTAINMENTS.

Electricity has not only its ornamental and useful application—as for instance, for decorative purposes, telegraphy, telephony, lighting, and transmission of power for tramways—but we find that a considerable number of persons are now employed in providing entertainments in which the use of electricity enters very largely. Leaving apart minor apparatus—such as the kinetoscope, phonograph, and kindred appliances—we may mention the various arrangements in use for the taking and reproduction of living pictures or animated photographs which are being shown in theatres and lecture halls under the various names of animatograph, biograph, cinematograph, theatroscope, vitascope, and viroscope. The latter (which is at present being exhibited at the Royal Aquarium, Westminster, whose manager, Mr. Richards, is always ready to give new experiments a trial) has perhaps made the most stir on account of the vast sums which were paid by the inventors for the rights to take the pictures of an American prize fight which they represent. The arrangement in the various machines named above is almost an identical one.

The pictures of the prize fight were taken on a winter's day upon a roll of sensitised celluloid film, and at the rate of 168,000 per hour. An arc lamp of 35 amperes was employed in taking, and a similar one is used in reproducing the pictures. They are thrown on a screen by means of a powerful lantern, and magnified according to the place at the disposal of the exhibitor. The screen at the Aquarium is 24ft. by 20ft., which permits the figures to appear in life size. The roll of film bearing the developed negatives passes through the lantern at the speed which was used when the figures were taken. This particular film bears pictures 2in. by 2¼in., and is said to be 2,000 miles long. We may add that we have not measured it ourselves. The power (100 volts) is obtained from the Westminster power-house direct, the Aquarium supply being of course not sufficient to bear the extra strain. On damp days the celluloid shrinks, which materially affects the clearness of the pictures reproduced on the screen.

A new departure in this line is a number of biograph pictures with larger sized origins—*i.e.*, 2¼in. by 2¾in.—taken at the rate of 40 to 60 per second, necessitating 290ft. of film per picture—which are being shown at the Palace Theatre, Shaftesbury-avenue, where that veteran of managers, Mr. Morton, still ably presides. A series of Santa Claus visits at Christmas were taken this way lately, and in spite of the London winter atmosphere produced remarkably fine results. Amongst the novelties we remarked a fine portrait of Mr. H. S. Maxim serving one of his quick-firing guns, and another which speaks well for the advance made in the science, for it was taken by a machine standing on the platform of a train running through a tunnel at the rate of 60 miles an hour. The moving scenery, the approach of the dark mouth of the tunnel, gradually widening until everything is enveloped in total darkness; finally a light speck in the distance, getting larger and larger as we approach the farther end, until the sunlit landscape bursts upon our view, gives a most complete illusion, especially when accompanied by the swishing, snorting, and whistling of the train, and other incidental noises supplied from behind the scenes.

At the Crystal Palace Mr. Templeton shows a model of a gold mine, which is worked by electricity from the supply to the Palace. The entire workings of the model, which fills a good-sized room, and which include working miners, lifts, trolleys, stampers, aerial railway, etc., are all worked by one circuit. He has also a model of a coal mine underground. There is a centrifugal fan running at 300 revolutions per minute and capable of displacing 100,000 cubic feet of air in that time; also an ingenious electrical mining lamp (Eccles), the construction of which by a mechanical arrangement absolutely prevents the miner opening the top of the lamp before opening the bottom part. While the bottom part is being unscrewed, the air is shut off, the lamp goes out, and therefore the light cannot come into contact with any bad air. An electric drill which bores a hole 4ft. deep in one minute, and the way of firing of fuses by means of electricity, are also shown. Various other electrical appliances for haulage, telephone, etc., complete this exhibit, which is worked by power obtained from the Crystal Palace and District Electric Supply Company.

Mr. Wieland exhibits at the Palace Theatre an improvement of the illusion called "Zæo," which was formerly exhibited at the Royal Aquarium." This consists in producing, by means of many powerful arc lamps and various colouring effects, the Parsee fire dance and many fascinating poses of a living dancer in colours no brush can reproduce in vivacity or brightness. Imperceptibly to the audience, the dancer, who was just now enveloped in flames, changes into a peaceful butterfly, a multicoloured Japanese screen, and so forth. The apparatus consists mainly of a box under the stage in which six arc lamps of 30 amperes each are placed. Each of these has a powerful parabolic reflector. Above this bunch of lamps is a sheet of glass 1½in. thick, and specially made colourless. By means of coloured gelatine mediums, which are rapidly changed, the light is projected from below on to the dancer, who stands upon the glass.

In front of the glass is a slot through which gold-rain ascends. This is an invention of Mr. Slade Olver, the electrician of the Palace Theatre, who is also the inventor of a special stage lamp, which is being manufactured after his design by the Walsall Electric Company, and which is used in many theatres. It has a feeding screw, an elevating screw, and also an arrangement for moving the lamp sideways. It has been found necessary in stage management, in order to locate the person responsible for a fault, to avoid clockwork lamps, and this new lamp seems to answer its purpose remarkably well. A ½-h.p. motor drives a blower, into which metal shavings are fed, and these are then blown up through a pipe upon the stage. Six additional arc lamps—four in front and two behind the performer—are lifted up into the flies, and from there also project their light at 30 amperes each through similar coloured mediums, while an optical lantern from the back of the auditorium helps to complete the illusion by means of coloured slides. Of course the stage is in absolute darkness, and six mirrors hidden at the back are used to multiply the effect. Altogether it is a most charming application of electricity, and we hear that Mr. Wieland, who has himself perfected most of the arrangements by which this effect is produced, is about to heighten the same by further improvements.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We shall also in future give *two shillings and sixpence* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared, and should be written on one side of the paper only. Questions may be sent at any time.

QUESTIONS.

26. Given a system of distribution by triple concentric armoured cables supplied from a distant generating station by concentric feeders, what would you consider the best arrangement at a feeding point where, say, four distributors come on the end of the feeder; to combine in itself efficient sealing for the ends of the lead-covered cables, detachable and easily accessible links for disconnecting any conductor without interfering with the others, and insulation able to stand underground conditions? Give sketches.—H.

27. Describe the Wright maximum demand indicator and the purpose for which it is used.—P. T.

[NOTE.—Do not in this last question take up the financial aspect of the system of charging for electrical energy in which the indicator is used.—ED. *E. E.*]

ANSWERS.

Question No. 21.—What are the advantages and disadvantages of mechanical stokers in connection with the boilers in electricity works?

Best Answer to No. 21 (*awarded* 10*s*.).—No doubt the chief advantage of using mechanical stokers is the prevention of smoke, but at the same time it is not the only way in which smoke may be prevented. It is a well-known fact that with careful hand-firing smoke can be avoided, provided good coal is used. Of course, in central stations, as in factories, etc., the coal item goes a long way towards killing the profits. The mechanical stoker is a very economical method of burning slack, and enables a small and regular supply of fuel to be introduced into the furnace without the admission of too much air. The flue gases do not carry away so much smoke, and great heat is obtained in the furnace. The steady evaporation ensured by a good arrangement of mechanical firing is rather an objection to its use, especially where the quantity of steam required varies constantly. Another objection urged against most systems of mechanical firing is that the speed of evaporation is inferior to hand-firing. However, in some cases the rate of feeding, thickness of fire, etc., can be altered to suit this. With good round coal, hand-firing is preferable to any description of mechanical firing, with respect to both rapidity and economy of evaporation, and it may be said that very little skill is needed to prevent smoke satisfactorily when there is sufficient boiler power. As electricity works grow larger and larger, and the profits increase, more boiler power will be needed. Better coal can then be afforded, and mechanical stokers will not be absolutely necessary to bring about economical results or prevention of smoke. The Vicars and the Bennis stokers appear to be the best in the market. The Vicars is a coking stoker, the Bennis a sprinkling stoker. In the first arrangement the coal is pushed on at the front end, and the fire is gradually carried to the back end, the fire tapering down to nothing. In the second case the fire is kept level. The fuel is thrown on in small quantities, each time in a different place. The latter machine is more adapted for central-station use, as the amount of coal burned can be regulated from about 15lb. to 50lb. per square foot of grate per hour, thus readily responding to large fluctuations in load. It is sometimes argued that with mechanical stokers the stokehole hands may be reduced. This is a very impotent reason for their use. It must be borne in mind that attendance is necessary for its successful operation. The fireman who looks after them is not the man to repair them. The first cost of stokers is high. They require power to work them—either a steam-engine or an electric motor—and a strong draught, forced or natural, is needed. Like all machines, they must be kept in repair, and all this adds to cost of operating.—F. BRUTON.

[The rest of the answers to this question were very poor in quality. We trust our readers will make a better attempt at No. 24, which covers practically the same ground. Figures as to the actual evaporation per pound of coal and cost of working should be given if possible.—ED. *E. E.*]

Question No. 22.—What are the advantages and disadvantages of (1) running all the feeders and alternators in parallel; and (2) using a machine to supply each separate feeder?

Best Answer to No. 22 (*awarded* 10*s*.).—*The Advantages and Disadvantages of Running all the Feeders and Alternators in parallel.*—There are several advantages in this system: (1) It is efficient, as the machines can be kept running at full load, and others switched in as the load rises; thus, during light loads one or two machines may be sufficient to supply all the circuits, and large machines can be used for heavy loads, which are more efficient than small ones. (2) Should a machine break down, the other machines will pick the load up almost immediately and the lights will not be affected, unless the machines were already doing their full load, when of course the volts will drop and the lights burn dim until another machine is switched in. When a number of alternators are running in parallel, a margin should be left if possible, so that should a machine break down and have to be switched out, the others may pick up the load without exceeding their normal maximum output by more than 10 per cent. (3) The machines may be changed over without affecting the lights, but in a system of this kind the inner 'bus bar should be made in sections, so that any one machine or circuit may be isolated for testing or repair without in any way interfering with the others.

The disadvantages of this system are: (1) There is a risk of total breakdown to the lighting, as a short or dead earth on any machine or circuit might blow all the main fuses before the defective circuit or machine could be switched out, which would mean total stoppage of the lights till new fuses could be put in and the machines synchronised with each other. (2) Should the alternators get out of step all the lights will be affected and "pump." (3) When the load rises very quickly, as in the case of a fog, each machine must be synchronised separately with the others already on load before it can be switched in to supply current, which takes time, and a longer time when the load is rising quickly than when it is steady. (4) All the circuits must be kept at the same voltage, no matter what the length or capacity of each may be.

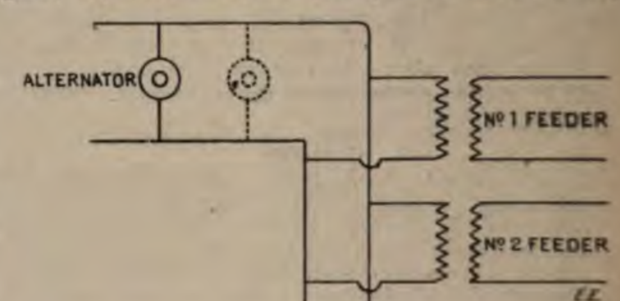
Although these disadvantages may appear to be somewhat serious, they are insignificant when compared with the advantages of running all the plant and feeders in parallel, as with properly designed alternators and switchgear, and care in their use, very little trouble is experienced in practice—at least, the writer has found it so.

2. *The Advantages and Disadvantages of using a Machine to Supply each Separate Feeder.*—The advantages of this system are: (1) Very slight risk of complete stoppage of light, as each machine and feeder being separate from the others, any breakdown to engine or alternator, or any short or earth on the circuit will affect that particular plant and circuit only, and will in no way interfere with the other lights being supplied from the station. (2) Very little time is required to switch a machine on circuit and run it up, as there is no synchronising to be done. (3) Each circuit can be kept at its most economical voltage. (4) Various types of alternators may be used, with different speeds and periodicities if required, but this is a questionable advantage on account of the number of spare machines which would be needed.

The disadvantages of this system are: (1) Its great cost when compared with the system of running all the plant and feeders in parallel, as it costs very much more in coal, labour, and oil to run several small machines than one large one; and with this system a machine must be kept running on a circuit if there are only a dozen lamps alight, so that at light load time only a fraction of its total output would be required of each machine, which would, therefore, be working at a low efficiency. This is a very serious disadvantage, and one which would prohibit the use of this system in any but special cases. (2) Should a machine break down, all the lights on that particular circuit will be put out, and remain out until a spare machine could be switched in, which is also a serious disadvantage.—R. S.

Answer to No. 22 (*awarded* 2*s.* 6*d.*).—When the feeders in an alternating-current system are all in parallel with the engines, there are the following advantages: The high-tension networks may be paralleled, or the feeders alone be paralleled, with the result that the engines can be kept running at their economical load, that the pressure can be kept very constant; and there is no doubt that the economy of the running will be higher than with the second method, as not only will the engine load factors be better while running, but the plant horse-power hours will be less. By the plant horse-power hours is meant the sum of all the terms—horse-power to run engine and dynamo empty multiplied by the hours each is run. This is a very good measure of the economy of running. The amount of attention required will be low, as all the voltage regulation may be done by one engine, and there is a great advantage in the fact that the hum of the alternators will be much less than by the second method. The great disadvantage of paralleled feeders is that any failure of a cable will cause an extinction of the whole of the lights; that with some types of alternator the exchange of current between the paralleled machines is heavy, with the result that there is a considerable amount of wattless current preventing the machine from being fully loaded with safety if the coils run at all hot. The whole drop of pressure on high-tension feeders rarely exceeds 5 per cent., and a 20 per cent. difference of load from the normal on any circuit at any instant will only cause a 1 per cent. difference of pressure on the distributors. This being the case, the distributors can be isolated while the feeders are paralleled, and upon any earth appearing, the circuit affected can be separated and run on a separate engine until the "earth" is removed, when the circuit can be paralleled with the rest again. Even in the case of a short-circuit, if persistent, the feeder fuse on the circuit affected will be blown, and the rest of the lighting will not suffer. When the drop of pressure on any feeder is very different from the rest, a booster can be used, such as that used at Sardinia-street station and other places. One disadvantage of the first method—*i.e.*, paralleling feeders and alternators—is that when an earth appears on one pole in any district, the potential difference between earth and the other pole is doubled, and a weak cable on another circuit may break down and "earth," a short being formed between the two poles through, perhaps, a mile of earth. For this reason, whenever an earth is shown by the glow tubes, the circuit must be found by experiment, and the main should be run separately. The right main cannot always be easily found, as all the glow tubes (which indicate the potential from earth) will go dark on that pole, so circuit after circuit must be isolated until the rest of the glow tubes light up and show that the right one is discovered. It must be remembered that this disadvantage is removed when concentric mains are used, as the outer always is at earth potential, owing to the effect of capacity, and the inner is always at the full voltage from earth. Again, a real earth on a concentric cable is always a short, which must show itself plainly, and which is local.

The advantages of separate running are few. Separate running is a survival of the pre-historic times five or six years ago, when boosters were unknown; when parallel running of alternators was looked upon with suspicion, and the engineer who had run his machines in parallel was looked upon as a very daring man; when it was necessary for manufacturers to read papers to show that alternators could be paralleled, and when theorists went into long mathematical investigations to show that they could not. Separate running should only be allowed when the dynamos are bad, or when the mains are worse. If the dynamos are expected to collapse every moment, they should not be paralleled, as disaster may result; and if short-circuits appear on the mains with every shower of rain, I would run separately. The advantage of separate running, when the pressures needed on the feeders vary, is disposed of by the use of boosters. Most of the disadvantages have already been mentioned in the first part—viz., those referring to efficiency—and need not be repeated; but there is another one, that the voltage is upset; and a great deal of work is entailed by paralleling and switching over mains to the light-load machine at light load, and in separating and running separately for heavy load. This practically reserves the advantages (to the mains) of separate running to the heavy-load time, or else each feeder must be on separate transformers, as in the figure; or, worse still, all the dynamos must be kept



running through the day. The other disadvantage is the excruciating torture to the staff caused by the slight difference in notes of the separate running alternators. The coming into and out of step of the alternators causes the "beat" or interference phenomena, which are calculated to send the staff to the asylum prematurely, and which must be heard to be appreciated. The alternating-current station assistant's life is never a pleasant one, but he should at least be spared this refinement of torture.—W. FENNELL.

Answer to No. 22 (*awarded* 2*s* 6*d.*).—Method No. 1 is the usual English practice, and is the most efficient, as the number of machines in circuit may be regulated so as to give each machine a full load. It is also the least complicated as regards the switchboard arrangements, and even if a machine fails it does not necessarily mean an interruption in the supply, as the other machines will give the extra current required of them till another is run up to speed and thrown in in parallel. On the other hand, there is the troublesome operation of paralleling to be performed with every considerable increase of load.

It was principally on account of the difficulty in getting their machines to run in parallel that American engineers took to running their different circuits each from its own machine, but this is an extremely uneconomical method, as several large alternators may have to be kept running at only a fraction of their full load. Each circuit, too, requires a separate switchboard, which has also to be so arranged that it can be connected up with the rest in order that the light day load may be taken by a single alternator. One incidental advantage of this system is the ease with which the pressure can be varied to suit the different lengths of feeders, etc., but the disadvantages so preponderate that

the separate circuit system has not been adopted in England, and has also been discarded in all the newer American stations.—Geo. D. Seys.

ELECTRIC LIGHTING PROVISIONAL ORDERS.

The following is a complete list of applications for provisional orders deposited with the Board of Trade up to Dec. 21, 1897, under the provisions of the Electric Lighting Acts, 1882 to 1890:

Title of Order and Description of Area.	Name of Promoters.
Airdrie Burgh Electric Lighting Order. The Burgh of Airdrie.	The Corporation.
Aldershot Electric Lighting Order.—The Urban District of Aldershot.	The Urban District Council.
Aston Manor Electric Lighting Order. The Urban District of Aston Manor.	The Urban District Council.
Barnes Electric Lighting Order.—The Urban District of Barnes.	The Urban District Council.
Batley Electric Lighting Order.—The Borough of Batley.	The Corporation.
Birkdale Electric Lighting Order.—The Urban District of Birkdale.	The Urban District Council.
Bolton Electric Lighting Order.—The County and Municipal Borough of Bolton, the Urban District and Township of Astley Bridge and the Townships of Heaton, Smithills, Darcy Lever, Breightmet, Lostock, Deane-over-Hulton, Middle Hulton, Tonge, and Great Lever, within the Bolton Rural District.	The Corporation of Bolton.
Brechin Electric Lighting Order.—The Royal Burgh of Brechin.	The Corporation.
Bridgwater Corporation Electric Lighting Order.—The Borough of Bridgwater.	The Corporation.
Burslem Electric Lighting Order.—The Borough of Burslem.	The Corporation.
Chelmsford Rural District Electric Lighting Order.—The Parishes of Writtle, Great Baddow, Broomfield, Springfield and Widford, within the Chelmsford Rural District.	Chelmsford Electric Lighting Company, Limited.
Chichester Corporation Electric Lighting Order.—The City of Chichester.	The Corporation.
Chislehurst Electric Lighting Order.—Portion of the Parish of Chislehurst.	Chislehurst Electric Supply Company, Limited.
Chorley Corporation Electric Lighting Order.—The Borough of Chorley.	The Corporation.
Colne Corporation Electric Lighting Order.—The Municipal Borough of Colne.	The Corporation.
Crewe Electric Lighting Order.—The Borough of Crewe.	The Corporation.
Darlington Electric Lighting Order.—The whole of the Borough of Darlington, except the detached portion of the Township or Civil Parish of Darlington known as Oxen-le-Field.	The Corporation.
Dartford Electric Lighting Order.—The Urban District of Dartford.	The Urban District Council.
Doncaster Corporation Electric Lighting Order.—The Borough of Doncaster.	The Corporation.
East Ham Electric Lighting Order.—The Urban District of East Ham.	The Urban District Council.
East Stonehouse Electric Lighting Order.—The Urban District of East Stonehouse.	The Urban District Council.
Gravesend Electric Lighting Order.—The Municipal Borough of Gravesend.	The Corporation.
Greenock, Port-Glasgow, and Gourock Electric Lighting Order.—The Burghs of Greenock, Port-Glasgow, and Gourock.	North British Electricity Supply Company, Limited.
Hamilton Electric Lighting Order.—The Burgh of Hamilton.	The Corporation.
Hastings Corporation Electric Lighting Order.—The Borough of Hastings.	The Corporation.
Hereford Electric Lighting Order.—The City of Hereford.	The Corporation.
Hornsey Electric Lighting Order.—The Urban District of Hornsey.	The Urban District Council.
Hove (Aldrington) Electric Lighting Order.—The Parish of Aldrington in the Town of Hove.	The Hove Urban District Council.
Ilford Electric Lighting Order.—The Urban District of Ilford.	The Urban District Council.
Ilfracombe Electric Lighting Order.—The Urban District of Ilfracombe.	The Urban District Council.
King's Norton Electric Lighting Order. The Parishes of King's Norton and Northfield in the Rural District of King's Norton.	The Rural District Council.
Kingswinford Electric Lighting Order. The Rural District of Kingswinford.	The Rural District Council.
Leatherhead Electric Lighting Order.—The Urban District of Leatherhead.	The Urban District Council.
Leigh-on-Sea Electric Lighting Order.—The Urban District of Leigh-on-Sea.	The Urban District Council.
Lewes Corporation Electric Lighting Order.—The Borough of Lewes.	The Corporation.
Lowestoft Electric Lighting Order.—The Borough of Lowestoft.	The Corporation.

THE COUNTY OF LONDON.

Title of Order and Description of Area.	Name of Promoters.
Bermondsey Electric Lighting Order.—The Parish of Bermondsey.	The Vestry.
Bermondsey, Rotherhithe, Greenwich, and Lewisham Electric Lighting Order.—The Parishes of Bermondsey and Rotherhithe and the Districts of Greenwich and Lewisham	County of London and Brush Provincial Electric Lighting Company, Limited.
Bethnal Green, Poplar, and Whitechapel Electric Lighting Order.—The Parish of Bethnal Green and the Districts of Poplar and Whitechapel.	County of London and Brush Provincial Electric Lighting Company, Limited.
Holborn District Electric Lighting Order.—Portion of the Holborn District,	Charing Cross and Strand Electricity Supply Corporation, Limited.
Holborn and St. Giles Electric Lighting Order.—Portion of the Holborn District, the District of St. Giles, Lincoln's inn, Gray's inn, Staple-inn, and Furnival's-inn.	County of London and Brush Provincial Electric Lighting Company, Limited.
Lewisham District Electric Lighting Order.—The District of Lewisham.	The District Board of Works.
Lewisham Electric Lighting Order.—Portion of the Parish of Lewisham	Great Western Electric Light and Power Company, Limited.
St. Giles District Electric Lighting Order.—The District of St. Giles.	Charing Cross and Strand Electricity Supply Corporation, Limited.
St. Marylebone Electric Lighting Order. The Parish of St Marylebone.	The Vestry.
St Marylebone Electric Lighting Order. The Parish of St. Marylebone.	County of London and Brush Provincial Electric Lighting Company, Limited.
St. Marylebone Electric Lighting Order. The Parish of St. Marylebone.	Marylebone Electric Supply Company, Limited.
Maidenhead Electric Lighting Order.—The Borough of Maidenhead.	The Corporation.
Margam Electric Lighting Order.—The Urban District of Margam.	The Urban District Council.
Melton Mowbray Electric Lighting Order.—The Urban District of Melton Mowbray and the Parishes of Sysonby, Welby, Eye Kettleby, Burton Lazars, and Thorpe Arnold, in the Rural District of Melton Mowbray.	Melton Mowbray Electric Light Company, Limited.
Middlesbrough Corporation Electric Lighting Order. — The Municipal Borough of Middlesbrough.	The Corporation.
Midland Electric Power Distribution and Lighting Order.—The Boroughs of Walsall, Wednesbury, West Bromwich, and Wolverhampton, the Urban Districts of Bilston, Coseley, Darlaston, Heath Town, Rowley Regis, Sedgley, Short Heath, Smethwick, Tipton, Wednesfield, and Willenhall, and the Rural District of Walsall, in the County of Stafford; and the Borough of Dudley, and the Urban District of Oldbury, in the County of Worcester.	Midland Electric Corporation for Power Distribution, Limited.
Mitchelstown Electric Lighting Order.—The Town of Mitchelstown.	The Mitchelstown Guardians.
Montrose Electric Lighting Order.—The Royal Burgh of Montrose.	The Corporation.
Norwich (Extension) Electric Lighting Order.—The Parishes of Thorpe St. Andrew, Postwick, Sprowston, Old Catton, Hellesdon, Costessey, Bowthorpe, Colney, Cringleford, Intwood, Keswick, Markshall, Arminghall, Trowse Newton, and Bixley, and the Shire Hall and Castle Ditches, Norwich.	Norwich Electricity Company, Limited.
Nuneaton Electric Lighting Order.—Portions of the Parishes of Nuneaton and Chilvers Coton.	Nuneaton Electric Company, Limited.
Oldbury Electric Lighting Order.—The Urban District of Oldbury.	The Urban District Council.
Ossett Electric Lighting Order.—The Municipal Borough of Ossett.	The Corporation.
Partick Electric Lighting Order.—The Burgh of Partick.	Kelvinside Electricity Company, Limited.
Penarth Electric Lighting Order.—The Urban District of Penarth.	Penarth Electric Lighting Company, Limited.
Perth Electric Lighting Order.—The Parliamentary Burgh of Perth.	The Commissioners of the Burgh.

Title of Order and Description of Area.	Name of Promoters.
Peterborough Electric Lighting Order. The Municipal Borough of Peterborough.	Peterborough Electric Light and Power Company, Limited.
Prescot District Electric Lighting Order. — The Urban District of Huyton-with-Roby.	British Insulated Wire Company, Limited.
Preston (Extensions) Electric Lighting Order.—The Urban District of Fulwood, and the Townships of Broughton, Lea Ashton Ingol and Cotam, Woodplumpton, Barton, and Penworthan, in the Rural District of Preston.	National Electric Supply Company, Limited.
Ramsgate Electric Lighting Order.—The Borough of Ramsgate.	Electric Supply Corporation, Limited.
Rawmarsh Electric Lighting Order.—The Urban District of Rawmarsh.	The Urban District Council.
Rochdale Electric Lighting Order.—The County Borough of Rochdale.	The Corporation.
Rotherham Corporation Electric Lighting Order.—The Municipal Borough of Rotherham.	The Corporation.
Rothesay Electric Lighting Order.—The Burgh of Rothesay.	The Corporation.
Royal Leamington Spa Electric Lighting Order.—The Borough of Royal Leamington Spa.	The Corporation.
Royal Leamington Spa Electric Light and Power Order.—The Borough of Royal Leamington Spa.	Midland Electric Light and Power Company, Limited.
Ryde Electric Lighting Order.—The Borough of Ryde.	Ryde Electric Light and Power Company, Limited.
St. Alban Corporation Electric Lighting Order.—The City of St. Alban.	The Corporation.
St. Annes-on-the-Sea Electric Lighting Order.—The Urban District of St. Annes-on-the-Sea.	The Urban District Council.
Shrewsbury Electric Lighting Order.—The Borough of Shrewsbury.	The Corporation.
Smethwick Electric Lighting Order.—The Urban District of Smethwick.	The Urban District Council.
Stoke-upon-Trent Electric Lighting Order.—The Borough of Stoke-upon-Trent.	The Corporation.
Warrington Electric Lighting Order.—The Municipal Borough of Warrington.	The Corporation.
West Bromwich Corporation Electric Lighting Order. — The County Borough of West Bromwich.	The Corporation.
Westgate-on-Sea Parish Electric Lighting Order.—The Parish of Westgate-on-Sea.	The Isle of Thanet Rural District Council.
Weston-super-Mare Electric Lighting Order.—The Urban District of Weston-super-Mare.	Weston-super-Mare Electric Light and Power Syndicate.
Weymouth and Melcombe Regis Electric Lighting Order.—The Borough of Weymouth and Melcombe Regis.	The Corporation.
Whiston Rural District Electric Lighting Order.—The Rural District of Whiston.	The Rural District Council.
Willesden Electric Lighting Order.—The Parish of Willesden.	The Urban District Council.

COMPANIES' MEETINGS AND REPORTS.

LONDON ELECTRIC OMNIBUS COMPANY.

The ordinary general meeting of shareholders of the London Electric Omnibus Company, Limited, was held on the 30th ult. at Winchester House, Old Broad-street, E.C., Major S. Flood Page, chairman of the Company, presiding.

The **Chairman** said they had postponed the meeting as long as possible until they could announce an alliance with a company for the building of the omnibuses, and with another company for the manufacture of the accumulators. The syndicate called the Electric Street Car Manufacturing Syndicate had now come into existence. On account of the insufficient capital at the disposal of the directors for premises, the several portions of the omnibuses had to be contracted for with various firms in different parts of the kingdom, the engineer then putting the parts together in London under great difficulties. This system was a most difficult one to carry out. This was instanced in the contracts required for the manufacture of the motors. Not one of the different contractors would agree to a penal clause. A contract for the delivery of motors at the end of four months had been made, but they were not delivered, and the contract had to be cancelled. The directors had been negotiating for and assisting in the formation of the Electric Street Car Manufacturing Syndicate, and an exchange of seats on the Board was proposed. They were the only company in England which had succeeded in running electric omnibuses along the streets without rails. At the present moment they had one omnibus which held 26 passengers, and a report from the engineer, Mr. Radcliffe Ward, stated that the technical difficulties in successfully producing and working such a vehicle are far greater than those for small vehicles carrying a few passengers. Another 10-passenger omnibus had been licensed, and it was expected that in a few days the 26-passenger omnibus would be licensed. In addition, another 26-passenger omnibus was partly built, and arrangements had been made with the Electric Street Car Manufacturing Syndicate for the building of another omnibus for the Company. Mr. Spagnoletti had written with reference to the Sola accumulator, saying that it was the best accumulator in the world. Referring to the manufacture of the accumulator, certain claims had been made, and when these claims were adjusted they would be able to show that they had a valuable property in that accumulator. They were a very small Company, and never could be in a position to seriously compete with the London General Omnibus Company, having only a capital of £50,000. Of that £50,000, £48,756 had been called, of which £20,000 was paid to the vendor. There was no reason for panic, least of all for winding-up the Company, as had been suggested. If the vendor and his associates had paid the money due on his partly-paid shares, the Company would have had ample funds for immediate requirements. He suggested the appointment of a committee to consult with the Board on the position and requirements of the Company, and had very little doubt that they would be able to put the concern in a stronger position, and one that would give great promise for permanent success. He moved: "That the report and accounts for the period extending from the registration of the Company on May 18, 1896, to Nov. 30, 1897, be, and are hereby, received and adopted."

During the discussion which ensued it was suggested that the omnibuses which had been spoken of by the chairman should be at once put upon the streets of London, say from Victoria Station to Piccadilly-circus, the fare to be 6d. per journey. Some time should be given to those in arrear of calls, permitting them to pay up in monthly instalments. If they did not avail themselves of that privilege the shares might then be offered to the remaining shareholders.

The resolution was then put to the meeting, and agreed to.

The **Chairman** said he had now to move that the following shareholders be appointed to consult with the directors on the position and requirements of the Company—namely, Colonel Turnbull, Mr. Hayden, Mr. Scrimgeour, and Mr. Condict—and that these gentlemen, along with the Board, be requested to report to the shareholders at a special meeting to be convened within 60 days.

This resolution was unanimously agreed to. Messrs. Percy Mason and Co. were reappointed auditors, and a vote of thanks to the chairman, on the motion of **Mr. Condict**, brought the proceedings to a close.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Cuba.—A decree will be published shortly for the construction of a cable from Cuba to Porto Rico (probably *viâ* Teneriffe).

Bedford.—Tenders are invited for the supply and delivery at the Bedford railway station of vulcanised rubber cables, for particulars of which refer to our advertisement columns.

West Hartlepool.—The Corporation invite tenders for various work in connection with their electric lighting station in West Hartlepool, for particulars of which refer to our advertisement columns.

Blackburn.—The Corporation are prepared to receive tenders for 500-kw. continuous-current steam dynamo and 100-kw. steam alternator, for particulars of which refer to our advertisement columns.

Salford.—The Town Council invite tenders for the supply of 300 yards of portable tramlines and 12 side-tipping trucks, to carry 20 cubic feet. For particulars apply to the Borough Engineer, Town Hall, Salford.

Guernsey.—The States of Guernsey require several hundred creosoted telegraph poles. Full particulars, with prices and earliest date of delivery, are to be addressed to Mr. A. R. Bennett 44, Manor Park-road, Harlesden, London.

Braila (Roumania).—Tenders are invited for the electric lighting of the town. The deposit required is £600. Specifications are to be obtained from, and tenders addressed to, the Municipal Authorities at Braila by Feb. 20 (March 4), at 4 p.m.

Tarifa (Spain).—Tenders are advertised for the lighting of the town for 20 years. Specifications are to be obtained from, and tenders addressed to, the Municipal Authorities of the above town, province of Cadiz, Spain. Tenders by February 1.

Tunis.—Tenders are invited for the construction of an electric tramway from Hammam-lif to Maxula Radès, a distance of about 10 miles. Specifications are to be obtained from, and tenders addressed to, the Secretary of the Société immobilière at Hammam-lif.

Bradford.—Tenders are invited for the wiring and electric lighting of a clothing establishment in Kirkgate, Bradford. Plans and specifications at the offices of Messrs. Milnes and France, architects, 99, Swan-arcade, Bradford. Tenders to be delivered to the Architects by noon on Jan. 8.

Bedford.—Tenders are invited for building offices and storerooms at the electricity works. Particulars can be obtained on application to the Engineer at the Electricity Works. Sealed tenders to be delivered at the offices of Mr. T. S. Porter, town clerk, Town Hall, Bedford, by January 10.

Novorossisk (Russia).—Tenders are invited for the construction, etc., of an electric lighting installation for the town. The deposit is 5,000 roubles. Specifications may be obtained from, and tenders addressed to, the Municipal Authorities of the town by March 1 (13).

Novorossisk (Russia).—Tenders are invited for the construction, etc., of an electric tramway. The deposit required is 5,000 roubles. Specifications, etc. (in French), are to be obtained from, and tenders addressed to, the Municipal Authorities, Novorossisk (Russia), by March 1 (13). The time has been extended from November 15.

Torrento (Spain).—Tenders are advertised for electric lighting of the town for 16 years. The estimated cost is 2 75 pesetas per light, and the deposit required is 5 per cent. Specifications are to be obtained from, and tenders addressed to, the Municipal Authorities of the above town, province of Valencia, Spain. Tenders by 11 a.m. on January 10.

Tarragona (Spain).—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's Chargé d'Affaires at Madrid, transmitting copy of a Royal order inviting tenders for the construction and working of a telephone system in Tarragona. Sealed tenders will be received at the office of the Civil Governor of the province of Tarragona for 40 days, counting from Dec. 11. Further particulars of the conditions of the tenders may be inspected at the Commercial Department of the Foreign Office any day between the hours of 11 and 6.

Wolverhampton.—The Public Works Committee invite designs and tenders for motor-vans for street scavenging and the conveyance of road materials. Outline specification and form of tender can be obtained on application to Mr. J. W. Bradley, C.E, borough engineer and surveyor, Town Hall Wolverhampton, Firms tendering do so at their own cost in every respect. Drawings and a full description of the motive power, capacity, and other particulars, addressed to the Chairman of the Public Works Committee, to be delivered by February 7.

Worthing.—The Electric Light Committee of the Town Council invite particulars and conditions under which any person, firm, or company is willing to instal and maintain the electric light in the borough for a term of years, with power to the Corporation to acquire the undertaking upon agreed terms and at stated periods. The provisional order of the Board of Trade, which is in the usual form, may be inspected, and a plan of the town, showing the compulsory area and other particulars, obtained, on application at the Town Clerk's Office, Liverpool-road, Worthing.

Guipuzcoa (Spain).—The Secretary of State for Foreign Affairs has received a despatch from her Majesty's Consul at Bilbao, reporting that the Provisional Board appointed in connection with the electric tramway which it is proposed to lay from Zumarraga to Zumaya, in the province of Guipuzcoa, invite plans and tender, to be received by February 28, for the construction and equipment of the line. Further particulars of the conditions of the tenders for the above-named tramline and branch, which together measure 30 miles, may be inspected at the Commercial Department of the Foreign Office between 11 and 6.

Bedford.—The Electric Light Committee are prepared to receive tenders for the supply and erection of the following plant: (Section A) one 420-b.h.p. double-acting compound enclosed engine; (B) one 250-unit alternator, with stationary armature. Specifications, with terms and conditions of tender and contract, may be obtained at the offices of Mr. T. S. Porter, town clerk, Town Hall, Bedford, on payment of a fee of 5s. for each section. Tenders, sealed and marked "Electric Lighting, Section A or B," must be delivered to the Town Clerk by January 10.

Bradford.—The Corporation require tenders for the construction and delivery of two steam-engines for their electricity works at Valley-road. Specification may be had on application to Mr. Alfred H. Gibbings, Electricity Department, Town Hall, Bradford, on payment of £1. 1s. to the City Collector, Town Hall; this sum will be returned on receipt of a bona fide tender, accompanied by the specification. Sealed tenders, endorsed "Tender for Steam-Engines," to be sent to the Town Hall, on or before Jan. 13. An assurance must be given by each contractor that he will pay to the workmen employed by him not less than the minimum standard rate of wages.

Leicester.—The Sanitary Committee invite designs and tenders for motor vehicles for the collection of house refuse. The motive power, capacity, and all other particulars are to be described in a full specification, accompanied by drawings and delivered at the office of Mr. E. George Mawbey, C.E., borough engineer and surveyor, Town Hall, Leicester, addressed to the Chairman of the Sanitary Committee, by January 31. The loaded wagons would have to ascend an incline of 1 in 20, turn in a limited space, back and tip over a beam about 14in. high by 12in. in width, and when empty descend a road having a gradient of 1 in 15. The Committee do not bind themselves to accept any proposal, and firms tendering must do so at their own cost, no fees being allowed for the preparation of drawings, etc.

St. Marylebone.—The Guardians desire to receive tenders for electric light wiring and fittings at their new administrative buildings of their workhouse in Northumberland-street, W. Persons desiring to tender may obtain bills of quantities and a form of tender, and inspect the specification and drawings, any time from the 7th inst. to the 15th inst. (both days inclusive), between the hours of 10 a.m. and 4 p.m. (Saturdays till 1 p.m.), upon application to the Guardians' architect, Mr. A. Saxon Snell, F.R.I.B.A., of 22, Southampton-buildings, Chancery-lane, W.C., and depositing with him a £10 Bank of England note, which will be returned to persons sending bona fide tenders in the manner and at the time stipulated. Quantities by Messrs. Northcroft, Son, and Neighbour. Tenders must be signed, sealed, and endorsed "Tender for Electric Lighting," and addressed and delivered to Mr. Henry T. Dudman, clerk to the Guardians, not later than 10 a.m. on 17th inst.

Gloucester.—The Electricity Supply Committee are prepared to receive tenders for the supply and erection of the following plant on the low-tension system, for the municipal electricity works: (Section A) boiler-house plant—Lancashire boilers and accessories, mechanical stokers, feed pump, injector, economiser, electric motor; (B) engine-house plant—steam dynamos and accessories; (C) overhead travelling crane; (D) switchboard and instruments; (E) accumulators; (F) mains—insulated cables and trenching; (G) public lamps—arc and incandescent street lamps and lamp-posts; (H) meters—the whole bound up in one specification. Tenderers are at liberty to tender for either section, but not for part of a section. Specification, with terms and condition and forms of tenders, may be obtained at the offices of Mr. Robert Hammond, M.I.E E., consulting engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., on payment of £3. 3s., which sum will be refunded on the return of the specification filled up with a bona fide tender. Duplicate copies of the specification £1. 1s. each, not returnable. Tenders (sealed and marked "Tender for Electricity Works") must be addressed to Mr. Geo. Sheffield Blakeway, town clerk, Guildhall, Gloucester, and be delivered by January 18.

Bootle (Lancs.).—Tenders are invited by the Corporation for the supply and erection of (1) Lancashire boilers and Green's economiser; (2) engines, dynamos, switchboard, condensers, condensing and feed-water pumps, balancing transformers, boosters, piping, tanks, crane, meters, wiring of electricity supply works, and alterations and additions to wiring at town hall; (3) secondary batteries and accessories; (4) feeder and distributing mains (solid system), potential leads, network and surface boxes, and service connections; (5) running of the electricity supply works for period not exceeding three years. Specifications, drawings, and form of tender can be obtained at the office of Mr. J H. Farmer, town clerk, Town Hall, Bootle, on payment of £5. 5s. (or £1 1s. per section), which will be returned on receipt of a bona fide tender. Any further information can be obtained from the consulting engineer, Mr. Thomas L. Miller, M I.E.E., 7, Tower-buildings N., Water-street, Liverpool. Contractors may tender for any section or sections, but not for part of a section, and contractor for No. 2 section must also tender for Section No. 5. The contractor whose tender is accepted will be required to enter into a formal agreement under seal, with sufficient and approved securities, for the fulfilment of contract. Sealed tenders, endorsed "Tender for Electric Lighting," and addressed to the Chairman of the Watch Committee, must be sent in by 12 noon on January 10.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to July 1, 1898.

RESULTS OF TENDERS.

London, E.C.—The tenders of Messrs. W. Smith, Gray, and Co. and Messrs. Bergtheil and Young, of Camomile-street, E.C., have been accepted for heating and electric wiring the extension of the Guildhall School of Music.

Derby.—The contracts for the supply of large coal have been equally divided between Mr. Walker and Mr. Carline. The tender of Messrs. Ferranti, Limited, for dynamo and engine, at £7,132. 10s., has been accepted by the Electric Lighting Committee.

Dewsbury.—The Town Council have given a contract to Messrs. E. Chadwick and Sons for the erection of an iron shed for the coal-crushers at the gasworks. The contract for the supply of coal to the electricity works has been given to Messrs. Crawshaw and Warburton.

Newcastle-on-Tyne.—The tender of G. W. Lummis-Paterson and Co., Cardigan terrace, Heaton, Newcastle-on-Tyne, has been accepted for the installation of the electric light in the church, lecture hall, vestries, and lobbies, etc., with front and side lights, at Heaton-road Wesleyan Church.

Barking (Essex).—The Urban District Council have received the following tenders for the erection of an electric light station at East street:

F. J. Coxhead, Bulwer-road, Leytonstone	£3 297
Thomas and Edge, Anglesea-avenue, Woolwich	2,790
G. Sharpe, Gibbins-road, Stratford*	2 666

* Accepted by committee subject to approval of Council.

Barrow-in-Furness.—The Corporation have received the following tenders for the erection of an electric light station near the top of Buccleuch-street:—

W. W. Fairbairn, Abbey-road, Barrow-in-Furness (accepted)	£3,386	10	0
T. Brown, Hindpool-road, Barrow-in-Furness	3,444	5	2
W. Gradwell and Co, Limited, Hindpool Sawmills, Barrow-in-Furness	3,447	13	10
W. Saddler, Barrow-in-Furness	3 510	0	0
W. Bradley, Millom, Cumberland	4,031	9	5

Eccles—The Town Council has been recommended to accept the following tenders: Messrs. W. T. Glover and Co. for underground works, comprising cables, piping, attachments to lanterns, required trenching and making good the streets to the satisfaction of the borough surveyor, for the sum of £2,849. 6s.; Messrs. Tinkers, Limited, for boilers, condensers, and steam exhaust and water pipes, etc., for the sum of £1,620; Messrs. Pritchetts and Gold for accumulators, for the sum of £646; Messrs. Browett, Lindley, and Co., Limited, for steam-engines, steam-driven alternators, motor-alternator, switchboard. instruments, and transformers, for the sum of £4,277—total, £9,392 6s.

BUSINESS NOTES.

Innerleithen.—Additional premises have been fitted up with the electric light this week.

Electric Construction Company.—The transfer books for the first mortgage debentures will be closed from 8th to 14th inst. inclusive.

F. C. Allsop.—We hear that, owing to increased business, additional premises have been taken by this firm at 126, Queen Victoria-street.

Brierley Hill.—A plan for the British Electric Traction Company, Limited, respecting alteration of turnouts on the new line has been approved by the Urban District Council.

General Electric Company, Limited.—The Company state that they are now in a position to supply a thoroughly good enclosed arc lamp for alternating-current circuits taking six amperes.

City of London Electric Lighting Company, Limited—We are informed that the warrants for interest due Dec. 31, 1897, on the £400,000 5 per cent. debenture stock have been duly posted.

New Book.—"A Trip to Venus," a novel by John Munro, author of "The Wire and the Wave," "The Story of Electricity," etc. (London, 1897: Jarrold and Sons, 10 and 11, Warwick lane, E.C.)

A Rumour.—Sir W. G. Armstrong, Whitworth, and Co. have, it is stated, absorbed the well-known London firm of Easton and Anderson, Limited, of the Erith Hydraulic and Electrical Works.

Clerkenwell.—A special meeting of the Vestry of St. James and St. John was held on the 6th inst. to discuss the question of purchasing and maintaining an electric water-van for street watering in the parish.

Poplar.—A motion, already referred to by us, referring to the rescinding of a resolution disallowing further visiting expenses to the Electric Lighting Committee has now been disposed of by a vote of 12 for and 21 against such recision.

Lambeth.—At a meeting of the Vestry yesterday, a petition signed by owners and tenants in Bengeworth, Conderton, Bredon, and Cambria roads, on the subject of the erection of a dust destructor in the rear of Bredon-road, was discussed.

Colchester.—The Electric Light Works Committee's report that the temporary lighting of the military hospital had been taken over by Messrs. Siemens, Limited, and everything was working satisfactorily, has been adopted by the Council.

Bexhill.—The Urban District Council have received notice from the Local Government Board that an inspector will hold an enquiry at the town hall on the 12th inst. in reference to the Council's proposal to borrow £20,000 for the purpose of electric lighting.

Huddersfield.—The Chamber of Commerce have discussed the question of municipalisation of the telephones. A motion in favour of the Corporation's scheme, and also one to oppose the company's proposal, were advanced, but finally the discussion was postponed until the next meeting.

West Bromwich.—The Town Council will oppose the provisional order of the Electric Corporation for Power Distribution, Limited. During the debate on the subject it was mentioned that the Gas Committee had already negotiated for land for the generating of electricity.

Dublin.—The application of the Dublin and Manchester Steamship Company to erect poles in connection with a proposed installation of electric light at the place on Sir John's Quay where their steamers are to be berthed has been postponed for a week, pending the report of the harbour master and engineer.

Lincoln.—The Local Government Board have sanctioned the borrowing of £1,500 for land and £19,150 for electric lighting purposes, and the Council have agreed to create Lincoln £3 per cent. stock to raise such sums, and that the stock be issued in such sums as the Finance Committee should agree to.

West Derby.—The Board of Guardians of this union have instructed Mr. Thos. L. Miller, M.I E.E., of 7, Tower-buildings, Liverpool, to prepare full plans and specifications, and to invite tenders, for the lighting of their Mill-road Infirmary by electricity. The installation, we understand, is estimated to cost upwards of £5,000.

Kingston-by-Sea.—A parish meeting having on the 3rd inst. passed a resolution to the effect that it was desirable to light a certain portion of the parish of Kingston-by-Sea, a committee has been appointed to enquire into the whole matter of the lighting, and to report thereon to a parish meeting to be held that day fortnight.

Springfield.—The proposed application by the Chelmsford Electric Lighting Company for a provisional order to carry electric lighting works into Springfield has been considered by the Parish Council, and a resolution carried approving the introduction of the electric lighting system, and expressing the opinion that the wires should be laid underground.

Lacey, Clirehugh, and Sillar.—We are informed that Messrs. S. V. Clirehugh, M.I.E.E., A.M.I.C E., and F. A. Cortez Leigh, A.I.E.E, consulting electrical engineers, have entered into partnership with Mr. E. M. Lacey, A.M I.C.E., and Mr. A. M. Sillar, M.I E.E Their offices will be at 78, King street, Manchester, and at 10, Delahay-street, Westminster.

Matlock.—With regard to the proposed Bill of the Power Distributing Company, it was decided by the Urban District Council at its last meeting to oppose the application to Parliament. The company is formed with headquarters at Warsop, and the Chairman said if the Bill were obtained it would create a monopoly and place it in the hands of entire strangers.

Poplar.—A meeting of the Board of Works was held on the 4th inst. at which a report from the Electric Lighting Committee, recommending that the Board oppose the application of the County of London and Brush Provincial Electric Lighting Company, Limited, to the Board of Trade for a provisional order for supplying the district with electricity, was received.

Dewsbury. — The Electricity and Water Committee have reported that they have appointed Mr. G. H. Randall, of Gloucester, and Mr. W. Halliwell, of Dewsbury, to positions on the staff at the electric lighting station. They have also referred to a sub-committee a plan for an extension of electric mains in Oxford-road and two contiguous thoroughfares.

Portsmouth.—The Electric Lighting Committee reported to the Council at its last meeting that the borough accountant had submitted a demand for income tax which he had received, amounting to £143. 8s. The committee had offered no objection to the demand. The clause was referred back, and it was contended that there were really no profits to charge upon.

Westminster Electric Supply Corporation, Limited.—The following reduced rates, to take effect from the 1st inst., were fixed upon at a meeting on the 5th inst.: up to 4 000 units used in each year, 6d. per Board of Trade unit; over 4,000, 4d. net per unit; 3d. per unit will be charged for current used solely for purposes other than lighting, and supplied through a separate meter.

Fenton.—The North Staffordshire Tramway Company's application for an order to construct additional tramways in the district has been approved by the Urban District Council; and it has been resolved not to oppose the application of the British Electric Traction Company for an order authorising light railways in the district.

Wednesfield.—A deputation from the Midland Corporation for the supply of electric power attended a meeting of the Urban District Council, and explained the nature of the undertaking, asking for the support of the Council in the application for powers. Various questions were put as to the way in which Wednesfield would be affected, and the Council promised to consider the matter.

Burnley.—The Gas and Electric Lighting Committee, in extending the electric lighting station, have decided to adopt a different type of engine—viz., a high-speed compound-condensing three-crank engine of 450 b.h.p The procuring of such an engine, it was explained, would complete the system at the central electric lighting works, whereas by continuing the use of the present engines they could only get one fourth the power they required.

Electric Cabs in Leeds.—The electric motor cab has made its first appearance in the Leeds streets. By arrangement with the Leeds Corporation Hackney Carriage Committee, a specimen was sent down from the works of the London Electrical Cab Company, Limited, and was put to the test. Generally speaking, the impression formed by those who saw it and rode in it was distinctly favourable, the greasy state of the roads notwithstanding.

Otley.—At the last meeting of the District Council, it was proposed that tenders be invited from electrical engineers for lighting up the streets with the electric light. The Council was urged not to make the mistake which had been made by other authorities by allowing outsiders to step in and create a monopoly, which the Council would in a few years have to purchase at a considerable cost. After discussion, the matter was referred to a committee.

Calendar.—We have received of Messrs. Hodges and Todd a serviceable wall calendar for 1898. The firm state that during the last year the demand for their large switchboard and central-station requirements, ammeters, and voltmeters, together with their specialities in high-tension apparatus, has been far ahead of previous years, and that they have consequently opened new

premises in George-street, and cabinet works in Seaton-street, to cope with that increase.

Fairfield.—In reply to a question as to whether the Buxton provisional electric lighting order embraced the Fairfield district, it was stated at the Urban District Council's meeting that it was particularly mentioned that it only covered the Buxton urban district. Notice would have to be given before the Fairfield area could be included. The subject was deferred in order that a copy of the order be obtained.

Lowestoft.—A telephone labourer named Henry Simmons, aged 50 years, living at Great Yarmouth, was trimming a tree to clear it from off the telephone wires at Somerleyton, on the 21st ult., when he lost his footing and fell heavily to the ground. He was picked up and taken to the Lowestoft Hospital, where he was attended to by Dr. Bell, who found him suffering from internal injuries and severe bruises. The unfortunate man appeared to be progressing favourably, but died on Friday morning.

Newcastle-on-Tyne.—The plans of Messrs. G. W. Lummis-Paterson and Co. have been accepted for the electric lighting of Heaton-road Wesleyan Church. Tenders were received from nine firms.—The Parliamentary Committee have under consideration a letter from the Gateshead and District Tramways Company, stating that an agreement has been entered into between the company and the British Electric Traction Company, Limited, the main object of which is the substitution of electric traction in place of steam.

Waterloo-with-Seaforth.—At the ordinary monthly meeting of the District Council the Finance Committee's minutes were considered. They referred to the establishing of an independent telephone company in the district, and a letter which was received from the managing director and secretary of the new Mutual Telephone Syndicate, Limited, of Manchester, on the subject, requested the support of the Council in obtaining a license from the Postmaster-General. The clerk was instructed to write for further information.

Almanac.—One of the most unique almanacs we have seen is that issued by the Brockie-Pell Arc Lamp Company, Limited, 97, Queen Victoria-street, E.C. The dates of the days and the years up to 1903 are on a revolving cycle, and the days and the months are stationary. The year being set opposite the month gives a complete almanac for that particular month, and so on till the end of the chapter. The idea is very good, but to our mind it smacks somewhat of the slide rule! The device is protected by a provisional patent.

Commissioners of Sewers.—At a meeting held on the 4th inst. a motion that application be made to the Treasury asking for an enquiry into the cost and efficiency of the telephone service in London, and as to how far the chief officials of the Post Office have been concerned with the National Telephone Company was considered, and also a letter from the Charing Cross and Strand Electricity Supply Corporation, Limited, intimating their intention to apply for a provisional order to enable them to supply electric energy for lighting and motive power purposes within the City.

Rotherham.—The Sportsman Inn has been fitted with an electric lighting installation. Sixteen candle-power incandescent lamps are arranged in the rooms and passages. A 100-c.p. lamp is to be fixed at the outside of the hotel, and when the new assembly hall is finished that also will be lighted by about a dozen 16-c.p. lamps. The dynamo was made by Messrs. Royce and Sons, Manchester, and is driven by a gas-engine. The wiring and the fixing of the switches and other appliances has been entrusted to Messrs. Heap and Worthington, of Alexandra-road, Manchester.

Eccles.—The Council have accepted a number of tenders in connection with the electric lighting of the borough. The Council has been recommended to dispose of the plot of land, containing 1,766 square yards or thereabouts, situated at Hall Bank, Winton, conveyed by the Bridgewater Trustees to the late Local Board, on March 25, 1884, for an electric lighting station, subject to a yearly rent of £16. 19s. 4d. It is stated that the Corporation would have at its command a sufficient load for tramway service if at any time the electric system should be introduced into the borough.

Handley and Shanks.—We are informed that, owing to increased trade in Ireland, this firm have opened new offices and showrooms at 12, Dawson-street, Dublin. Mr. Arthur Handley, A.M.I.E.E., who has had 14 years' practical experience, will act as manager for Dublin and neighbourhood. The firm state that they undertake all classes of electrical work, and that they are carrying out large contracts for railway companies; also that during the last two years they have erected electric lighting plants, in Ireland alone, to the extent of over 1,000 b.h.p, or the equivalent of 20,000 8-c.p. lamps.

Eastbourne.—At the last meeting of the Town Council the Chairman of the Lighting and General Purposes Committee, in answer to a question when Messrs. Manlove, Alliott, and Co.'s report on the alteration of the destructor would be ready, replied that the borough engineer was engaged in obtaining and forwarding information. When such information had been discussed the firm's representative would go further into the matter with the borough engineer. The latter has also had an interview with Mr. Cooper, electrical engineer, who is engaged in sketching out a scheme of public lighting.

Electrical Power Storage Company.—A copy of the blotting-pad sent by the above firm this year to its chief supporters has reached us. We note that the Royal arms ornament each sheet of blotting-paper, accompanied by the words "by special appointment to H.M. the Queen." Hence, the pad will tend to remind us of the fact that the first Royal warrant given to the electrical trades was awarded this year. The general features of the pad, with its useful diary and calendar, are somewhat similar to that found in last year's issue. The information about the accumulators manufactured by the firm is, however, fuller.

Blackpool.—The *Yorkshire Post* of Dec. 31 says: "The Blackpool Tramway Committee met to consider a peculiar position of affairs yesterday afternoon. A short time ago they applied to the Local Government Board for permission to substitute the overhead trolley system for the conduit system of electric traction on the promenade. Not only has the Board refused this permission, but it has condemned the existing conduit system as well. This has come as a surprise upon the committee, who are going to interview the officials in London on the matter. Meanwhile, they have decided to lay a tramline through Claremont Park instead of along the low promenade."

Cardiff.—At the last meeting of the Electric Lighting Committee Mr. N. Appelbee, as electrical engineer, presented a report upon the question of condensing water at the electrical works, and the saving thereby effected. The report set forth the different methods of condensing, one of which had been tried at the electrical works for the past nine months, and had worked satisfactorily. The report recommended an extension of the system now in use—*i.e.*, the cooling by forcing the warm water at a slight pressure through a series of specially-shaped nozzles, which threw it into the air in jets of spray. Over £100 per annum would be saved by adopting this system. It was resolved that the report be printed and circulated.

Leeds.—At the last meeting of the Parliamentary Committee it was stated that a friendly interview with representatives of the House-to-House Electric Company had been arranged with a view to the purchase of their undertaking by the Corporation. The Corporation have passed a resolution confirming the committee's recommendation, and have also agreed to apply to the Local Government Board for a provisional order to issue irredeemable or redeemable stock, or for powers otherwise to enable them to acquire the House-to-House Company's undertaking. A joint conference of the committees of the Leeds and Bradford Corporations have come to the conclusion to jointly oppose in Parliament the Bradford and Leeds Light Railway Bill.

Removals.—Owing to 19, Great George-street being required for the site of the new Government offices, Edmundson's Electricity Corporation, Limited, have removed their offices to Broad Sanctuary-chambers, Westminster.—Messrs. Harrison and O'Brien have removed their offices and testing department from Albany-buildings, 45, Victoria street, Westminster, to 19 and 21, Queen Victoria-street, E.C. They state that at their new address they are increasing the size of their laboratory and testing department, and will now be able to undertake all classes of work in that line, in addition to outdoor testing and inspecting.—Messrs. Handcock and Dykes are removing on January 29 from 5, Victoria-street, S.W., to Westminster-chambers, 1, Victoria-street, S.W.

Torquay.—Mr. W. H. Trentham, engineer of the electric lighting works, has reported to the Town Council that practically the whole of the plant, save one engine and alternator, had been delivered. After his visit this week he hoped to be in a position to fix the date of the opening ceremony. The Town Clerk has reported that the electric light works had cost £21,180, which, with 5 per cent. for contingencies, came to £22,239, whereas they received sanction to expend £22,300. About £1,800 more would be required for consumers' extensions, and the works would be extended as the demand arose. They had probably not laid so much main as they intended (three miles), but they had only expended money on those roads from which they were likely to derive revenue.

Bedford.—At the last meeting of the Town Council it was unanimously resolved: (1) "That in the interests of trade, industry, and social commerce it is essential that the fullest possible development of the telephone service in this country should be promoted; (2) that in order to effect such development it is necessary that only a moderate rental be charged; (3) that the best and cheapest service can only be secured by competition; (4) that this Council earnestly requests the Postmaster-General to grant licenses to municipalities or companies which comply with the Treasury minute of March 23, 1892 (which provides that 'competition shall not be prevented'), without further enquiry as to charges of efficiency of present service, such enquiries involving unnecessary expenses and delay."

Bilston.—At the adjourned meeting of the Urban District Council the question of the Council's consent being given to the application of the Midland Electric Corporation and Power Distribution Company for a provisional order to supply electricity in Bilston was discussed. The following resolution was carried: "That the consent of the Council be given to the promotion of the order of the Corporation for supplying electricity within the district of Bilston subject to the following conditions: (1) that the promoters insert in the order provisions undertaking to supply electricity at the prices quoted by them to the Council; (2) that the consent is without prejudice to the Council's right to promote an order hereafter under the Electric Lighting Acts for supplying electricity within the district of Bilston."

Cheltenham.—The Electric Inspector reported to the Council at its last meeting the result of his tests of the electricity supply during the past month, showing a result for low-pressure cables averaging more than two volts above the legal standard. It was resolved that the extensions to supply current to various premises be carried out, and that the Local Government Board be applied to to add an additional £282 to the loan for which sanction has

already been applied for to provide for the cost of these extensions; and that a certain extension be carried out if the occupant will pay £30 towards the cost. The report was approved, and the recommendations of the electrical engineer were adopted. The electrical engineer was instructed to make an experimental trial of lamps, etc., for lighting the town clock by reflection.

Stirling.—At a recent meeting of the Police Commissioners that body was charged with unbusiness-like conduct. It was argued that their action of inviting Prof. Kennedy to come to Stirling before having ascertained his fee for reporting on the proposed electric lighting scheme was an unusual one, as they did not know from what source the expense could be met. The Board of Trade might not approve Prof. Kennedy's scheme, and in that case they would have no borrowing powers against which to debit the fees, while they had no power to take the expenses from the police rate. After some further discussion it was agreed to let the matter lie over until Prof. Kennedy came to Stirling. This view on the matter is entirely incorrect, as the Act provides distinctly that such preliminary expenses may be met out of the rates.

Islington.—An ordinary meeting of the Vestry will be held to-day, at which a report from the Electric Lighting Committee will be considered. The report states that the committee has had under consideration the question of erecting an arc lamp on the refuge at the junction of Canonbury and St. Paul's roads, and is of opinion that as the corner is a very dark one it would be distinctly advantageous for the better illumination of this point; that it has also considered the advisability of erecting an arc lamp on the refuge in Holloway-road between Seven Sisters and Parkhurst roads, and is of opinion that considering the amount of traffic there an additional lamp would greatly improve and properly complete the illumination at this point; and recommend that the two lamps in question be erected at a total estimated cost of £206.

St. Pancras.—A general meeting of the Vestry was held on the 5th inst., when the adjourned discussion on a motion that the Vestry approve of the whole scheme of the extension of the electric lighting to the Highgate district, including the provision of mains and distributing plant for the supply of current to the side streets, as set forth in the report of the Electricity and Public Lighting Committee, was resumed, and also on a motion to the effect that before proceeding with the extension of the electric lighting mains into the Highgate district, the Electricity and Public Lighting Committee be instructed to send a circular, as provided in the St. Pancras lighting order, to every occupier in the streets proposed to be lighted, enquiring whether they were willing to take the current and to what extent; the committee to report the result of the enquiry to the Vestry.

Ipswich.—An animated discussion has taken place over the question of gas *v.* electricity in the lighting of the new workhouse. The question was finally settled by the chairman's casting vote in favour of the electric light. The first report on this question was presented on Dec. 11, and its consideration was adjourned in order that members might consider the details. The Workhouse Erection Committee now presented a supplementary report, which was accompanied by an elaborate table showing the relative cost of gas and electricity. The conclusion arrived at, in brief, was that electric lighting will involve an expenditure of about £206. 11s. a year, with from £40 to £50 interest on capital outlay, and that the net charge for gas per annum will come to £278. 3s. 6d. Under these circumstances the committee recommended that the new workhouse should be lighted by electricity.

Swansea.—The work of laying down plant, etc., for the installation of the electric light at the market, which was done by Mr. J. S. Brown, Oxford-street, has been completed. The engine is a horizontal electric light engine, capable of developing 40 b.h.p., and the dynamo is one of the Electric Construction Company's latest improved wound dynamos for an output of 22,000 watts—a quantity of light equal to 36 2,000-c.p. lamps. Three heavy mains are carried by cast-steel suspenders from the premises of the Swansea United Breweries to the switchboard in the centre of the market, and from this switchboard there are 12 branch circuits, each containing two Koerting 2,000-c.p. lamps so arranged that if anything should go wrong with any of the circuits the accident could only affect two lamps, leaving the other 22 intact. These particular lamps, unlike others very much in use, are said to give an absolutely steady light.

Manchester.—The Manchester Carriage and Tramways Company propose to introduce a Bill to enable them to work the system of tramways now under their control by electricity. The City Council are committed to the policy of tramway municipalisation, with electricity as the motive power, upon the expiration of the leases now held by the company, and their opposition to the company's Bill will be of a strenuous character. The opinion is held by several members of the Corporation that the company are promoting the Bill simply to strengthen their position in view of the negotiations for purchase.—The report of the Electricity Committee recommending the purchase of land for a new generating station has been agreed to. It has also been resolved to apply to the Local Government Board for sanction to borrow further moneys (£50,000) for the purposes of the Manchester Electric Lighting Orders, 1890 and 1896, and of Part V. of the Manchester Corporation Act, 1897.

Chelmsford.—Mr. A. H. Pott, representing the Chelmsford Electric Lighting Company, attended before the Rural District Council at its last meeting in reference to the application of his firm for a provisional order for the extension of the light to several parishes in the union. In reply to questions, Mr. Pott stated that the proposed order would relate to the parishes which touched Chelmsford borough—Springfield, Broomfield, Widford, Great Baddow, and Writtle. The Board of Trade would not allow them to put the wires overhead in any urban district. As to other places, it was a matter for the consideration of the District Council, who might make representations to the Board of Trade. Later on the matter was considered *in camera*. It was understood that neither the Council nor the parishes concerned had any desire to oppose the company's application, subject to certain conditions. There was a unanimous expression of opinion that the wires should be carried underground.

Wolverhampton.—Rapid progress is being made with the new electric sub-station at Chapel Ash, and it is hoped that in a month's time it will be in working order. When this is done the mains will be extended down the Tettenhall, Compton, and Merridale roads, in which thoroughfares there are a considerable number of residential dwellings, the occupants of which are expected to use the electric light instead of gas. The electricity turned out on Christmas Eve shows an increase of 34 per cent. over that turned out on that day in 1896. There is always a good demand before Christmas, and the officials at the head office reckon to get more customers in the Christmas quarter than any other. If this increase is maintained, there can be no doubt that the time is not far distant when the light will be extended over the entire borough. This speaks well for the popularity of the illuminant. It may be added that an additional boiler is about to be put in at the Commercial-road works, and in a month's time another new engine will be placed there.

Hanley.—The *Staffordshire Advertiser* says amongst the many matters which the enterprising Corporation of Hanley have done, perhaps nothing has been more successful than the establishment of electric lighting in the borough. Since its introduction about four years ago the demand for this new system of illumination has exceeded the expectations of its advocates, and has silenced, through its success, the criticisms and prognostications of its opponents. So much has the demand increased that during the year it was found necessary to make further application to the Local Government Board for extended borrowing powers, and the enquiry, which was held in May last before Colonel J. T. Marsh, resulted in the consent to pledging the town to a further expenditure of £15,000. It is a notable fact that from its inception down to the present time not a single penny has been charged against the rates of the borough, but the instalments of principal and interest on the sinking fund has been paid out of the receipts, and the price of gas, which was 3s. 6d. per thousand cubic feet, has been reduced to 2s. 3d.

Eastern Telegraph Company.—In a Bill to be introduced into the next session of Parliament by this Company, power is sought to create £2,000,000 "new 3½ per cent. cumulative preference stock" for "the purpose of converting into preference stock the existing preference shares, and for raising further capital for the purposes of the Company." The conversion of the existing preference shares is proposed to be effected by giving to each holder £18. 10s. of the new preference stock for every £10 share now held. The balance of the new preference stock which is not required for the purpose of this conversion "may be created and issued as the directors see fit and applied to any purposes of the Company to which capital is properly applicable." The Bill further provides for the creation and issue of new additional preference stock or shares from time to time, provided that the total amount of preference capital shall not exceed one-half of the ordinary capital. According to the preamble, the ordinary share capital already issued is £4,000,000. The Company also seek power to create and issue debenture capital to any extent "not exceeding one-third of the total amount of the capital in ordinary and preference stock and shares for the time being created and issued." At the present time the total amount of debenture stock issued is £1,521,868, but of this sum £89,600 5 per cent. stock is redeemable in 1899.

Waterloo.—A meeting of the Parish Council was held recently for the purpose of considering the question of a proposed tramway from Cosham to Horndean, at which Mr. A. W. White, J.P., explained that a company had been registered, called the Hampshire Light Railway Company, with the object of intersecting the districts unserved by railways, and bringing such districts into communication with the railway stations at various points. The present object of the company was to acquire from the Provincial Tramways Company the tramway line from Hilsea to Cosham, and relay it as part of the proposed light railway; then carry it along the main road as far as The Priory at Cosham, divert from the main road on the west side of Cosham, and crossing the Porchester-road and the Southwick road, join the main road at the top of Portsdown-hill, proceeding thence along the main road to Horndean. The object of this tram service would be not only the conveyance of passengers, but by specially constructed vehicles goods would be taken from the trucks at Cosham Station and delivered at houses all round the district. The company had taken powers to supply electric light in conjunction with their light railway scheme, so that Cosham, Purbrook, Waterloo, and Horndean will immediately secure the advantage of that system of illumination. The Council unanimously passed a resolution in favour of the scheme.

Wednesbury.—At the last ordinary meeting of the Town Council, the Town Clerk stated that he had received a communication from the Board of Trade announcing that they had granted to the South Staffordshire Tramways Company permission to use steam on their lines for a further three months. The Board of Trade added that they had urged the improvement of the tram service, and had told the company they must not rely upon obtaining further extensions. The General Purposes Committee recommended that the town clerk be instructed to oppose the

application of the Midland Electric Corporation for Power Distribution, Limited, for a provisional order to supply electricity in the borough. It was considered that the Town Council should take upon itself to as soon as possible supply electrical power. They might start in a small way, and they must show the Board of Trade that they were anxious to do something for themselves, or they might pass over their opposition The Mayor said the matter of electricity had occupied his attention for some time, and it appeared to him they would not have to secure an order to supply the town hall, art gallery, post office, and the School Board offices. Before the question was thoroughly taken up he thought the ratepayers should be appealed to. The Town Clerk remarked the cost of the opposition would not be excessive, and ultimately the resolution was carried.

Middlesbrough.—At the last meeting of the Electric Lighting Committee of the Corporation a consultation took place with Mr. Hammond, advising engineer, and the following area was selected for compulsory lighting by electricity for all purposes, including household, street, and shop lighting: South-street, Sussex-street, Linthorpe-road to Southfield-road, Southfield-road to Dairy Knoll, and thence to the left—Albert-road, Queen's-square, Durham-street, East-street, and the Market-place; all Corporation-road, Zetland-road, and Newport-road to St. Paul's Church. At the last meeting of the Streets Committee attention was called to the unsatisfactory state of the telephone service in Middlesbrough, and a reduction of rates was advocated. The Town Clerk said he had received a letter and a prospectus from the Mutual Telephone Company of Manchester, expressing their desire to extend their service to Middlesbrough on the grounds that the telephone service of the country was becoming too much a monopoly of the National Company, and that in the interests of industry, trade, and social convenience such a monopoly was undesirable. They stated that they had already got over 2,000 subscribers, and asked the Corporation to pass a resolution as required by the Treasury asking them to extend their service to Middlesbrough. A resolution as desired was passed, and the company is to be asked for an estimate for connecting all the municipal offices in the town.

Belfast.—The following report of the Electric Committee has been adopted by the Council: The new station buildings are now progressing satisfactorily, the delays in the earlier stages of the work being chiefly caused by the difficulty in obtaining the structural ironwork. The contractors expect to have completed the first section of the work by the middle of February, and soon after that the committee hope to be in a position to supply current. They recommend the Council to approve of the adoption of Wright's system of charging for electric current as from July 1 next. Over 30 of the principal towns of the United Kingdom have already adopted the system, and many others have it under consideration. The principle has been fully explained in the chairman's report, a copy of which was furnished to each member of the Council, and its effect will be beneficial to the department, owing to the increase in the number of consumers who use the current for several hours daily, and to the consumer by the reduction of the charge till electric light becomes as cheap as other illuminants. The committee also desire authority to supply and let on hire motors, for which they propose to charge a rental of 15 per cent. on cost to cover interest, sinking fund, and depreciation, with the object of increasing the output during daytime when the works would otherwise be idle and unproductive. In Bradford this system has been introduced with marked success.—The following have been appointed members of the Electric Committee: Aldermen M'Connell and Pirrie, and Councillors Andrews, Dawson, Hutton, Laird, Liddell, Macartney, Magee, O'Connell, Taylor, Thompson, Wheeler, Wilson, and Workman.

Rochester.—A town's meeting, called to consider the proposal to establish a comprehensive and extensive system of electric trams for Rochester, Chatham, and district, was held at the New Corn Exchange, Rochester, last week. Mr. Fraser, the engineer to the company, entered into an elaborate description of the proposed scheme, which will connect all points of Chatham, Rochester, Strood, and Gillingham, and so tend to a development of trade in the district. He remarked that a statement of the cost of construction of the line had been lodged with the town clerk. That estimate gave the cost at about £150,000, without electrical equipments, cars, or anything else. He (Mr. Fraser) would think it extremely good business if they were able to get the line down for £200,000. He told the meeting, and he was responsible for what he said, that the whole of the £200,000 was ready. The company would keep the road in repair to the satisfaction of the surveyor. The company would pay nothing for the privilege of going through the streets, and so "spoon-feed" the ratepayers both ways, as they would have cheap fares. The scheme could be municipalised in 42 years. As to the completion, there was a clause in the order that the scheme was to be completed in five years. Ultimately the following resolution was carried: "That this meeting, having heard the details of the proposed scheme of electric tramways for Rochester and district, hereby expresses its approval of such scheme."

Norden.—The District Council having no desire to incur the expense of obtaining borrowing powers, the contract for lighting the length of 1,300 yards of main road was let to Mr. G. L. Adamson, electrical engineer, Smallbridge. The formal inauguration ceremony took place in the power-house at Wolstenholme on Friday last. The work had been almost completed, and it would have been entirely finished had it not been for the inclemency of the weather for some weeks after the contract was let, and for other matters over which the contractor had no control. Although the District Council could not induce the Rochdale Corporation to light the road now under notice, they are using Rochdale gas to provide the present illuminant. The power-house is a roomy brick building, capable of holding a much larger plant. It is stationed near the end of the gas-main, and contains a 2-b.h.p. gas-engine, specially made by the National Gas-Engine Company for the purpose to which it is now being put. This engine drives a dynamo capable of generating the current at 250 volts necessary to supply the line. On a wall near the dynamo is fixed a switchboard containing a double-pole switch, a fuse lightning arrester, a pilot lamp, etc. The line is made of copper wire, and is mounted on fluid insulators to give high insulation. The poles on which the line is carried are 50 yards apart, and on each alternate pole is fixed a strong lamp bracket. The lamps are of Edison-Swan manufacture. They are of high efficiency, and are each 25 c.p., and $2\frac{3}{4}$ watts per candle-power. To provide additional protection for the installation against damage by lightning, a barbed steel lightning wire has been fixed above the whole length of the line, and it is connected with the earth at each pole. At the close of the formal proceedings on Friday, the party adjourned to the Technical Institute, Norden, where Councillor Cudworth entertained the whole company at dinner, when the usual toasts were proposed and responded to.

Nottingham.—At the last meeting of the City Council, the provisions of a Bill deposited for introduction in next session was considered. The Bill is promoted by Mr. Thos. Thompson, Mr. William Alexander McArthur, Mr. Ernest Arthur Lazarus, and Mr. Albert Robert Monks, with the object of incorporating a company with compulsory powers to purchase land at a place called Sookholme, near Warsop, and to erect thereon machinery for generating electricity. The company also propose to take powers to distribute this electricity to a radius including an area of 26 miles from the north-west corner of the parish church at Warsop, and all the cities, county, or other boroughs, towns, villages, urban districts, and all other places within that radius. They also seek to acquire powers to lay mains to supply beyond that radius, but in that case with the consent of the road authority. The company do not propose to ask for exclusive right to supply energy to all the area referred to. They ask that powers may be conferred upon them to break up streets for the purpose of laying mains and pipes, for putting in street boxes, and for other purposes of their undertaking, without the consent of the local authority within the area. Fourteen days, however, before the commencement of any such works the company must serve notices upon the local authority describing the proposed works. If the local authority object thereto the company may appeal to the Board of Trade, and the Board of Trade may make such order in the matter as they think fit. The capital of the company is set down at £750,000, in shares of £10 each, with powers to borrow £250,000 in the happening of certain events. The company cannot issue shares until one-fifth of the capital has been paid up. The area referred to in the Bill includes Nottingham on the south, Sheffield on the north, Lincoln on the east, and Derby on the west. After carefully considering the Bill, the City Council unanimously resolved to offer uncompromising opposition to it in Parliament, on the ground that it would alter the practice of Parliament with regard to this city, where for the last quarter of a century it has been the struggle of the inhabitants to secure their streets from disturbance by private companies, and on the ground that the gas, water, and electric lighting supply were taken over in order that the Corporation might have full control over such matters. A committee was formed for the purpose of taking charge of the opposition of the measure, and the town clerk was instructed to draw up a petition against it, and take all other necessary steps which were required.

PROVISIONAL PATENTS, 1897.

DECEMBER 28.

30572. Improvements in joints for electricity conductors. Cecil Charles Fowler and the Mutual Electric Trust, Limited, 111, Gloucester-road, Brighton.

30619. Improvements in primary galvanic batteries or cells. James William Bullock, 143, Gidlow-lane, Wigan.

30622. A combined manual and automatic switch for electric circuits. Robert Lee Hailey, 17, St. Ann's-square, Manchester.

30626. Improvements in the method of and means for regulating the phase relation between current and electromotive force in alternating-current systems of electricity distribution. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Charles P. Steinmetz and Edwin W. Rice, jun., United States.) (Complete specification.)

30627. Improvements in and relating to electric railways. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (William B. Potter, United States.) (Complete specification.)

30628. Improvements in induction wattmeters. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Elihu Thomson and William H. Pratt, United States.) (Complete specification.)

30678. A new or improved method of retransmitting telegraphic messages and apparatus for use in connection with the said method and for other purposes. John Rymer-Jones, Norfolk House, Norfolk-street, Strand, London.

30686. Improvements in and relating to primary batteries. Charles Jones Hubbell, Harry Gross Hubbell, William de Walde Boyer, and Edward Pierce Mucklow, 77, Chancery-lane, London. (Complete specification.)

DECEMBER 29.

30744. Improvements in coating tubes by electro-deposition. James Greenwood, 4, South-street, Finsbury, London.

DECEMBER 30.

30832. Improved arc lamp carrier. James Brockie, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

30838. Improvements in apparatus for use in the manufacture of accumulator plates. Carl Marschner, 111, Hatton-garden, London. (Complete specification.)

30841. Improvements in electrolytic apparatus. George Croydon Marks, 18, Southampton-buildings, Chancery-lane, London. (Henri de Solages, France.)

30846. A method or methods for controlling a mechanism or mechanisms by means of electric or electromagnetic waves of high frequency. Ernest Wilson and Charles John Evans, 64, St. John's-park, Blackheath, London.

DECEMBER 31.

30848. Operating railway points by electromotors. Illius Augustus Timmis, 2, Great George-street, Westminster, London.

30881. A new or improved method of electrical signalling. Samuel John Motton, 8, Coulson's-terrace, Penzance.

30912. Improvements in electrical resistance apparatus. Henry Alexander Mavor and Mavor and Coulson, Limited, 46, Lincoln's-inn-fields, London.

30917. Improvements in electrically-operated clocks. Richard Bürk, 6, Lord-street, Liverpool. (Complete specification.)

30923. Improvements in electric elevators. Henry Harington Leigh, 22, Southampton-buildings, Chancery-lane, London. (Frank J. Sprague, United States.)

30926. Improvements in or connected with fog signalling apparatus for railways. Herbert Tomlins and the Electric Fog Signal Syndicate, Limited, 53, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1896.

28367. Electric arc lamps. Hungerbühler.

28400. Electrically-propelled motor road vehicles. Thompson. (Dulait.)

28704. Switches for electric currents. Rawlings and Rawlings.

28725. Prepayment meters for gas or other fluid and electricity Webber.

1897.

73. Apparatus for the manufacture of metallic pipes and rods, and for covering electric telegraph and telephone cables and wires. Wylie.

615. Means for electrically obtaining ozone and employing the same for curative and other purposes. Böhm.

1337. Electrical apparatus for the production of ozone or for other purposes. Verley.

1581. Electric lampholders, wall sockets, and the like. Swift.

2039. Electrically-operated gas burners. Pettersson.

2275. Electric meters. Tomkins.

2559. Method and apparatus for dividing an alternating-current into two currents whose phases are shifted relatively to each other, more particularly applicable for working or starting single-phase alternate-current motors. Siemens Bros. and Co., Limited. (Siemens and Halske.)

3330. Electric arc lamps. Davy.

3594. Telephone systems for common or party telephone lines and switch devices for use therein. West.

4035. Insulation of electrical conductors. Bathurst.

7005. System of current supply for electric railways. Petzenbürger.

11383. Electric heel plates and like articles. Gibbs.

14708. Apparatus for coating metal articles by electro-deposition. Nash.

19179. Process of manufacturing white lead by electrolysis. Woltereck.

20500. Surface-contact electric railways. The British Thomson-Houston Company, Limited. (Parker.)

21705. Secondary electric batteries or accumulators. Hart.

22203. Process of and apparatus for electrically treating ore. Boult. (Soden.)

22216. Electric recording wattmeters. The British Thomson-Houston Company, Limited. (Pratt.)

23033. Electric plug contacts. Gover, Blair, and Proctor.

23369. Electric safety fuses. Gover and Proctor.

25386. Chemical-electric generators. Hess.

25528. Valve apparatus for electric batteries. Akester.

25745. Reactance coils. The British Thomson-Houston Company, Limited, and Hobart.

TRAFFIC RECEIPTS.

Bristol Tramways.—The traffic returns for the week ending December 31 were £2,654. 0s. 1d., compared with £2,394. 2s. 3d. for the corresponding period of last year, being an increase of £259. 17s. 10d.

Dover Tramways.—The traffic receipts for the week ending January 1 were £150. 0s. 0d. The total receipts up to the same date were £1,931. 10s. 11d. The mileage open at present is 2½ miles.

Birmingham Tramways.—The traffic receipts for the week ending January 1 were £4,057. 3s. 5d., as compared with £3,709. 13s. 1d. in the corresponding week in 1897, being an increase of £347. 10s. 4d.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended January 2 amounted to £1,357, as compared with £1,374 in the corresponding week of the previous year, being a decrease of £17.

City and South London Railway.—The returns for the week ended January 2 were £1,050, compared with £1,077 for the corresponding period of last year, being a decrease of £27. The total receipts for the half-year amounted to £1,050, compared with £1,077 for the corresponding period last year, being a decrease of £27.

South Staffordshire Tramways.—The traffic returns for the week ending December 31 were £718. 15s. 4d., as compared with £718. 2s. 9d. in the corresponding week of the previous year. The aggregate receipts so far were £32,924. 5s. 3d., as compared with £31,838. 10s. 1d. in the corresponding period in 1896.

S.D. Tramways, Dublin.—The traffic receipts for the week ending December 17 were £366. 6s. 10d., as compared with £414. 10s. 0d. in the corresponding week in the previous year, being a decrease of £48. 3s. 2d. The number of passengers carried was 63,574 in 1897 and 63,798 in 1896. The aggregate returns up to date are £15,035. 8s. 3d., as compared with £15,853. 18s. 1d. last year, being a decrease of £818. 9s. 10d. The mileage open is the same as last year—viz., eight miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	11½
Brush Company, Ordinary	3	1¾-2¼
—— Non. Cum., 6 per cent. Pref.	2	2¼-2¾
—— 4½ per cent. Debenture Stock	100	109-113
—— 4½ per cent. 2nd Debenture Stock	100	100-103 xd
Callender's Cable Company, Debentures	100	107-111 xd
—— Ordinary	5	7-8
Central London Railway, Ordinary	10	9½-10½ xd
——	6	5½-6 xd
—— Pref. Half-Shares	1	1¼-1½ xd
—— " "	5	4-4½ xd
Charing Cross and Strand	5	12½-13½
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	10½-11
—— 4½ per cent. Debentures	100	112-114 xd
City of London, Ordinary	10	26-27
—— Prov. Cert.	10	25½-26½
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	129-134 xd
City and South London Railway, Consolidated Ordinary	100	67-69
—— 4 per cent. Debenture Stock	100	138-140
—— 5 per cent. Pref. Shares	10	15½-16
—— " " " '96	10	13½-14½
County of London and Brush Provincial Co., Ordinary	10	13½-14
—— 6 per cent. Cum. Pref.	10	15½-16
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
—— 5 per cent. Debentures	—	86-91 xd
Edison and Swan United Ordinary	3	2½-3
—— 5 per cent. Debentures	5	4½-5½
Electric Construction, Limited	2	2½-2¾
—— 7 per cent. Cumulative Pref.	2	2½-3¼
Elmore's Copper Depositing	1	¼-¾
Elmore's Wire Company	2	½-1
W. T. Henley's Telegraph Works, Ordinary	10	20-21
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	11-11½
India Rubber and Gutta Percha Works	10	23½-24½
—— 4½ per cent. Debentures	100	105-107
Kensington and Knightsbridge Ordinary	5	14½-15½
—— 6 per cent. Pref.	5	8½-8¾
London Electric Supply, Ordinary	5	2½-2¾
Metropolitan Electric Supply, Limited, Ord. No. 101-50,000	10	18½-19½
—— " " " 50,001-82,500	10	18-19
—— 4½ per cent. First Mortgage Debenture Stock	100	117-121 xd
National Telephone, Ordinary	5	6½-6¾
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	14-16
—— 5 per cent. Non. Cum. Third Pref., No. 1-119,234	5	6-6½
—— " " " 119,235-250,000	4	5½-6½
—— 3½ per cent. Deb. Stock, Red.	100	103-107 xd
Notting Hill Company	10	17½-18½
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8-8½
—— £4½ shares	4½	7-7½
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal	—	145-147
—— 4½ per cent. First Shares Mortgage Debentures	100	105-107
South London Electric Supply, Ordinary	2	2½-2¾
St. James's and Pall Mall, Limited, Ordinary	5	17-18
—— 7 per cent. Pref.	5	10-11
—— 4 per cent. Deb. Stock, Red.	100	101-104 xd
Telegraph Construction and Maintenance	12	36-39
—— 5 per cent. Bonds	100	101-104 xd
Waterloo and City Railway, Ordinary	8	12½-13 xd
Westminster Electric Supply, Ordinary	5	16-17
Yorkshire House-to-House	5	8-8½

NOTES.

Faraday House.—Mr. James Swinburne commenced yesterday a course of lectures at the above institution on "Dynamo and Transformer Construction."

Plough for Conduit Lines.—The illustrated article on the plough for electric conduit lines which appeared in our last issue should have been accredited to *Dingler's Journal.*

The Persian Murder.—The recent sad death of Mr. Graves, the telegraph official in Persia, will be remembered by all. We are glad to hear that a punitive expedition has left Bombay to mete out justice or vengeance on the offending tribesmen.

The "Zeitschrift fur Elektrotechnik" of Vienna appears now in quarto form. Hofrath Kareis, who has been the editor of that journal during the last 15 years, retired on the first of this month, and Dr. Sahulka has been appointed in his stead. We wish the new editor every success.

The City of London Tradesmen's Club.—Mr. Robert Hammond delivered an address on "Electric Lighting" before the above club on Thursday last. The rival attractions of the Institution of Electrical Engineers prevented us from accepting an invitation to be present.

The Institution of Civil Engineers.—At the ordinary meeting on 11th inst. the paper read was on "The Machinery Used in the Manufacture of Cordite" by E. W. Anderson, A.M.I.C.E. At the students' meeting to-day, the paper to be read will be on "Mechanical Draught," by R. Gordon Mackay, Stud.Inst.C.E. Sir Albert J. Durston, K.C.B., M.I.C.E., will preside.

Royal Meteorological Society.—The annual general meeting of this society will be held at the Institution of Civil Engineers, Great George-street, Westminster, on Wednesday, the 19th inst., at 7.45 p.m., when the report of the council will be read, the election of officers and council for the ensuing year will take place, and the president (Mr. E. Mawley, F.R.H.S.) will deliver an address on "Weather Influences on Farm and Garden Crops," which will be illustrated by lantern slides.

Paris.—Procrastination is not, after all, the sole characteristic of British officialdom, for it was only in November last that the Chamber of Deputies determined to adopt the electric lighting for use in the chamber. Of course we cannot understand the delay in adopting electric lighting in all public buildings, especially in highly decorated rooms and where pictures abound. However, as has been said, all things come to him who knows how to wait. We have plenty of offices not yet electrically lighted, and trust there may be little more delay ere the work is put in hand.

Institution of Junior Engineers.—The next meeting of the above institution will be held at the Westminster Palace Hotel on Friday, the 21st inst., at 8 p.m., when Prof. A. C. Elliott, M.I.C.E., Hon.Memb.I.J.E., of Cardiff, will give a lecture on "Laboratory Testing Machines." The next day (Saturday, 22nd) a visit is to be paid at 3 p.m. to the engineering laboratory of the Central Institution, South Kensington, when Prof. W. C. Unwin will give a demonstration of the working of the testing machines under his care. A better combination of lecture and visit could not have been selected.

A Retrogressive Invention.—We see in the daily press that a Mr. Randall has invented a new telephone, to be used on the ordinary telegraph circuits with iron wires. As the *Daily Mail* naively puts it, he is able to use a much stronger current. The wire is cheaper, and as an earth return is possible, only half the length of wire is required. In spite of these so-called advantages, the new invention did not give satisfaction on Tuesday last, when the attempt was made to speak from London to Stockport. We would advise Mr. Randall to study the first principles of telephony before finally deciding that an earth return circuit will give satisfaction for telephonic purposes.

Royal Institution.—On Tuesday, Jan. 18, Prof. E. Ray Lankester will begin a course of 11 lectures at the Royal Institution on "The Simplest Living Things"; on Thursday, Jan. 20, Prof. Dewar will deliver the first of a course of three lectures on "The Halogen Group of Elements"; and on Saturday, Jan. 22, Prof. Patrick Geddes will begin a course of three lectures on "Cyprus." The Friday evening meetings of the members will be resumed on Jan. 21, when Sir John Lubbock, M.P., will deliver a discourse on "Buds and Stipules." At a meeting of the managers, held last week, Prof. E. Ray Lankester was elected Fullerian professor of physiology in the Royal Institution.

Co-operative Enjoyment.—The staff of three of our largest London electric lighting companies combined to hold a smoking concert in The Falstaff, Eastcheap, on Tuesday last. The companies represented included the City of London, the Metropolitan, and the London Electric. Mr. A. H. Walton, acting engineer of the Metropolitan Company, was in the chair, and a most enjoyable evening was spent. About 200 attended this concert, and it was announced that at the next smoker, to be held in February, Mr. P. W. D'Alton will take the chair, and Mr. G. Partridge the vice-chair. We note especially that the songs were all contributed by amateurs on the staffs of the electric lighting companies.

Exhibitions.—The Paris Exhibition of 1900 is fast taking definite shape. The following gentlemen have been nominated to form the committee of Group V.—Electricity: For Class 23, dealing with the production and mechanical utilisation of electricity, MM. A. Guitton and L. Lombard-Gerin; for Class 24 (Electro-Chemistry), M. J. Sarcia; and for Class 25 (Electric Lighting), MM. P. Azaria, E. Berthier, A. Chatard, A. Ducommum, and A. Tricoche. Two years may seem a long time in which to perfect the organisation of an exhibition, but it must be remembered that there are exhibitions and exhibitions, and that of 1900 at Paris is to be the most complete, the best organised, and the most wonderful the world has ever seen.

Berlin.—The *Bulletin des Usines Electriques,* in an article discussing the question of extending the time of the concession for lighting Paris, gives a few interesting details about Berlin to the effect that there are some 300,000 incandescent lamps of 16 c.p. installed, besides several thousand arc lamps. The length of mains is about 186 miles, and the power developed is about 28,000 h.p. There are also some 1,600 motors, taking 6,450 h.p. The price for lighting is 7·5d. per kilowatt-hour, for power 2d. per kilowatt-hour. Paris demands some 25,000 h.p. for about 418,000 lamps of 10 candles and 7,448 arc lamps, with about 240 miles of mains. The motors number 513, requiring 1,940 h.p., and the price is 11½d. per kilowatt-hour.

Power Distribution.—Several of the large towns in the Midlands are now considering the proposals of a company who wish to obtain a provisional order for the supply of electrical energy for power purposes in their districts. As will be seen in another column, the company in question is willing to agree not to supply light, and also not to supply power, in certain cases without the consent of the corporations concerned. Private consumers would be supplied with power at 1d. per unit as a maximum, and reductions below this are hinted at. That power must be

supplied below that price to compete with steam plant in such places where coal is cheap is well known. The company will on their part have to secure the best-designed machinery and mains to enable them to earn profits at these rates.

North-East Coast Institution.—The third general meeting of the session of the above institution of engineers and shipbuilders will be held in the lecture theatre of the Technical College, Hart-road, West Hartlepool, to-morrow, the 15th inst., at 6 p.m. Papers will be read by Mr. Archibald McGlashan on "Water Ballasting of Steamers," and by Mr. H. E. J. Camps on "Some Considerations in Connection with the Transverse Framing of Ships." Members attending the meeting will have an opportunity of seeing the electric transmission of power plant installed in the works of Messrs. Thos. Richardson and Sons. The plant in question is of the three-phase type, and will repay careful inspection. The visit to the works is timed for 3 p.m. The annual dinner of the institution is to be held in Newcastle-on-Tyne on Feb. 4.

Another Chance.—The Queensland Commissioners, we are informed, are enquiring as to the practicability of using electricity as the motive power for the suburban railway line. No doubt our English firms are fairly represented in Australia, but facts are nasty things to deal with, and when we find Sydney dealing with America for the George-street tramway stock, we wonder why our firms do not come in. Perhaps Mr. P. Sellon has hit the nail on the head when he corroborates the views often expressed in these pages as to wages and hours of work. You cannot expect purchasers to pay more to us for a thing they can get equally well from America. A representative manufacturer recently told us that he was compelled to get machinery from America, but that he did not like this, and had determined to manufacture for himself. Perhaps with automatic machinery we may circumvent our competitors yet.

Rontgen Society.—Mr. William Webster read a paper on "Practical Work with the X-Rays" before the Röntgen Society on the 11th inst. He also showed a number of photographs, lantern-slides, and screen experiments. The demonstration and lecture were both on similar lines as that which took place at the Camera Club recently, and to which we have already referred. The slides shown were mostly chirurgical cases, and Mr. Webster went more into the mechanical details of the process. He said that for quick exposures it was highly advantageous to place a thick glass plate between the photographic plate and the subject. By arranging a mirror, the process of exposure might then be watched by removing the back slide behind the photographic plate. Short exposures with a heated cathode gave the best results. The "singing anode" came in again for discussion, but the phenomenon was not further elucidated.

Short Belt Drives.—The exponent of the use of belt-driven sets with short drives in this country is undoubtedly Dr. John Hopkinson, and the Manchester station is the outcome of his advice. The use of a well-designed jockey pulley to diminish the distance between engine and dynamo, and to increase the arc of contact between the belt dynamo pulley, has been successful. Even then the floor space required for a given power is more than with direct-coupled sets. An article in the *Western Electrician* on a compact central station at Flushing recalls, however, the excess to which such belt driving can be carried. In this case the belt does not pass round and over the engine flywheel, but after coming under the wheel and up to a point just over the horizontal axis at the side furthest from the dynamo, it goes back over two jockey pulleys, below the under side of the wheel, and along to the dynamo pulley again. The lower jockey pulley is used to tighten the belts. The result is not pretty to look at, and the strain on the upper jockey pulley is heavy. The floor space occupied is more than that with the single jockey pulley at Manchester, and is also much more expensive in upkeep than a direct-driven set.

Motor Wagons.—A general move is being made by corporation engineers to obtain details of motor wagons suitable for the collection of refuse and other general work. The driving power is a matter of indifference to these gentlemen, provided the wagon is not a nuisance to the general public, and hence electricity has a distinct advantage over oil and gas driven vehicles. We notice that in nearly all cases the designs of the motor wagons are asked for to enable the town engineers to judge of the value of the wagons when built. In the case of Wolverhampton, however, the Corporation go so far as to propose to purchase 10 complete wagons. Where the electricity works belong to the corporation, as they do at Wolverhampton, and consequently power can be obtained in the daytime at cost price, there should be a good prospect for the electric accumulator wagons. It must be remembered by those preparing designs that for such work high speeds are not required.

The Magnetic Behaviour of Iron.—Dr. V. Wietlisbach, of Berne, has written a special article on the above with respect to telephony for the current number of the American magazine *Electrical Engineering*. The author's death is announced by the editor in a footnote to the article, and we regret to have to chronicle the loss of such an able writer on electrical matters. In the text, the special requirements of the magnetic circuit to be used for telephone work are described. The great desideratum is that residual magnetism after the changes in the magnetic flux shall be small. This is more important than a low magnetic resistance with a corresponding lag in the magnetic flux. It is required, in fact, that the magnetism produced by quickly undulating currents should be always proportional to the strength of current, that the hysteresis should be as small as possible. This means that no closed magnetic circuits or long cores should be used for telephonic purposes, and that short rods are best. The short cores should be composed of many fine wires, to avoid retardation in the magnetism, and the wires should be as soft and homogeneous as possible.

Electric Lighting of Powder Magazines.—Acting on the instructions of the French Minister of War, a committee of the Académie des Sciences have drawn up a report on the precautions to be taken in fixing electrical conductors in or near powder magazines. The committee make no distinction between electric light and power conductors and telephone or telegraph wires, since all these may be exposed to lightning. The recommendations can be summarised as follows: All underground conductors for electricity, as well as gas and water pipes, should be kept at least 10 yards from the magazines. Aerial lines should be placed even further away—20 yards is recommended—and should be so arranged that they will not fall across the magazine in case of fracture. If light is required inside the magazine all wires are to be led in strong metal pipes, and then all switches and fuses, etc., controlling the lamps are to be placed outside the magazine. Only fixed lamps are permissible, and then they should be protected by a second envelope of glass. No voltages over 110 may be used. Any electric bells required in the magazines must be placed at least four yards from the powder, and the bells must be such as require very little current.

The Jungfrau Railway.—Reports on the progress of the Jungfrau Railway show that the work of construction is being pushed forward in spite of the severe weather

which prevails in Switzerland. In Lauterbrunnen water power to the extent of 2,400 h.p. is now available, and half of this force is being utilised for the dynamos employed in the boring of the Eiger Glacier tunnel. The mountain stream has been diverted from its course for a distance of six miles, extending from the waterwheel house to Scheidegg Station and the Eiger Glacier, while the open line between the Scheidegg and the glacier, with a tunnel of 88 yards, is prepared in its main details, so that the electric railway over this portion can be opened in the first half of next June, in time for the tourist season. The principal tunnel has been carried to a distance of 164 yards by hand boring—mainly accomplished by Italian workmen—and the preliminaries for tracing out the great tunnel have been accomplished after some two years of labour. The rock is found to be excellently adapted for tunnelling, and experiments on the Jungfraujoch have proved that it is reached at a depth of from 80ft. to 100ft. under the snow, instead of 230ft., as was at first apprehended. The opening trial of the Cornergrat Electric Railway has likewise proved satisfactory. It was completed a short time ago, and the line will be opened to passengers in the early spring.

Frankfort Street Railways.—In regard to the offers submitted to the Municipality from the electric street railways, the experts have, says *Kuhlow's German Trade Review*, reported on the offers of Messrs. Brown, Boveri, and Co., and Messrs. Siemens and Halske, as being the cheapest and best. Messrs. Brown, Boveri, and Co. guaranteed, with a full load over the transformer, an efficiency of 91 per cent. The cost of working this system per kilowatt-hour for current, etc., would be 1¼d. The overhead wire will be used, but the 115 cars which will be built will be so constructed that they can readily be used for accumulators. The town is to pay £100,000 to the old company, and the introduction of the electric system is estimated to cost another £175,000. A contract has been made with the two firms named, in which the contractors agree to have the plants ready in six months' time. The town handed over the whole of the existing lines on Jan. 1, 1898, and the rental will be £15,000 a year. In addition to that, 4½ per cent. has to be set aside for repayment of capital, and a further 4 per cent. for a renewal fund, for machinery and reserve fund, exclusive of the value of the land on which the station buildings are erected. After these charges have been met the town gets 95 per cent. of the profits, and the contractors get 5 per cent. The town bears the whole cost of initial construction, and has fixed the maximum price to be charged for the current at 1¼d. per kilowatt-hour.

Electricity in Cotton Mills.—Mr. W. B. Smith Whaley read last month a paper on the above subject before the American Society of Mechanical Engineers. In it are exact figures for comparing the power required to drive two mills, one of which was steam driven, with ropes for transmission of power, and in the other the power was distributed by electricity. In the steam-driven mill there was an 800-h.p. Corliss engine of the cross compound type, built in 1895, with a rope-wheel 24ft. diameter with grooves for 26 1¾in. ropes. The mill was equipped with 11,776 spindles and 720 looms. All the spindles, etc., were always running, but the looms working averaged 682 per day. In the second mill the electric power was taken from a central station near, and drives four 150-h.p. motors. The plant was put down in January, 1897, to drive 12,448 spindles and about 356 looms out of a total of 500. In the steam mill an average of 535 h.p. was required, out of which 228 h.p. was taken by the shafting only with all the belts on the loose pulleys. From other figures the author finds that an average of ·168 h.p. per loom, and that 60 spindles taking 1 h.p. was required. Similar figures were then taken for the electrically-driven mill, and it was finally ascertained that about 77 h.p. is saved by the use of the four motors instead of rope gearing. It will be noticed that even in the electrically-driven mill there was only one motor provided per floor, and that considerably more shafting could have been dispensed with by the use of more motors.

Light Railways.—A *résumé* of the work actually accomplished by the Light Railway Commissioners will be of interest to our readers, as electricity is likely to be the motive power on a good number of the lines. In December, 1896, the first batch of applications was made up. In this list there were 28 lines proposed, of which 15 were for England. Out of these 15, 11 were passed, one was withdrawn, and three refused. There were three applications for light railways in Wales, of which one was passed and two were refused; and 10 in Scotland, of which six were passed, three were withdrawn, and one was adjourned. In a large number of cases lines will be arranged to run along the public roads, and power has been given to the local authorities to purchase the lines at periods varying from 25 to 35 years. In these cases the fair market value of the undertakings as going concerns has to be paid. In the case of the light railway between Ramsgate and Margate the period mentioned was 42 years. The value for repurchasing the railways is to be determined on the basis laid down in Section 43 of the Tramways Act, 1870, plus 25 per cent. Of the above applications only 10 up to the end of the year had been submitted to the Board of Trade for confirmation, and only a few of these have been actually passed. The applications sent in in May, 1897, also numbered 28, while in November there were 30 applications. The net results of the May applications cannot yet be given, as all the enquiries have not yet been held, but we note that in a large number of cases electricity is put down as the motive power.

Electric Traction in Germany.—The *Elektrotechnische Zeitschrift* publishes statistics of electric railways in Germany completed up to Sept. 1, 1897, from which we take the following: The number of the towns in which electric traction was in use at the end of the different years is respectively: 1891, 3 towns; 1892, 5; 1893, 11; 1894, 20; 1895, 32; 1896, 44; and on Sept. 1, 1897, 56 towns. In addition to the above there were at that date 34 towns where electric tramways or railways were either definitely decided upon or already in course of construction, while in 30 towns the same referred to extensions of existing electric lines. In eight of the above-mentioned 34 towns the lines were actually open for traffic on Jan. 1, 1898, so that the total on that date was 64. The total length of line was 594 miles, the total length of single track was 842 miles, the total number of motor carriages 2,255, the total number of trailer carriages 1,601, while additional lines of 504 miles length with 619 miles of rails were either being constructed or at least had been definitely decided upon. The total capacity of the electric generators was, exclusive of accumulators, 21,465 kw. as far as could be ascertained. If the lines are added which have not supplied details, or which do not receive their current from municipal central stations, this total will be increased to 24,920 kw. This is calculated on an average of the whole lines, which gives 35 kw. per mile of rail, 40 kw. per motor carriage at the maximum grade, varying from 0·3 to 20 per cent., 4 and 5 per cent. being the more frequent; 7 per cent. was about the average of these grades.

American Patent Law.—The state of the patent law and practice in the United States has at times been highly

spoken of to us by citizens of that country. We remember one case where this was specially brought forward, when the inventor claimed that his invention must be a good one because the United States Patent Office had accepted it. This was his point of view, but the details under which the patent was granted were as follows: The inventor, who acted as his own agent, found that his papers were returned, and promptly visited the Patent Office and cornered the man responsible. After three hours' talk, the poor official was so bored by the unaccustomed application that he accepted the patent for an electrical appliance which was deficient in first principles. In other words, if the Patent Office official understands the invention and thinks the idea may work, or if the applicant can convince the officials, even against their better judgment, a patent is granted. If not, the matter stands over or is refused. Thus we hear that the American Patent Office has just granted a patent to an application dated 1883. The patent claims the broad principle of transformer distribution with alternate currents, and if held valid may be a master patent. The granting of this 15 years after the application—and as two others dated 1887 were granted on much the same subject, it is not an individual case—is a scandalous imposition on the industry. The life of the patent dates from the time it is granted, and not from the date of application, as with us in England. Hence these three patents, which are said to cover the general principles of alternate-current distribution, will not run out for 17 years. Two of the patents belong to the General Electric Company of America, but the 1883 one belongs to a Mr. W. K. Stephens, of Philadelphia. We would suggest that the annual income derived from these patents be deducted from the salary account of the Patent Office, and then returned to the licensees working under the patents in question. In any case a series of lawsuits are likely to be the result of the issue of these new patents.

The Relative Size of Compound Engine Cylinders.—The initial condensation of steam in an engine cylinder has much to answer for in the question of economy, and engines are often designed without due regard to this fact. This is brought out by a paper read by Prof. Robert H. Thurston and Mr. Louis L. Brinsmade before the American Institution of Mechanical Engineers on the subject of the economy resulting from varying proportions between the sizes of the cylinders in a compound engine. Thus it was found that a certain triple-expansion mill engine used 12·67lb. of water per indicated horse-power when developing 199 h.p. and using all three cylinders. The boiler pressure was 142lb. The intermediate cylinder was then cut out, and the steam passed straight from the high-pressure cylinder to the low-pressure receiver. The engine then used 12·76lb. of steam per indicated horse-power when developing 180 i.h.p. The piston displacement of the high-pressure cylinder was less than one-eighth that of the low-pressure, whereas in ordinary practice the ratio varies from 1 to 3 up to 1 to 4. Following on this trial, further experiments were made by the authors at Sibley College on a smaller triple-expansion engine. In this case three sets of trials were made—*i.e.*, one as a triple-expansion engine, one as a compound engine with the high and low pressure cylinders only (ratio 1 to 7), and one as a compound engine with intermediate and low-pressure cylinders only. Taking the results as shown per brake horse-power, the triple expansion showed the highest economy with heavy loads, but its economy on low loads was less than that of either of the others, owing, perhaps, to its greater frictional losses. For the same reason the 3 to 1 compound shows at low loads a better economy than the 7 to 1 compound. The curves of steam per indicated horse-power with various ratios of expansion showed that the most economical ratio is about 12 for the 3 to 1 compound and 21 for the triple, the value for the 7 to 1 being in the neighbourhood of 17 expansions. The authors concluded that in compound engines designed for varying loads larger low-pressure cylinders than at present used could be adopted with advantage, and that the drying effect of the expansion between the high and low pressure cylinders so obtained gave greater economy.

A New Fire-Alarm.—The present method of electric fire-alarms consists of placing electric devices which are affected by heat in various parts of the building. When the temperature at these points rises above the limit at which the thermostats are set to make contact, the alarm bells ring and give warning. The chief fault in such an arrangement is that the number of thermostats is usually small, and hence the outbreak of fire may, if started in an intermediate position, reach a dangerous stage before giving alarm. The Montauk multiphase fire cable, described in the *Scientific American*, is designed to get over this by practically extending the thermostats in one continuous length throughout the building. The cable in question is made up of an inner copper wire, which is coated with a metal that fuses at the low temperature of 374deg. The fusible metal alone would serve to carry the current, but the copper is introduced to increase the conductivity. Around the fusible metal is wrapped a suitable insulation, and over this again is wrapped a series of smaller wires with insulations between them, the whole being covered with an outer protective wrapping. One of the outer wires serves the fire-alarm, another the burglar alarm, another may be used for the servants' call, and others may be added to serve a multiplicity of electric connections. When a fire breaks out in the neighbourhood of the wire, the heat fuses and expands the inner fusible coating and forces it out through the insulation into contact with the overlying return wires, thus forming a metallic contact between the inner and outer wire, closing the circuit and turning on an alarm. The idea is good, but an insulation which permits of a flow of melted metal through is too novel for appreciation without practical tests.

Aerial Ropeways.—At the meeting of the Liverpool Engineering Society at the Royal Institution in that city on Wednesday, the 5th inst., Mr. J. Walwyn White read a paper on "Aerial Rope Railways, with Special Reference to Traffic between Liverpool and Manchester." After reviewing the various schemes which had been suggested for cheapening and facilitating the transport of merchandise between the two cities, he said that any plan of traction on the existing highways for such immense traffic must end in failure, even assuming a perfect self-propelled engine, which had yet to be produced. But for some fatal objections, Mr. Calthrop's plan of a narrow-gauge light railway hauling the loaded horse lorries, without any handling or break of bulk would have been the best from both the engineering and the commercial standpoints. Any plan that would retain the advantages while avoiding the disadvantages would meet the case. The system of carrying the loads in the air by means of aerial ropeways seemed to meet certain of the conditions. It did not interfere with ordinary street traffic, while it avoided all questions of compensation for severances, purchase of costly land, or building costly bridges. Only a small foundation was needed about every 300ft., where supporting standards were placed, and he would use a separate rope for each span of roadway, thus evading some difficulties, and no rope was called to bear a greater strain than was due to the maximum load ever upon one span at a time. There were

l advantages in the case of electric haulage. An auto- and effective absolute block system was provided, the ig load making its own electrical connections, and no etting within a clear span of the load in front or behind he goods were to be loaded on a loose top on the horse , and this with its load would be lifted and hooked on e ropeway carrier. The ropeway could transport 6,000 per day at a working speed of five miles an hour. ches could be taken off to supply intermediate towns. vould place a high signal tower every five miles, and in honic communication with each other. He estimated ost of 35 miles of double lines between the two cities, complete outfit, at £450,000, and calculated a net profit 0,000 a year, or sufficient to pay a dividend of 13½ per on the cost without reckoning some of the probable s of profit he mentioned.—*Times.*

ibroine.—This is the name of a new insulating ial being manufactured in France, of which Mr. J. A pellier has a good deal to say in *L'Electricien*. Leaving inions on one side, we cull the following statements he material and its properties. The materials enter- to the composition of ambroïne consist of fossilised asbestos, and mica. The proportion of the above nces are varied according to the use to which the t is to be put. The substances are ground up finely, itimately mixed together. Then a special chemical ent follows, of which details are not forthcoming. sult is the material called ambroïne, which is moulded pressure when heated. This is said to be a perfect geneous material which does not change shape with The surface obtained in this way is smooth and polished, and there is no difficulty in moulding inter- able parts in ambroine. As regards its insulating ties, a sheet ·135in. thick was not pierced by 5,000 Other figures for the resistance of a short cylinder iven, but the proportions of the sample render the quoted meaningless. It is claimed that ambroïne is very little affected by a moist atmosphere. Thus, soaking a sample of the material in water heated to C. for an hour and a half it had only absorbed per cent. of its own weight. On the other hand, stabilite l to have taken up 1·41 per cent. in the same conditions, etna absorbed 3·17 per cent., vulc-asbestos 8·5 per , and vulcanised fibre 24·5 per cent. of their own ht. The acid-resisting properties of ambroïne are as s: Sulphuric acid (density 45deg. Baumé) does not k it, neither does a concentrated solution of hydro- ic acid. The mechanical properties of the insulator said to be good compared with ebonite, vulcanised , etc. Thus it will stand a tensile stress of 1,120lb. quare inch, and a compression of 6,400lb. per square is required to produce deformation. It is pointed however, that these figures were obtained from cubes from sheets, and that the moulded material was not so strong. The chief facts we miss in the article to do with the electrical properties of the substance. statement that a certain thickness stood 5,000 volts t be supplemented by the figures at which the ple actually gave way. Also the question of time s in, and some types of insulation which is excellent n new give out after a short time.

rof. Lodge's Lecture.—The summary of the last re of the series delivered by Prof. Oliver Lodge on he Principles of the Electric Telegraph" was given in last issue, but it did not convey any idea of the able ner in which space telegraphy would be treated. The owing extract from the *Times* clearly shows the system being used, which is specially suitable to a youthful ience. Referring to the subject of telegraphing across space without conducting wires, the lecturer said there was not so much difference between this and ordinary telegraphy with wires as was sometimes supposed. Both systems depended on the emission into space of a wave equally electric and magnetic. By means of a wire this could be guided to a destination, but it spread in all directions like sound if a wire were not employed, and, therefore, it was not possible to signal by its use in one direction only. Hence to telegraph without wires, waves must be started and allowed to travel to a distance, suitable instruments being provided for their detection. The nature of these instruments was explained by analogy with the behaviour of two tuning-forks, it being shown that the air waves from one tuning-fork in vibration would set up vibrations in another, provided that the latter were tuned to—or, as it was called, in syntony with—the former. The same sort of plan was adopted for the detection of electric oscillations. The oscillations given off by a Leyden jar arranged to discharge through knobs could be detected by a similar independent Leyden jar arranged with a small overflow circuit. Every time that a spark passed between the knobs of the first jar, a spark was also seen between the knobs of the overflow circuit of the second, if the two main circuits were tuned to each other. The importance of this tuning was illustrated by lengthening and shortening one circuit, whereupon the sparks ceased. If the overflow knobs were placed so close as just not to touch, and put in a circuit with a battery and bell, cohesion set in between the knobs and the bell rang whenever a spark passed. This device, which required very delicate adjustment, was one of the earliest forms of coherers. But a Leyden jar arranged in this way did not give electromagnetic waves, which were discovered by Hertz some 10 years ago. He spread out the two coverings of a Leyden jar in space, so that the current from an induction coil could cause a magnetic field round the wire and create an electrostatic field in the plates, as the coverings in this way became, which then radiated true electromagnetic waves. The best method of detecting these was by means of the coherer invented by M. Branly, which consisted of a tube filled with metal filings, giving a number of loose contacts as in the microphone, but responding to electric, not sound waves. When an electric wave fell upon such a coherer it had some effect on the filings, which made them conduct a current, and they continued in this conductive state until they were decohered by a mechanical jar or knock. Another form of coherer was formed of a needle resting lightly on a watch, and the lecturer showed how it responded to electric waves set up in an adjoining room, and how, when arranged with a relay and telegraphic sounder, it could be used to receive signals. A young Italian gentleman, Signor Marconi, had recently interested the British Government in the application of these waves and detectors to business telegraphy, and, though he had not made scientific advances, he had drawn the attention of the peoples and telegraphic departments of the world to the possibility of wireless telegraphy. He used a form of Branly coherer, with relays and suitable mechanical arrangements for decohering, and in this way had succeeded in sending signals over a distance of nine miles. Another method of signalling electrically across space had been tried by Mr. Preece, who used the inductive effects produced in one wire by currents passing in another. In conclusion, Prof. Lodge alluded to other forms of wireless telegraphs, such as the heliograph, and thanked all those who had helped him by lending apparatus and in other ways, especially Mr. Muirhead, who had been indefatigable in collecting specimens.

WILLIAM ASHCOMBE CHAMEN.

Glasgow is an important centre of municipal work, and any man who is appointed to a responsible office under the Corporation must expect his actions to be largely criticised. When the office is that of electrical engineer, a still closer examination will be made into every step taken, for this official, like his colleagues in such large centres as Manchester, Nottingham, Bradford, etc., is looked up to as a guide to others of less experience. Thus the object of our sketch becomes with his appointment at Glasgow a public man, and will be expected to conform to the disabilities which surround public men. We do not think he will fail, either in carrying on the responsible duties of his office, or in setting an example to less prominent workers. In previous issues a few brief remarks were all that could possibly be made, but we may now venture into a little more detail. Mr. Chamen was born at New Cross, so London may claim him as her son.

He was educated at Forest School, Walthamstow. In 1879 he went into the works of Messrs. Gibbs and Co., of Plymouth, where he gained his practical mechanical knowledge. However, the young man was ambitious, and as the opening at Messrs. Gibbs did not satisfy his craving he returned to London in 1881, and, taking his fortune into his own hands, called on Mr. Crompton, offered his services, was accepted as an improver, and from then till he received his appointment at Glasgow remained an active, honoured employé of the firm. It is with some diffidence we venture to go outside our ordinary course, but we think no words of ours can so adequately show the estimation in which Mr. Chamen was held by his employers as the words of Mr. Crompton when recommending him to the good graces of the Glasgow authorities. We have known Mr. Chamen during the whole of his electrical life, and, as we have previously said, we think the Glasgow authorities have done well in choosing him for this responsible office. This is what Mr. Crompton says:

"Mr. Wm. Ashcombe Chamen came to us 16 years ago, very shortly after we commenced electrical engineering. He was then 18 years old, and had been trained as a mechanical engineer in a shop at Plymouth. I put him in charge of our men who put up the first installation of arc lighting at the Great Northern Railway Station at King's Cross, and he was in charge of this work, and was practically responsible for the running for two or three years. He was sent out by us in charge of the plant we exhibited at the Münich Exhibition, one of the earliest electrical exhibitions that was held, and afterwards he became our engineer in Italy, where he put down several installations of mill-lighting in Tuscany, his headquarters being Milan. When this work was completed, on his return to England, we put him in charge of part of our staff then engaged on the first large installation of incandescent

lighting in the kingdom—*i.e.*, in the new Royal Co
Justice in the Strand. At that time there were no
electrical workmen available; we were the first pe
take men from the bellhanger trade and teach th
new profession. Mr. Chamen had himself to arra
this training, and bore his share in working out an en
amount of designing and scheming the special ap
necessary for such a novel departure as this was.
the Law Courts he went to the Forth Bridge wor
was in charge of our men putting down our ma
on the north side and on Inchgarvie. Abo
time he became our principal outdoor enginee
has continued in that position ever since. He
complete charge of our very extensive job at
Docks, which was carried out in 1884, so that 1
ago he was already in a very responsible p
From that time forward he has been chief engin
practically personal assistant, to me in all engi
matters of importance that our firm have carri
Among these I should mention the design and arran
of the two stations of the Kensington and Knight
Company, which were practically the first two
stations in London; he also designed and carri
an extensive central station for Barry Docks on th
nating system, and about the same time two low-
stations for the towns of Northampton and Southa
During the whole of this time we were also c
on ship-lighting work, and fitted up a consi
number of ships, Mr. Chamen being responsible
work. Shortly after this, he was engaged on
central-station work for the Westminster Compan
then came our large job for the Great Eastern Rai
Liverpool-street, which is a central station, which i
of size and power developed will rank with several
metropolitan electric supply stations, and is larg
most of the provincial stations. Simultaneously he
out for us the electrical railway at Southend, and fo
on this a large job for the L. and S.-W. Rai
Southampton Docks. Then came the complete
for the town of Dewsbury, which was worked
Mr. Preece as consulting engineer. That for th
of Yarmouth followed; this was an alternating job als
Mr. Preece. The work done in this town has been con
exceptionally satisfactory and has been freer from
downs than any alternating job in the kingdom.
had a very extended experience in modern str
lighting for various important towns, one of these b
Edinburgh, one at Brighton, where he carried out t
special requirements desired by Mr. Wright, and ot
Southport, Hanley, Blackpool, and elsewhere. In se
these cases rectified currents were used, and it fell
to deal with the special difficulties connected wit
rectified currents. This he was quite successful i
Among later jobs have been that for the Agricultur
(which employs the largest sets of plant driven
engines), the South Kensington Museum, the ligh
Birkenhead under Mr. Shoolbred, and the extensive
contracts which have been carried out for St. Pancras
During this time he has been solely responsible to my
our Board for his assistant engineers, and for the me
him, which have occasionally amounted to 250 or
will be seen from the above long list that Mr. C
career commenced with the commencement of the
development of electrical engineering in this coun
that he has been not merely a contractor's engi
charge of work, but has also contributed very la
the designing of the work and to the carrying out
which were often submitted to him in the crudest
those who employed us. As I have known him so int
for this long period of years, I have had such a complet
tunity of forming an opinion of his knowledge, experie
business capacity, I am exceptionally well qualified
in his favour as a candidate for the post that you are
I understand that you require an engineer who
has great capacity for design, but who also understa
has had full experience of the difficulties and
expenses involved in constructing works, and who
had extended experience in the running cost of
stations. As may be well known to some of you,
have made this last question a personal one, as I h

Institution of Civil Engineers and other similar s a series of papers on the cost of producing elec- gy, and in the preparation of these papers I have discussions and consultations with Mr. Chamen, ay therefore say that he has these matters pletely at his fingers' ends than any other man Mr. Chamen has this singular advantage that he y 33 years of age, and yet he has had 14 years ious work in charge of men. This has aged him him the appearance and authoritative weight of years his senior. Mr. Chamen has been on the f the Institution of Electrical Engineers, and was as one of the committee which prepared the n standard rules, and served on that committee years. He was chosen on that committee on of his special knowledge of the requirements of nd fitting up houses and business premises for ighting and power."

ES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

[*Copyright.*]

.—Vol. XX., p. 710, column 2, for "867 calories along," *read* "875 calories." Vol. XXI., p. 14, n 2, for "one watt-hour = ·867 kilocalorie," *read* kilocalorie"; for "one kilocalorie = 1·153 watt- ' *read* "1·166 watt-hour"; and for "one kilo- = 423·3 kilogrammetres," *read* "499 kilogram- ."

LV.

important to realise the equivalence of the ons for work or potential energy, and for kinetic In the system of dynamics generally adopted by s—viz., that of "gravitation measure," which is tly accurate for practical purposes—the foot-pound as the unit of work. The unit of mass is the avoirdupois; and thus the unit of work is (incor- nit mass raised through unit length, instead of ce overcome through unit length, which is the any absolute system. Since force (pressure or measured by the velocity it produces in unit time mass when this is free to move, the force, or, the *acceleration* (since the *force* depends upon the f gravity is taken as $g = 32{\cdot}19$; this being the , in feet per second, obtained in one second by the 1lb. (or any other mass) falling freely *in vacuo* ar the sea-level at London.

ding, therefore, to this system (which is not a ientific one, and necessitates therefore frequent s by g) work is expressed as

$$W = m\,l \quad . \quad . \quad . \quad . \quad . \quad . \quad (\text{I.})$$

$$f = g = \frac{v}{t} = 32{\cdot}19 \quad . \quad . \quad . \quad . \quad . \quad (\text{II.})$$

istance fallen through under the action of g will he mean velocity $\frac{v}{2}$ (or half the final velocity v) ied into the time in seconds during which the s moved with this mean velocity, or

$$l = \frac{v}{2}\,t \quad . \quad . \quad . \quad . \quad . \quad . \quad (\text{III.})$$

Equation II.,

$$t = \frac{v}{g} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (\text{IV.})$$

tituting this value for t in Equation III.,

$$l = \frac{v}{2} \times \frac{v}{g} = \frac{v^2}{2\,g} \quad . \quad . \quad . \quad . \quad (\text{III}\textsc{a}.)$$

equently,

$$m\,l = W = m\,\frac{v^2}{64{\cdot}38} \quad . \quad . \quad . \quad . \quad (\text{V.})$$

t expression being that for kinetic (sometimes, bsurdly, called visible) energy.

Equation V.,

$$v^2 = 2\,g\,l, \text{ whence } v = \sqrt{2\,g\,l} \quad . \quad . \quad (\text{VI.})$$

LVI.

When, by losing its own potential energy, a mass (M), acted upon by gravity, raises (gives potential energy to) a smaller mass (m), the accelerating force becomes

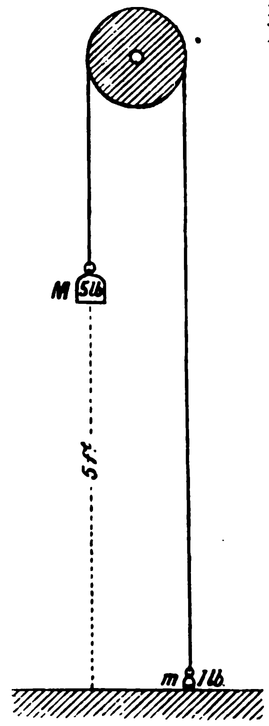
$$f = g \times \frac{M - m}{M + m} \quad . \quad . \quad . \quad . \quad . \quad (\text{VII.})$$

Thus, in the case illustrated by the diagram, if M = 5lb. fall through $l = 5$ft., raising the mass $m = 1$lb., it will obtain the velocity

$$v = \sqrt{2\,f\,l} = \sqrt{2 \times 32{\cdot}19 \times \frac{5-1}{5+1} \times 5} = \sqrt{214{\cdot}6} = 14{\cdot}6\text{ft.}$$

per second.

This same velocity will be obtained by m when M has fallen through 5ft. Then the kinetic energy of m will be—



$$k = m\,\frac{v^2}{2\,g} = 1 \times \frac{214{\cdot}6}{64{\cdot}38}$$
$$= 3{\cdot}\dot{3} \text{ foot-pounds.}$$

This kinetic energy will raise m through $3{\cdot}\dot{3}$ft., additional to the 5ft. through which it has already been raised; and the potential work stored up in this unit mass will be $m\,l = 1 \times 8\frac{1}{3}$ft. $= 8\frac{1}{3}$ foot-pounds.

Since M is five times greater than m, the kinetic energy stored up in it (and converted into heat) when it strikes the ground is evidently $k \times 5 = K = 16{\cdot}\dot{6}$ foot-pounds.

Summing up, we have

Dr. to potential energy—
M l = 25 foot-pounds.

Cr. by potential energy—
$m\,l = 8\frac{1}{3}$ foot-pounds.
Kinetic ditto $16\frac{2}{3}$ „
Total... 25 „

LVI.

This simultaneous falling together and pulling apart (decessus) of masses is the analogue of what takes place in every voltaic couple. But in this case, atoms, molecules, or chemical equivalents are substituted for masses, and a difference of affinity for the difference in the pull of gravity upon unequal masses. Moreover, the distance through which the molecules fall is inconceivably small; whilst, in practice, their number is inconceivably great. As in the mechanical illustration a great many interfering causes may prevent us from obtaining in practice the results indicated by theory, so in the voltaic cell there are interferences of a more recondite nature which are only partly understood. But the fundamental law is, I think, that which, many years ago, I enunciated as follows: "In working a voltaic battery we exchange an equivalent of one electro-positive for an equivalent of another; or, in other words, an equivalent of some electro-positive is necessarily liberated for every equivalent of the positive element that enters into combination. Thus, in the batteries of Wollaston and Smee we exchange an equivalent of zinc dissolved for an equivalent of hydrogen set free; in Daniell's battery, an equivalent of zinc for one of copper; in Grove's, an equivalent of the same positive element for one of nitric oxide (NO), or of nitric peroxide (N_2O_4); and in that of Marié-Davy, an equivalent of zinc for one of mercury. The electro-positive separated from combination is in all cases electro-negative in relation to that which enters into combination. The E.M.F. of a voltaic couple is proportionate to the difference between the calorific equivalents of the electro-positive bodies, of which one replaces the other in combination within the voltaic cell."*

* The *Electric Telegraph Review*, Nov. 12, 1870 (A Dictionary of Electrical Terms, Art. "Circuit—Voltaic"). See also the *Electrician*, April 15, 1887.

By the scientific exercise of the imagination, suppose the larger mass (M) to represent the zinc which is dissolved, and the smaller mass (m) the copper which is deposited, in a Daniell cell; and let the surface to which M falls represent the acid radical SO_4. Now although the masses of Zn and Cu corresponding to M and m are nearly equal, their respective attractions for SO_4 will be as 1·6 to 1. The *accessus* of Zn and SO_4, if unimpeded, would generate kinetic energy equivalent to an E.M.F. of 3·13 volts. On the other hand, the *decessus* of Cu from SO_4 would generate potential energy equivalent to an E.M.F. of nearly 2 volts (without taking into account any possible effect of *vis viva*). The actual E.M.F. generated would thus be 3·13 − 2 = 1·13 volts. We need not, I think, be greatly surprised to find that this value is 2·26 per cent. higher than that experimentally obtained by Mr. Latimer Clark for a Daniell cell mounted with pure metals and solutions—viz., 1·105 volts, at 64deg. F. Nor need we, at the present time, enter upon the consideration of the various causes which may occasion such discrepancies.

LVII.

One observation, however, it is most important, from our point of view, to make. Anything that can diminish the attraction between Cu and SO_4 (analogous to the weight of m) will increase the E.M.F. of the Daniell cell—*i.e.*, the kinetic energy developed by the affinity between Zn and SO_4 (analogous to that obtained by the mass M). And, if we could diminish the attraction between Cu and SO_4 to zero, it is conceivable that the E.M.F. developed would be 3·13 volts; in the same way that, if the mass m were removed, the kinetic energy obtained by M would be 25 instead of 16·6 foot-pounds. It is equally important to consider that the theoretical compound SO_4, if we could isolate it, would be an extremely endothermic body—*i.e.*, it would render kinetic a great quantity of energy in becoming decomposed into SO_3 + O. And this fact will explain an apparent discrepancy, *primâ facie* of a most puzzling character, in tables of calorific equivalents. The thermo-dynamic equivalent of Zn | SO_4,Aq., for instance, is 72·6 kilocalories, whereas that of Zn | O | SO_3,Aq. is but 53 kilocalories. Now $ZnSO_4$,Aq. and $ZnOSO_3$,Aq. represent the same body—viz., an aqueous solution of sulphate of zinc, which may be considered as having a certain definite heat of constitution. But to decompose this body into Zn plus the strongly endothermic compound SO_4Aq. (supposing this could be isolated), a far greater quantity of energy would be required than to decompose it into Zn + O plus the strongly exothermic compound SO_3Aq.—*i.e.*, diluted sulphuric acid. And this is what is expressed by the thermo-dynamic or calorific equivalents. Still employing the imagination in (I hope) a scientific manner, if we could form with $CuSO_4$ an endothermic compound which, when decomposed, would effect the separation of Cu and SO_4 with a production, instead of with an absorption of kinetic energy, the employment of this compound would be analogous, not merely to the removal of m in our mechanical illustration, but to its projection upwards with a *vis viva*, which might add considerably to the 25 foot-pounds of energy stored by means of the apparatus.

LVIII.

The relation between volts and calories has still to be explained. It is frequently stated that one volt = 46 kilocalories, or 23 kilocalories, according as the dyad or the monad gramme equivalent is taken as the electrolytic unit of mass. Since volts and calories are incommensurables, such statements, taken literally, are obviously absurd. But if we know the calorific equivalent of the watt-hour—heat and work being values of the same dimensions—we can readily arrive at the relation above referred to. The watt-hour is the unit product of amperes, hours, and volts. Thus one ampere × one hour × one volt = one watt-hour = ·857 kilocalorie.

Now one ampere-hour = 3,600 coulombs (ampere-seconds), and this quantity of electricity corresponds to 4·025 grammes of silver, or to ·03738 gramme of hydrogen, or to this latter value multiplied into the equivalent weight of any other given element or compound. Taking the ampere-hour as constant, and making volts variable, we have: one ampere-hour × n volts = n watt-hours = ·857 × n k
or, calling h the number of kilocalories evolved,

$$E = \frac{h}{\cdot 857 \text{ kilocalorie}} \text{ volts,}$$

when the equivalent of electricity is one am
or when the volts are associated with the am
equivalent of electrolytic mass—viz., the mona
equivalent × ·03738. But if E (volts) be refe
ampere-hours, or n ampere-hour equivalents, th
becomes

$$E = \frac{n\,h}{\cdot 857 \times n} \text{ volts,}$$

this value remaining unaltered, although work
be n ampere-hours equivalent to n ampere-hour
of electrolytic mass.

Now, the number of ampere-hours correspondi
monad gramme equivalent of electrolytic mass
= 96,600 coulombs; or, in this case, n = 26·
$n\,h = h$ kilocalories, our equation becomes

$$E = \frac{h \text{ kilocalories}}{23 \text{ kilocalories}} \text{ volts.}$$

Thus it may be correctly stated that one vol
calories when the unit of electrolytic mass is
gramme equivalent, corresponding to 26·833 am
This quantity, or 96,600 coulombs, correspondi
gramme of hydrogen, may be called the mona
equivalent of electricity or electrical quanti
coulombs, corresponding to ·03738 gramme of H,
ampere-hour equivalent of electricity.

LIX.

SOME (GRAMME) AMPERE-HOUR AND MONAD GRAMME E
(To reduce to grains multiply by 15·432.)

Elements and compounds (valency indicated).	Atomic and molecular weights.	Ampere-hour equivalents. 3,600 coulombs.	e… 9… lo… am…
Silver, Ag'	107·66	4·025	
Hydrogen, H'	1	·03738	
Zinc, Zn''	64·9	1·2133	
Copper, cupric, Cu''	63	1·177	
Copper, cuprous, Cu'		2·355	
Iron, ferric, Fe'''	55·9	·6968	
Iron, ferrous, Fe''		1·0448	
Lead, Pb''	206·4	3·8578	
Potassium, K'	39	1·4595	
Sodium, Na'	23	·8594	
Sulphuric acid, H_2SO_4''	98	1·826	
Nitric acid, HNO_3'	63	2·348	
Chlorine, Cl'	35·37	1·322	
Oxygen, O''	16	·299	
Peroxide of lead, $PbO_2^{''\text{IV}}$	238·4	4·442...2·221	1

LX.

I was once taken to task by a well-known elect
and told that I was "17 years behind the age"
as in the following and preceding tables, t
notation for the designation of chemical compou
taking the monad equivalent weights to express t
of these compounds to certain definite quantiti
tricity (ampere-hours or coulombs), and to th
values which indicate, directly and comparat
affinities by which these compounds are held
But such a course, it may be seen, is absolutely
with a view to avoid confusion and misconcepti
mystification, on the part of the reader. The sy
instead of H_2O, for water would at the present ti
a suggestion of hydric peroxide; the formula
instead of HNO_3, for nitric acid might be unin
and AgO would be taken to represent argenti
rather than the normal oxide. On the other
calorific values of the monad, dyad, etc., atomic
not directly convey any notion of the intrinsic
the elements or of the affinities to be overcom
compound can be decomposed. The opinion
authority in electro-chemistry, Mr. John T. Spr

here be quoted. He says: "Mr. Fitz-Gerald is entirely right in using a fixed unitary value:

$$\frac{\text{Atomic weight}}{\text{valency}} = \text{electric equivalent},$$

which means basing the calorific values on the relation of one atom of hydrogen, not upon two, because we write water as H_2O. . . . We should reduce all molecular calorific values to the terms of the equivalent in grammes of each substance."*

Some Monad Gramme Calorific Equivalents.

(The weights in grammes are half the (dyad) atomic weights.)

Elements and molecules combining or separated.	Kilocalories evolved or absorbed (approximate values).
H_2 | O (gaseous)	34·2
Zn | O (O gaseous)	42·3
Pb | O "	25·2
idem (indirectly arrived at)	27·7
Cu | O " "	10·9
idem (O gaseous)	10·0
H_2 | O | SO_3,Aq.	38·4
H_2 | SO_4,Aq.	53·7
ZnO | SO_3,Aq	11· (?)
Zn | O | SO_3,Aq	53·0
Zn | SO_4,Aq	72·6
Zn | SO_4Aq – H_2 | SO_4Aq	18·8
Zn | SO_4Aq – Cu | SO_4Aq	27·4
Zn | SO_4Aq – Pb | SO_4	16·2 (? 18)
PbO | SO_3	11·7
PbO | SO_3Aq	12·4
PbO | H_2SO_4Aq	10·7
Pb | O | SO_3	37·
Pb | SO_4,Aq	56·5
PbO | O (endothermic)	– 6
Pb_2O_3 | O "	– 6 - x (?)
CuO | SO_3,Aq	7·7
Cu | O | SO_3,Aq	18·6
Cu | SO_4	45·2
H_2O | O (hydric peroxide)	– 11·5

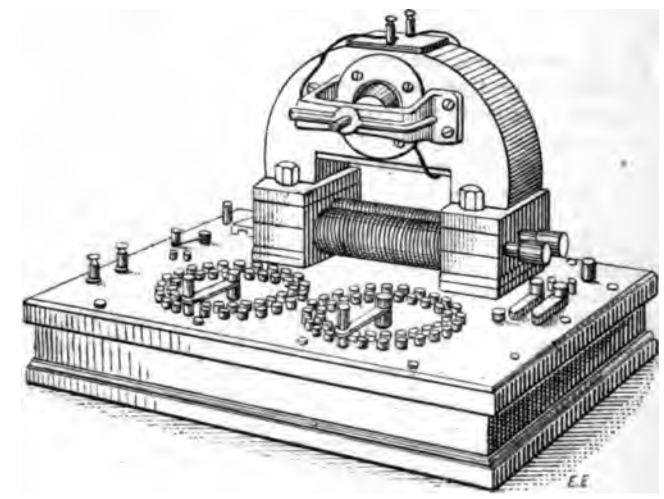
A NEW MAGNETIC TESTING APPARATUS.†

BY R. B. TREAT AND J. W. ESTERLINE.

Along with the gradual improvements in the methods of electrical design, there can be traced a simultaneous development in the different kinds of apparatus and accessories useful in determining data, or in testing machinery which has been built. The more recent methods of design and the high standard which has been attained in the manufacture of generators, motors, and transformers, make it necessary for the engineer to have at his command an accurate, commercial means of testing the magnetic qualities of iron and steel.

With these facts in mind, the apparatus described in this article was designed and constructed by the authors at the laboratories of Purdue University, Lafayette, Ind. The work was begun in November, 1896, and two identical machines were completed in July, 1897. In principle the apparatus embodies a combination of several well-known methods of testing, rather than the development of any new method, although it is believed that some new features have been brought out. The intention of the designers was to produce a form of apparatus with which it would be possible to determine both the permeability and the hysteresis of iron; an instrument adapted to the testing of solid and sheet metal made into a form of specimen easily shaped; and especially to give accurate results when used in an ordinary testing-room, or when in the neighbourhood of other electrical machinery. It was also desirable that the results should be obtained from the tests without resorting to the long and tedious calculation which is necessary in some methods.

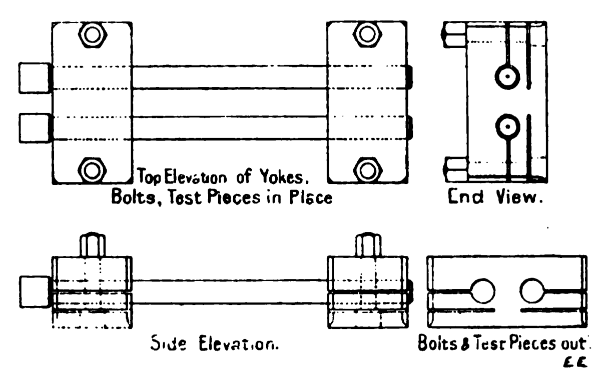
In the accompanying illustration there may be seen a view of one of the completed machines, which will give an idea of the size and general character of the apparatus. For solid iron the test-piece used is a cylindrical rod 10in. long and ·575in. in diameter, as this form of specimen can be turned up accurately and finished without much labour. The side of the square inscribed in a circle of ·575in. diameter is approximately ·41in., so the sheet metal samples are built up into square rods of this cross-section. The strips are riveted together at the ends and milled smooth on the edges. The ends of the test bars are clamped in two heavy wrought-iron yokes, shown in the working drawing; the holes in the yokes being cut $\frac{1}{1000}$in. in diameter than the test bars, with two slots sawed in from the ends, as shown. The head of the clamping bolt



General View of Magnetic Testing Apparatus.

rests on the middle portion, or that between the slots. In the tests made on the joints their reluctance was found to be very low, though not by any means negligible. The length of the portion of the test bar between the yokes is 12·566 cm. = 4 π cm. Holes are provided for two bars, and on each is a vulcanite spool, wound with 100 turns of silk-covered stranded conductor capable of carrying 10 amperes.

A diagram of the wiring is shown, by reference to which the principle upon which the machine works will be readily understood. There are three distinct methods of operation, and each will be explained separately. First, to test the permeability of a specimen by comparison with a standard bar whose B-H curve is known. The standard is clamped in the coil, A A′, and the bar to be tested in



Details of Yokes and Test Bars.

B B′. The coils are wound so as to aid each other in driving the flux around the circuit made up of these two bars and the yokes, and when both bars are carrying the same number of lines of force, the difference of magnetic potential between the yokes is zero. The two coils are connected in series, and, having the same current, the relative magnetising force of the two is equal to the relative number of turns. By means of the three-point switch, M, the number of active turns on the standard bar may be made either 50, 75, or 100, this arrangement making it possible to test bars of better and poorer grades than the standard. With any given density in the standard bar, the flux, through the test bar is made equal to that in the standard by increasing the number of active turns on the test bar by means of the dial switches, which give a variation from 0 to 100 turns, in steps of one turn. An

* *Electrician*, vol. xix., p. 7.
† From the *Electrical World* (New York).

inner circle of contacts on the dials connects with idle coils of wire equal in size and length to those of the magnetising coil; so that when a turn is "cut in" on the bar, one of equivalent resistance is "cut out" by the switch arm, thus keeping the current constant while a balance is being obtained. O is a reversing switch for changing the direction of the current in the coils to eliminate hysteretic effects. So long as the two bars are not at the same magnetic density there exists between the yokes a difference of magnetic potential which sets up a flux through the magnetic circuit formed by the pole-pieces and armature core, so that when the armature develops an E.M.F. we know that the bars are not balanced magnetically, a balance being obtained only when the armature develops no E.M.F.

The pole-pieces are made of a fine grade of wrought iron, specially prepared and forged for the instruments. In order to reduce the reluctance of the circuit, the poles and armature are made rather large in proportion to the rest of the parts. The area of the air-gap at the joint with the yokes is 32 times the area of the test-piece. The polar air-gap is $\frac{1}{100}$in. across, with an area 36 times that of the specimen. The armature is driven at 4,000 revolutions per minute, and is of the ring type with toothed periphery. There are 40 slots, and in each are wound 175 turns of No. 30 B. & S. double silk-covered wire, making 7,000 turns on the armature. The core is built up of 15-mil stampings, and mounted on the brass end plates, which also serve to protect the wire on the

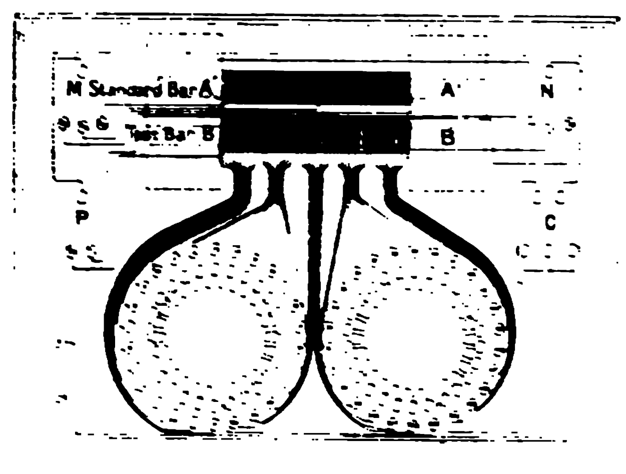


Diagram of Circuits.

ends of the armature. With a single line of force across the air gap the armature will develop an E.M.F. which is easily detected. Using a Weston milli-voltmeter, a balance accurate to one turn in 100 can easily be obtained, and may be more accurately determined by interpolating the throws of the needle of the voltmeter, which occur when a change of one turn is made in each direction.

To determine the hysteresis cycle of a specimen it is necessary to remove the standard bar and cut its coil out of the circuit by placing the arm of the switch, N, on the point, T. The total flux now passes through the armature circuit, and the density in the bar may be determined, as it is a function of the E.M.F. developed by the armature. The current is kept constant, and the magnetising force increased by steps to a maximum by increasing the number of active turns. It is then decreased to zero, the current reversed and the operation repeated. With the density in the bar at 17,000 gausses and the armature running at 4,000 revolutions per minute, the E.M.F. developed is about 90 volts, which is within the range of an ordinary voltmeter, and insufficient to cause the burning out of the armature, even though it becomes accidentally short circuited. The B-H curves may also be taken in the same manner as the hysteresis cycles if care is taken to thoroughly demagnetise the bar before beginning the test.

The machine is mounted on a slate base, 12 in. by [illegible] in., and beneath this is a hardwood sub-base, which contains the wiring and connections. From the time of the first ones made up to the present, both machines have been giving entire satisfaction and good results in every way.

THE WALTON AUTOMATIC TRANSFORMER SWITCH.

The use of transformers with the high-tension alternate-current system of distribution gives most excellent results at full load. Then the efficiency of distribution is high, and in the early days of alternate-current working the question of the light load loss was not considered. As soon, however, as the system of placing transformers in consumers' houses was well under weigh, the importance of keeping down this light load loss due to hysteresis in the transformer cores was appreciated. The next step was the introduction of sub-stations to contain transformers supplying several houses or a small district. In such cases the banking of a number of transformers on to common low-tension bus bars is usually adopted. These transformers are usually switched on as the load increases, and again switched off as the load diminishes, to avoid the iron loss referred to above.

One of the drawbacks to the earlier use of these sub-stations was the fact that whatever saving was effected by reducing to a minimum the loss from magnetising current, particularly during the hours of light load, was more than counteracted by the expense, among other things, of the services of attendants always on the alert to switch in and out the transformers with the variations of the load. To reduce as much as possible this serious item of sub-station expenditure and risk of the attendant not being on the spot when required, the automatic transformer switch, which is illustrated herewith, has been designed by Mr. A. H. Walton, acting engineer of the Metropolitan Electric Supply Company, Limited.

From the illustrations it will be seen that the set of apparatus, which is used to supply a three-wire low-tension system, has on it six switches—i.e., one double-pole switch for the primary, mounted on an independent marble base; two single-pole switches for short-circuiting the controlling solenoids after the switch is brought into action; and three for connecting the transformer on the low-tension side of a three-wire system. Its action can be followed from the description below. Fig. 1 is a front elevation of the automatic switch showing the full details of the apparatus as arranged for transformers working on a three-wire system, the coils, a a', being in the main circuit, one on each of the outer wires. Fig. 2 shows a side elevation of the same. Fig. 3 shows point at which the weight operates. Fig. 4 is a section on line A A (Fig. 3). a and a' are series electromagnets, having laminated cores, b and b', with projecting pole-pieces, c and c', suitably shaped for attracting the armatures, d and d', which armatures are pivoted to the pieces, e and e', of the bases, f and f', of the electromagnets.

The armatures are counterweighted and adjusted by the regulating screws, g and g', which regulate the position of the balance weights, h and h', these weights being locked in any desired position on the screws by the nuts, g'', as shown. The armatures, d and d', are tongued, as at d'', in order to engage (when being drawn up the pole-pieces), with the collar piece, i, attached to a spindle, k, whose freedom of motion through the pillar, l, is limited by the collar and nuts, m, as shown. At the same time the armatures, d and d', are inoperative until they reach the collar, i, thus preventing the working of the apparatus from being uncertain, and also relieving the armatures, d and d', from any friction, and making the pull the magnets have to exert to lift the armature perfectly constant. n is an adjustable weight sliding on the tongued bar, o, and locked by the set screw, o', as shown. This weight is thrown slightly forward beyond its centre of gravity by the indiarubber stop, p (Fig. 2). The object of the tongue on arm, s, is such that while engaging with the tongue, t, it prevents the weight falling further forward by gravity, whilst the current is gradually energising the electromagnets up to the prearranged maximum at which the switch is required to connect the transformer. The bar, u, works on a spindle, v, running through bearings, r r r r, to which spindle the arms, s s s s, are connected by pins or keys or other suitable means. The arm, s, is free to move on the spindle, v, for a certain distance, so that it may gain sufficient momentum before the moment of striking the body of the arms, s s, on either side of it.

method of actuating these arms is shown in Fig. 3 and 4, in which part of each side n is cut away, thus ...ing engaging parts of the arms with s s, which are

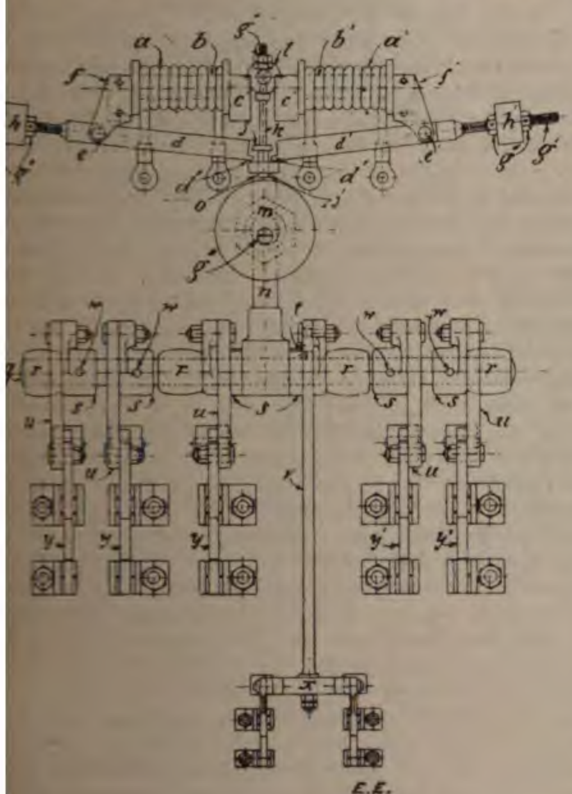


Fig. 1.

...arly treated. To one of the arms, s, is attached a ..., having a slot, t (shown dotted in Fig. 2); the ... of this slot is to enable the link, v, to close

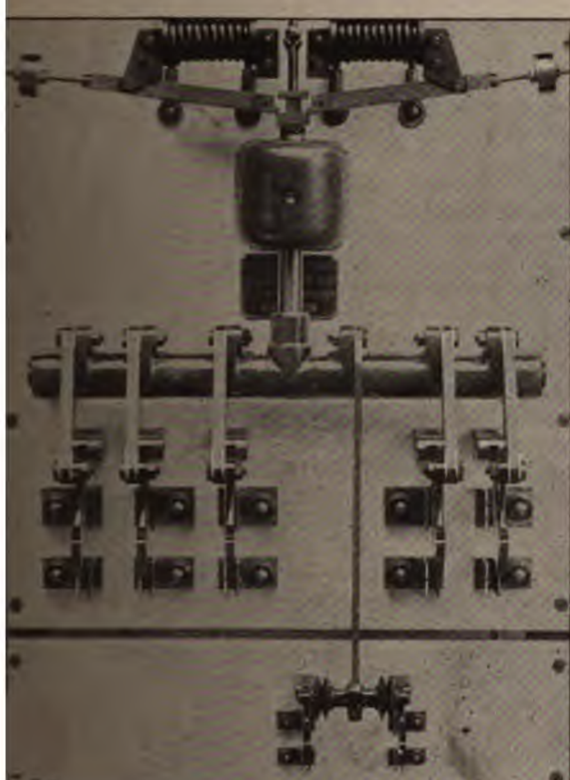


Fig. 5.—Switch in Off Position.

...small switch shown at x in Figs. 1 and 2 for ...ing the primary of the transformer after the larger ...ches, y y y y' y', have been closed. The three switches,

y y y, when closed introduce the secondary of the next transformer or group of transformers as previously arranged. The two switches, y' y', are for the purpose of short-circuit-

Fig. 4.

Section at A A.

Fig. 3.

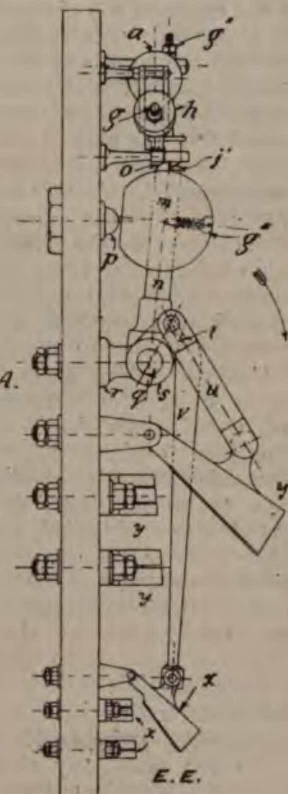


Fig. 2.

ing the coils, a and a', after they have completed their work, thus saving any loss of energy in same.

It may thus be seen that on any predetermined amount

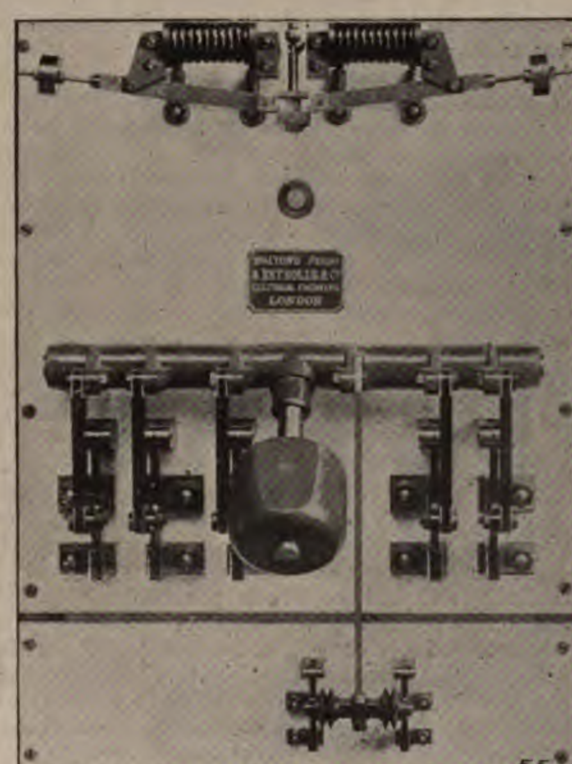


Fig. 6.—The Walton Transformer Switch in the On Position.

of current passing through the coils of the electromagnets, a' and a, their armatures, d and d', are drawn up immediately, thus releasing the weighted arm, n, which turns

freely for a limited distance on the spindle, q. On the prongs of the clutch (see Figs. 3 and 4) engaging the spindle, q, at once turns, and being attached by pins, w, to the arms, [illegible], closes first the five larger switches, and then by the means of the pin and slot, t, the small switch, r, attached to the link r. In opening the switches the action is the same, and the larger switches open first and the smaller switch opens last. The chief object and advantage of this arrangement is that, owing to the secondary of the transformer being closed first, the rush of current which would occur if the primary were switched in first is prevented by the iron being magnetised by the secondary coil, and also sparking is greatly reduced when transformers are taken out of circuit. The links, v (Fig. 1 and 2), are insulating pieces. The link v being metal, is insulated from the small switch at the point z (Fig. 1) by means of an insulating bar.

The two illustrations Figs. 5 and 6 show the switches actually in use at one of the sub-stations of the Metropolitan Company. The method of connecting up the switches on a bank of transformers is as follows: The bank of transformers feeds a district of which the maximum load is about 100 kw. To supply this, five 25-kw. transformers are employed. One of these is always on the circuit, and the connection between its secondary low-tension coils is made through the controlling coils on the automatic switch of No. 2 transformer. One of the controlling coils takes the current to one outside wire of the three-wire system, and the other the current to the opposite outside wire. Then if either side of the system gets loaded up to, say, 85 per cent. of the output of the transformer, the armature is attracted by the coil in that circuit, releasing the weight, which switches No. 2 transformer into the circuit. In the same way this transformer feeds the omnibus bars through the controlling coils of No. 3 transformer, and calls for help in that direction when its load increases beyond the predetermined limit. In this way the transformers come on as required till the full number are in. The switching off is done by hand, as this is not such a matter of time as the switching in. The advantages of this switch gear may be summed up as follows: (1) The use of springs is entirely dispensed with, and the action of gravity alone is depended on for all the operations. Also, as the releasing armature has a considerable motion before hitting the catch, the action is most certain. (2) The closing of the secondary just when switching in is a great advantage, as the primary high-tension circuit is closed only when the transformer is excited. The rise in voltage found in certain cases in switching in is thus avoided on the high-tension side. (3) In switching out, the low-tension circuit is broken first, so that the high-tension is carrying only the magnetising current when disconnected. (4) The short-circuiting of the two solenoids when the switch has gone in is good, as no energy is absorbed when once the switch is put on.

The switch is a great acquisition to any sub-station, paying for itself over and over again by the saving of labour otherwise rendered necessary. By its use one man can look after many sub-stations, all that he requires to do being to switch the transformers off after the load has fallen. In the case of a fog suddenly arising, the central-station engineer may rest assured that as many transformers are switched in as are necessary, and all he has to do is to send round and switch them off at his leisure. Nor can the attendant err by leaving in too few transformers for the load, for then each transformer in turn will be automatically switched in by its predecessor until the required load is reached. It will be noticed that this switch does not automatically cut out, and no doubt all practical men will agree that to ensure the sub-station being inspected, it is absolutely essential that there should be something to do when the inspector visits the sub-station. Several of these switches have been erected and have been in daily use in the sub-stations of the Metropolitan Company for many months, and their working up to the present has been eminently satisfactory. The switch shown is designed for use with a 30-kw. transformer.

The manufacturing of these switches is in the hands of Messrs. Reyrolle and Co., 20, Pancras-street, whose quality of work is now generally known.

NORTHERN SOCIETY OF ELECTRICAL ENGIN

PRESIDENTIAL ADDRESS BY JOHN S. RAWOI M.I.C.E., M.I.E.E.

Gentlemen,—My first impulse is to acknowledg my best thanks the spontaneous and almost embarra sudden invitation to accept the presidency of this which your good nature has forced upon me. As time of its receipt I was not even a member of co had no expectation of receiving such an honour; no yet satisfied, knowing as I do, from my experience Council of the Institution of Electrical Engineer onerous are the duties of a president, that I shall be fulfil them to your satisfaction. Especially do I feel following Mr. Dorman I am placed somewhat at a dis tage. Your meetings have been constantly enlivened wit, and the only solatium which I can find to offer change—the inevitable change—is that whereas it to be sometimes gay, it is also well to be sometimes There are many things in this world we would fai more of: the busy want more hours per day; th want more per night: the municipal engineer want machinery; the consumer wants more volts; woman more money; and man wants more of everything this exception, that I never yet heard of anyone w a craving for more presidential addresses. This is unfortunate, seeing that the only intellectual refresh am permitted to offer to you this evening is one of same unwanted addresses.

My task is rendered all the more difficult by th that we are only just outside the Jubilee year, i course of which we have had a surfeit of retro embracing every possible source of national se gratulation, profusely illustrated with figures, some some coloured, but all running into millions of thi millions of the other: all tending to cultivate in u reprehensible frame of mind in which Nebuchadnezzar "Is not this great Babylon that I have built?" You the sequel and the moral: you know that if we r our laurels, or in the contemplation of our own pr forget or despise our competitors, Darius will mar the very bed of the river of our commerce, and the city without firing a shot or blowing a This is no fancy picture; we have forts at Shee the heights of Dover bristle with guns, Portsm is impregnable, and Liverpool can laugh at invader who shows fight, but if he comes in shape of surplus American machinery or cheap Ge gimcracks, there is no barrier in either Tham Mersey that will keep him out. The war of the will be an industrial war, in which the resource and d perseverance of the English race will be as much in re as they were at Waterloo. We are up to our ankles already; and yet our engineers, the advanced gua our industrial forces, having heard so much abou might, majesty, and magnificence of the British e have thought it a small matter to desert the trench six months, vainly to discuss the breadth of the pr tion contained in the declaration of the centurion of "I say to this man 'go' and he goeth, and to an 'come,' and he cometh, and to my servant, 'do this he doeth it." But, gentlemen, we know that the n and sinew of the engineering trade is true at heart know that we have the right stuff at our backs; that when the specious agitator shall have desc to his proper place, and when danger shall have be apparent even to those who do not sit in the co tower, then there will be no desertion, then every will do his duty, and no one will dare to speak to the at the wheel.

The history of electrical engineering, apart telegraphy, is so short that we have probably no me who does not carry the whole of it in his memory; therefore, quite unnecessary for me to break out reminiscences. I cannot, however, refrain from remi you that when I started electrical engineering in chester, 20 years ago, there existed in Mill-street, An a factory devoted entirely to the production of dyn arc lamps, and projectors; we have every reason t

of our townsman, Mr. Henry Wilde, whose fame, ı world-wide, is surpassed by his modesty; and it be a source of satisfaction to every member of this ' to know that Mr. Wilde's genius and foresight ıt him a substantial fortune. After the era of Mr. 's activity, Manchester in matters electric moved but : now, however, under the inspiring influence of ılderman Higginbottom's faith and fervour, it is to an appreciation of its possibilities, and in all ıility will very soon again set the pace for the rest world.

one thing we want is faith—it is quite as important :hanics as in religion; for as by faith the walls of o fell down, so will the walls of prejudice and ulity, which at present bar your path to the promised ıf fame and fortune, collapse at the first brush with ·namics of faith. It is true we have had a bad time; ve had to fight and conquer innumerable difficulties; ew horse has been as bad to train to harness as a ; but, thanks to your indomitable pluck and persece under most trying conditions, our steed is now as as a coster's donkey, and it behoves us to consider we can make of him. The time for hesitation and eartedness is past, money is plentiful, and the investor ill confidence in "Electrics." I propose, therefore, to ihead a little, in the hope that I may at least succeed imulating you to apply your minds most seriously to roblem that lies before us.

e problem is—How can we possibly supply the ınd that is about to break upon us? When we ed upon this business we had practically only one nercial outlet—viz., lighting—and we were unable by amount of sophistry to make the public believe that ric light was cheaper than gas. Now the conditions changed, and Mr. Arthur Wright informs me that in ghton the working-man and the fried-fish shop are his t customers. He is actually realising Mr. Preece's oft-ided statement, that the electric light is the poor man's it. Ten years ago I was responsible for the electric hting of the town of Temesvar, in Hungary. The ant was afflicted with all the usual diseases, and a r others of which you have probably had no expence; but in spite of these ailments the light was heaper than gas, and the result was as electric as he light. In a very few years the gasworks had to hut up, and now electricity owns the whole field. We re gradually getting into a similar position, our costs are coming down, and I beg you to think what the result will be so soon as the great British public shall awaken to the fact that electricity, with its enormous advantages, can be bought for actually less money than its equivalent in gas; and it may awake any moment; probably your next presi-dent may be in the happy position of having to congratulate us thereon.

Unfortunately I, living in London, do not enjoy Man-chester privileges, but when my visitors enquire whether I y more for electricity than I used to pay for gas, I feel ined to throw them out of the window; but I refrain, I after lighting the gas, turn off the switch and smile ile they groan. I have one room fitted with a Welsbach ner. I still keep it in working order to expose its edness I fear many of our consumers do not live up heir privileges: they are satisfied with the equivalent nslight, but I go in for daylight all over the house—er daylight than you ordinarily enjoy in Manchester—I have my reward and am satisfied. I see things in true colours—the terrible "blues" have disappeared aly; I can even smile when I pay the bill. The pretion is: use 95-volt lamps on a 100-volt circuit, and ge them frequently; it is good for the consumer, good he lampmaker, good for the undertaker (not the man ack).

ch, gentlemen, is the prospect in electric lighting; at moment the tide may come in, and when it comes, year or next year, it will swamp the whole electrical stry. I said, a moment ago, that when we entered this business we had practically only one commercial t; even to-day that same outlet is our mainstay, but developments are growing so rapidly that one finds possible to keep pace with them; take, for instance, electro-chemistry: old in conception, new in economic application, it is now showing such vitality that the hope—I may even say the assurance—is rising within us that Widnes and St. Helens may soon cast out the "devils" which "possess" them, and, so far as it may be possible for them, atone for the sins of their youth by redigesting their waste heaps. Then, "in the inhabitation of dragons, where each lay, shall be grass with reeds and rushes." This great work has begun. Who can tell when it will end, or what demand it will make on our national capacity of production? Again, the melting and welding processes are being gradually introduced into engineering workshops; intrinsically expensive, they justify their existence by electrifying into life most costly corpses—an almost infinitesimal deficiency is made good, a blow-hole is filled, a crack is welded up, hundreds of pounds are saved by the expenditure of a few shillings. At present none but the enlightened use this process, but it is only a matter of two or three years before every engineering establishment in Great Britain shall be so provided.

I have now to call your attention to the subject of locomotion, and in so doing I do not intend to discuss the question of electrical transmission of power for main lines of railways. I leave that to my successors. I would rather direct your thoughts to the more pressing question of tramways and light railways. Hitherto we have done next to nothing, and the small experiments which have been undertaken have been carried out almost entirely with American machinery. Even under these conditions the results have been satisfactory. We must not, however, lose sight of the fact that we possess several home-made electric tramways, including Mr. Holroyd Smith's Blackpool line, which, although constructed 12 years ago in the face of difficulties not encountered in the case of any other electrical tramway in England, has nevertheless given satisfaction and paid its shareholders. We have also the Liverpool Overhead Railway, the Isle of Man tramways, and the South Staffordshire lines, as standing proofs of our native ability to deal with problems of the most varied and exacting character. The total mileage of electrically-worked tramways in Great Britain is now 93. The projected lines, however, amount to no less than 340 miles in length, and the capital required for their equipment will certainly not be less than £3,000,000. But even this large amount of prospective business represents only the beginning of the demand. Very soon horse traction will be superseded by electricity on the whole 1,000 miles of tramway now existing; and, in addition to this, London will be honeycombed with subterranean electric railways, and provincial towns will adopt systems of surface tramways far more elaborate and extensive than those which now exist, even if they have to widen their streets to accommodate them.

There is already sufficient indication of what is coming in the attitude of Manchester, Leeds, Sheffield, and Glasgow. The fact is, that electric trams pay both the owner and the user; wherever they run no one can afford to walk, except for exercise, for the saving of time is enormous. Even in England, where the eight miles an hour rule is in force, there does not appear to be any difficulty in getting over the ground. I cannot explain this in detail; you must see it for yourselves. What we want is to get rid of the horse in cities. He is all right in the country, but in town he is a nuisance. Consider for one moment what we could do if he were kept outside. Firstly, we should make our streets of hard asphalte as smooth as a billiard table; secondly, we should keep them quite clean; thirdly, our electric motor carriages would run with so little friction that even our present batteries would fulfil all the conditions. The only difficulty arises out of the time necessary for making the change; if it could be made in a night, then Manchester might start on the new system to-morrow, and even Alderman Higginbottom would not recognise his native city, so delightful would it appear. But although it cannot be done in a night it will be done by a long and painful process, in which the electrical engineer will have to overcome the obstruction of bad roads, and supplant the horse on his own ground; then, ultimately, the civic authorities will alter their roads to suit the new conditions.

What a pity it is that we electrical people cannot

start afresh and build a new city, embodying all the latest improvements. Imagine ham and eggs for breakfast per telephone ; the subscriber would put the fork in his mouth, and having attached the wire and touched the button, the young lady at the other end would connect him to the ham and eggs battery (ham positive, egg negative), and in 10 minutes he would be a new man. N.B.—Coffee thrown in. This idea is not new ; it was originated some 30 years ago by Mr. Alderman Hopkinson. Of course, in those days electrical methods were not perfected, so the scheme did not get beyond milk, and even with that simple fluid the trouble was that one subscriber might get all the cream and his neighbour skilly. So far as my memory serves me, the idea was not carried out in practice. I fear our electric city is a long way off, so in the meantime we must make the best of those we have, and no one will deny that there is room for improvement. In the first place, we must abolish smoke. Which idea brings me at one step right into the middle of a subject—the most pressing and important subject with which it is possible to engage the attention of a Lancashire audience. I refer to the driving of machinery for manufacturing purposes by electrical distribution of power, including the total abolition of line shafts, countershafts, wheels, ropes, pulleys, and belts. The day for tinkering with this problem is now over ; every man in this room knows that it can be carried through with absolute certainty, with satisfaction to the manufacturer, and with an enormous saving both to himself and the community. But the manufacturer does not yet know that the shaft of his machine can be fitted with a three-phase motor without commutator or brushes, and less complicated than his present double pulley and strap fork. When you have succeeded in impressing him with this fact, the remainder of your task will be an easy matter, but it must be undertaken methodically. The first step is to appoint a commission to settle uniform periodicity and voltage ; the second is to equip an electrical manufactory capable of turning out 500 cheap motors per week ; the third is for machine makers to attach the motor in place of their present pulleys, so that when a manufacturer buys a machine, he buys it all ready for attachment to his power circuit.

Having reached this point, it is obvious that the manufacturer will no longer desire to buy coal ; he will be quite satisfied with watts, which may be produced at the pit's mouth and sold retail for less than they can now be supplied mechanically to the machine axis. The whole question of external supply of power turns on this question of economics. Your manufacturer will not care two straws for your electrical development or for the annihilation of the smoke cloud which he interposes between the sun, the source of all our joys, and the dismal streets of Manchester ; but his eyes will gleam with rapture if you can prove that you can save him a thousand a year. Happily your task is an easy one, so far as argument is concerned ; and if illustration be required, I am not sure that we members of this society could spend our savings to better advantage than by taking a representative deputation of Lancashire and Yorkshire manufacturers through Switzerland and Germany, to show them how the old order is giving place to the new ; how the millwright is disappearing in favour of the electrician ; how 25,000 mechanics are struggling to keep pace with the demand for electrical machinery, of which about three-fourths is required for power purposes. Some of it, of course, is for the transmission of water power, but even in Switzerland water power is seldom so well placed that it can produce electrical horse-power cheaper than we can produce it by steam at the pit's mouth—that is to say, at about £4 per annum constant service, or £38 for factory hours. When we consider that the present cost of steam power for a cotton mill is about £3 per annum per indicated horse-power, and that the electrical horse-power required in its stead would not be more than 65 per cent., you can easily see what a large margin there is for profit to the producer and for saving to the consumer ; for it must be remembered that the load curve would be practically a parallelogram, or rather two parallelograms, one for the day and a smaller one for the night.

But, gentlemen, great as would be the saving to the
spinner, and the large manufacturer whose s
costs him £3 per horse-power, it would be vastl
those thousands who employ small steam-engine
up the cost of power to £10 or £12 per an
aggregate annual saving to Manchester and S
would be immense, quite beyond my powe
lation ; but you must not suppose that l
imagination fails to grasp the figures inv
the change which is coming will be long dela
account. Some friends of mine who have la
the Continent of Europe report as follows : "E
afforded us that not only are new factories a
Continent laying down electric power througho
works already equipped with steam power are
out and substituting electric." In America
process is going on, so it follows as a matter of
we must either quicken our pace or drop out of
altogether. Happily the coal-pits around Man
so close to the city that there will be no new d
transmission, and a very moderate voltage will
is obviously outside our province to discuss
possible methods of raising the capital. My c
sion is, that when the profitable nature of [the
comes to be understood, there will be no d
raising a million to put down a pioneer plant of
with an earning capacity of close on £200,000 p

Gentlemen, when I look round this room and
the fact that you are the men who must carry o
great works, then I understand the honour th
upon me in being called to be your president ;
thankful that you are all young and eager for w
is plenty of it waiting for you—but I am not
that we are few in number, for it is not possib
facture an electrical engineer either in five min
years, so in the very nature of things our
swell but slowly. Many of you doubtless w
wonder in sorrow, why our progress in this c
been so slow compared with the rapid str
have been made on the Continent. I have
heard many explanations, all partially true,
real and predominating reason is the low p
in this country, whereas on the Continent gas
so high in price that the investor did not feel an
in backing electric light to beat it. Consequen
works and manufacturing works were developed
rate, and are still increasing in size and output
which would frighten us in this country ; and
no hesitation in saying that if all our makers
electric machinery were forthwith to proceed
their capacity, they would not be in time to cop
demand which will come upon them. I have in
you several sources, of which three are principal
any one of which sufficient demand may arise
all our works. I say may arise, but the w
may with almost equal probability be tapp
same time, and then where shall we be ? Al
quantities of machinery are being imported
Continent and from America, simply because
prepared to make them here, and yet the blind
the blind think this a fit time to restrict the out
machinery. It is like shutting up the gun fact
middle of a war. Our only hope is that the s
discipline may atone for the six months' loss.

This brings me to the consideration of a sub
though not strictly electrical, is nevertheless
mately bound up with our lives and fortunes ;
the steam-engine. Our electrical brethren in S
and in some parts of America can get a
enough without the steam-engine, but it is n
us ; it is fortunate, therefore, that we ha
of coal with which to feed him. But this
of coal has tended to make us less care
than our less fortunate neighbours. The res
although we make good steam-engines, in spite o
comments to the contrary, we have not made ec
first consideration ; we have, moreover, been co
this practice by the belief that economy of coal
be obtained by increased capital expenditure an
some complications. But that view is totally
mentally erroneous. I have already proved in

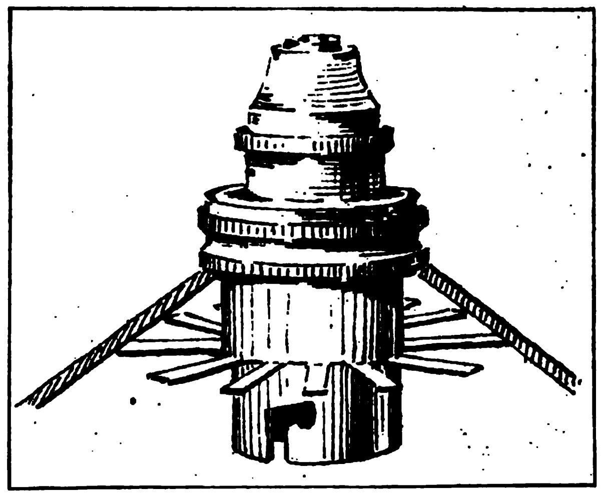
generation of electrical energy for tramways, read the Institution of Electrical Engineers in 1897, that i mean pressure is not uneconomical per electrical power, and, consequently, that the gain by using engines with very early cut-off is only apparent the indicated horse-power is taken as the basis of rison; further, I can give you this solid fact: the large engines at the Wandsworth electricity n are producing an electrical horse-power at ally the same steam consumption at full load as f load, thus showing that, taking all the losses into nt, the saving effected by extreme expansion is can-lout. Therefore we arrive at this fact, that existing es might easily drive more spindles without increasing xt per spindle, although there would be an increased er indicated horse-power. This seeming paradox will use you any trouble, though it may puzzle the cotton-er. But, gentlemen, our friends on the Continent gone a step further; they have improved their engine improved their steam by superheating to such an t that I have actually seen a 500-h.p. engine driving rage of 300 h.p., fed by a single-flued boiler 5ft. 9in. ter by 26ft. long. This impressed me more than the morial tests, which gave 8·8lb. of steam per indicated -power. To the saving in coal we must add the saving ilers and other subsidiary apparatus. My firm belief it the economy now being realised in Germany by elm Schmidt and Co. is obtained at a lower capital and with less complication, than we find with our ashire engines.

ntlemen, you are fully aware by bitter experience the demand for steam-engines in this country ether exceeds the supply, and that in consequence is state of affairs engines are being introduced from ica, which, although well built, will not comply with ch specifications as to economy; and consequently we i the position that, however we may exert ourselves the coming demand for electrical plant, we shall be : without the means of driving it or dependent on ican engineers for our steam-engines. This is not a itful prospect, but we must face it, even if it be to ome of two or three millions of additional capital in eering works.

ntlemen, the keynote of the few words which I have he honour of addressing to you this evening is faith— in yourselves, faith in electricity, faith in the new ization which is dawning on the world. The picture I have presented to your minds is made up of many s, each of which is more fully understood by some of ember than by me, for we hold in our ranks men of ighest attainment and widest experience in electrical echanical science. Your faith, therefore, will be faith ed on knowledge; and in exactly in proportion as rn it to account by making preparation to gather in rvest ripening under your eyes, so will be your of the fruit. You must copy the example of the st and financier, and obtain some monetary interest y good scheme you may be connected with. You l it will pay you better than working, though, it will not produce, and never can produce, that satisfaction which the village blacksmith enjoyed spreading chestnut tree—the same tree which now by the side of an electric lighting station. There or me nothing but to congratulate you on the fact r years of hard work, quite inadequately remu-he goal of your ambition is glittering before you. nonths you will be in the position of our fore-e mechanical engineers, who reaped their reward ore they had earned it. It behoves you, then, to be constantly on the watch for the little cloud no n a man's hand, and wait not for the prophet to , "Prepare thy chariot and get thee down, that op thee not."

NEW SHADE CARRIER.

mpanying illustration shows Messrs. Drake and ew patented shade carrier, the "Nelson," which this y putting on the market for supporting conical and s. Considerable trouble has hitherto been caused with the ordinary ring carrier of the bayonet-socket lampholder, owing to its being so difficult to remove for cleaning the shades, and also from the constant cracking of the shades owing to the expansion when hot. The D.G. "Nelson" carrier is said to overcome both these defects. It consists of a short brass tube which screws on to the standard bayonet-socket lampholder, one end of the carrier being splayed out into a number of projections or teeth. As the tube is screwed up under the shade the extremities of the splayed ends come in contact with the shade, forming a yielding but firm support, and it will be found that



several of these can be fixed or removed in the time necessary to manipulate one of the old pattern. The carrier is suitable for glass shades of all shapes and sizes, and is being put on the market by Messrs. Drake and Gorham at a low price so as to ensure its universal and rapid adoption throughout the trade.

FORTHCOMING EVENTS.

FRIDAY, JAN. 14.

Institution of Civil Engineers, Great George-street.—At 8 p.m., students' meeting. "Mechanical Draught," by Mr. R. Gordon Mackay.

SATURDAY, JAN. 15.

North-East Coast Institution.—At the Technical College, Hart-road, West Hartlepool, at 6 p.m., "Some Considerations in Connection with the Transverse Framing of Ships," by Mr. H. E. J. Camps; "Water Ballasting of Steamers," by Mr. Archibald McGlashan. At 3 p.m., visit to the works of Messrs. Thos. Richardson and Sons to view the electric transmission of power plant.

TUESDAY, JAN. 18.

Institution of Civil Engineers, Great George-street, Westminster. At 8 p.m., resumed discussion upon the paper "The Machinery used in the Manufacture of Cordite," by Mr. E. W. Anderson, A.M.I.C.E.

Royal Institution, Albemarle-street.—At 3 p.m., Prof. E. Ray Lankester, M.A., LL.D., F.R.S., on "The Simplest Living Things."

WEDNESDAY, JAN. 19.

Society of Arts, John-street, Adelphi.—At 8 p.m., "The Projection of Luminous Objects in Space," by Eric Stuart Bruce, M.A.

Institution of Electrical Engineers.—Students' meeting at 28, Victoria-street. Discussion on "Accumulator Traction."

Liverpool Engineering Society, Royal Institution, Colquitt-street. At 8 p.m., "Shallow-Draught Steamers," by Mr. Seymour B. Tritton, M.I.C.E., M.I.N.A.

THURSDAY, JAN. 20.

Institution of Civil Engineers.—Students' visit to the Central London Railway Works, by permission of Sir Benjamin Baker, K.C.M.G. Assemble at Notting Hill Gate Station at 2.30 p.m.

Liverpool Engineering Society.—Annual dinner at the Adelphi Hotel, Liverpool.

Royal Institution, Albemarle-street.—At 3 p.m., Prof. Dewar, M.A., F.R.S., on "The Halogen Group of Elements."

FRIDAY, JAN. 21.

Institution of Junior Engineers.—At the Westminster Palace Hotel, at 8 p.m., lecture on "Laboratory Testing Machines," by Prof. A. C. Elliott, M.I.C E.

Physical Society of London.—At the rooms of the Chemical Society, Burlington House, at 5 p.m., Prof. O. Lodge, F.R.S., "On Electric Signalling without Conducting Wires." A Tesla oscillator will be exhibited by Prof. S. P. Thompson, F.R.S.

SATURDAY, JAN. 22.

Institution of Junior Engineers.—Visit at 3 p.m. to the engineering laboratories of the Central Technical College, South Kensington.

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FLIES ROUND THE TREACLE POT.

"The Urban District Council of Acton h[as] approached Messrs. Kincaid, Waller, and Ma[nville] to advise on the subject of electric lighting, a[nd at] the time of so approaching them did not me[ntion] the fact that the Council had resolved to have reports, Messrs. Kincaid, Waller, and Ma[nville] upon becoming acquainted with this fact f[elt it] necessary to resign the appointment." Such i[s the] gist of a communication that has reached us i[n the] usual manner. Additional information, howev[er, is] to be found in the report of the last meeting o[f the] District Council. The following is the text o[f the] report in the local papers: "Messrs. Kin[caid,] Waller, and Co., electrical engineers, who [were] engaged at the last meeting to furnish a repo[rt to] the Council as to the best scheme of electric [lighting] for Acton, now wrote stating that they had no[ticed] an announcement in the Press to the effect tha[t the] Council had decided to obtain reports from electrical experts on the question. It was not [their] custom to submit reports on matters of this [kind] which might be put into competition with [other] reports, and they therefore hoped the Council w[ould] see its way to appoint them alone to advise i[n the] matter. In the alternative, they begged respec[tfully] to tender their resignation of the appointmen[t. A] large number of other letters and applications [from] electrical experts and others were received, and were all considered in committee."

When we read of such matters, we are inclin[ed to] ask if such a thing as professional etiquette ex[ists,] and in the reply to modify the expression of [Bret] Harte in "The Heathen Chinee," that profess[ional] etiquette is almost played out, existing only a[mong] the topmost branches of the profession, being [every-]where as dead as the dodo, embalmed as the mu[mmy] and enshrined in an odd corner of an archæolo[gical] museum. In the Acton case there are two p[oints] worthy of consideration: firstly, the actio[n of] the authority in attempting to play off one [con-]sulting engineer against another; and secondl[y, the] large number of letters received by the auth[ority.] Let us take the second point first. It really s[eems] that the professional idea of a number of elec[trical] consulting engineers is that a man should cr[ow as] loudly as possible upon his own dunghill, p[ut his] own estimation upon his value, and expect eve[ryone] else to swallow that estimation. He is not [back-]ward in pushing his own wares and acting a[s his] own traveller. He offers his services to all [and] sundry for a consideration, the consideration [being] just that amount he hopes will fetch a cust[omer.] Some are just a notch above this kind of t[hing,] and employ a brazen-faced trumpeter to d[o the] dirty work and pave the way for their em[ploy-]ment. Pecuniary inducements have been o[ffered] to those who are thought to have influen[ce in] determining employment, and a very com[mon] form of action is by means of socialities. [But] it is absolutely certain that the best men i[n the] profession are perfectly free from the vice[s we] have depicted. If an authority requires [their] services, it must seek them; they will not see[k the] authority in any underhand or unprofess[ional]

manner. Thus it may be taken as axiomatic that the authority which takes a man because of his own recommendation in a letter of application, does not select a man who ranks in the front of the profession. The younger and less-known men may retort, "We must make ourselves known and gain a footing somehow. There is nothing illegal or illogical in applying for a position one wants; hence we do it whether it has been recognised as professional or not." In reply, it may be at once admitted that their difficulties are very great, and the struggle for a footing almost herculean, but we contend that there are other and better ways to obtain employment than those we complain of. Cheapness in its vulgar sense has never been reckoned synonymous with "best," and yet in its more restricted meaning the best is generally the cheapest. Too many authorities never get beyond the former rendering, and with them the twenty-pound man is cheaper than the one-hundred-guinea man, and preferably to be employed. Brains are not weighed, nor is modesty appreciated. Thus the tendency to unprofessional conduct is as much due to the action of ignorant and incompetent authorities as it is to the misapplied energy of the touting engineers. With regard to the other point, there are several methods of procedure open to any authority. In our opinion the proper way is to employ a competent engineer, and put the whole matter in his hands and the whole responsibility upon his shoulders. If he is competent he will prepare the best design under the particular conditions prevailing, the apparatus he will specify will be the best for its work, and he will aim at producing something that shall be at once efficient and economical. The initial cost may be larger than with the design of less able hands, but initial cost is not the criterion of economy. Another plan is to throw the work open to all engineers and invite competitive designs. A worse plan could hardly be devised. It means the reception of an *olla podrida* of designs, and no one capable of picking out the tit-bit or of appreciating it if picked out. The third and worst plan of all is that adopted by the Acton authorities, to invite reports from two engineers. Such reports can only be required to compare the one with the other; to find out which man appears the cheaper, and in the end to appoint him the engineer. At least, that is our interpretation of the method; and we are glad to find that Messrs. Kincaid, Waller, and Manville have pursued the course they have in refusing business on such terms.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

THE ENGINEER'S STRIKE.

[The following letter has appeared in the *Times*. It confirms the statements from personal observation which we have published from time to time.—ED *E. E.*]

SIR,—Within the past few weeks I have had occasion to visit the leading Continental workshops representative of an industry which has already attained considerable proportions both in the Old World and the New, and is likely in the coming century to rank as one of premier importance as a field for the investment of capital and employment of labour. I refer to that of electrical engineering.

My tour embraced the leading industrial centres of Germany, Austria, Bohemia, Hungary, Switzerland, and France, where electrical manufacture is being conducted on a large scale. Careful enquiry and observation upon the spot have elicited the following facts, which may be of some interest at this stage of a struggle between capital and labour which, in the respects of organisation on both sides, of orderly conduct, and of the social, if not socialistic, issues involved, marks a new era in the history of such disputes.

Twenty years ago the electrical engineering, as distinct from its younger sister the telegraph, industry was non-existent. All manufacturing nations therefore had an opportunity of "starting level" towards the goal of industrial endeavour—viz., to supply their home and the world's markets with electrical products, for which the demand has grown and is increasing by leaps and bounds. If there were any odds at all the advantage might have been held to lie with the country on whom rested the blessings of free trade, industrial experience, world-wide commercial relations, and unparalleled Imperial and Colonial possessions.

What is the result? Briefly, as everyone interested in the subject is fully aware, that both American and Continental electrical manufacturers are underselling British-made goods in the neutral markets of the world, such as Central and South America, Russia, China, and Japan; have supplied a substantial proportion of the demand in our own Colonies, where, alas! patriotism, when weighed in the balance against prices, is found wanting; and are to-day threatening, particularly in the respects of electric traction and power plant, to introduce ruinous competition in our home market itself.

The capital invested in the electrical plant manufacturing industry in Great Britain has been estimated at not exceeding £4,000,000 to £5,000,000, in Germany at £10,000,000 to £12,000,000, and in the United States at £25,000,000 to £30,000,000. The output of manufactured electrical goods must be substantially in proportion.

Various special causes—such as restrictive legislation, vested interests, and the proverbial caution which constitutes the commercial "genius" of the British people—doubtless account in part for the relatively slow development of public electrical works, especially as regards electric traction and power, in Great Britain. But they do not account for the fact that Germany and America can undersell the English manufacturer in the common markets of the world which are equally open to all comers.

The root cause of the latter phenomenon must be traced to the relative cost and methods of production in the different countries.

Capital can be borrowed cheaper in England than in Germany or America. Materials, taken all round, cost about the same in the former and decidedly higher in America. Hence the difficulty does not arise on these grounds. The explanation undoubtedly lies in the conditions on which labour is obtainable.

I found that in the Continental workshops, not only is the 60-hour week the invariable rule, but that the leading trades involved in electrical manufacture—machinists, fitters, and electrical artificers—are receiving on an average 25 per cent. less wage per week; or, taken with the fact that they work 10 per cent. longer hours than are usual in England, nearly 30 per cent. less per man per hour. This of itself is a serious handicap for the English manufacturer; but worse remains behind.

English employers widely accuse the trade unions of attempting to dictate as to both the quality and quantity of labour to be employed in their workshops; of endeavouring to impose artificial restraints on the free and healthy productivity of both men and machinery by discountenancing piecework; by forcing highly-paid men to be employed on machinery where a cheaper form of labour would suffice; and by limiting their members' daily output of work to a predetermined average based on a low rather than a high standard.

I was unable to meet with a single Continental employer who brought similar charges against the workmen's organi-

sations in his country; and it need not be pointed out that, if correct, these charges knock the bottom out of the argument opposed by the men's leaders here that shorter hours in Great Britain will not prejudice industry because the British artisan is a "superior" or "intenser" workman.

The fact that American electrical engineering manufacturers can undersell British in the world's markets, in spite of their wage rates averaging some 30 per cent. higher, is pointed to by employers here in corroboration of these charges.

I do not wish to suggest that the American or Continental workman is more disposed to abstain from agitation than the English workman because he is better satisfied with his lot. On the contrary, all students of the subject know that their dissatisfaction is chronic and profound; and probably most will agree in thinking that English militant trade unionism is a healthier manifestation of dissatisfaction than the explosive, though temporarily suppressed, socialism of the Continent, or the American workman's periodical struggles with despotic capitalism supported by special police and shot-guns. Many will go further and hold that rational trade unionism is in the interests not only of the working classes but of society at large, as all ordered effort is better than chaos, and that it should not be discouraged.

But into the socio-moral aspects of the question it is not possible here to enter. My object is to call attention to the influence which unsound economic doctrines on the part of British trade unions are having upon an industry which, although at present insignificant when compared with the staple industries of the world, is growing in importance every day, and is destined to become the most important section of the engineering trades in the near future.

There are indications that the trade union leaders are willing to disavow, if they ever seriously held, these self-destructive doctrines affecting workshop management, regarded by employers generally as of far more vital consequence than the question of hours. If the unions, through their leaders, would clear up the present atmosphere of doubt and uncertainty by giving a clear and unequivocal statement of their attitude, the first and most important step will have been made towards a settlement alike honourable and advantageous to unionism by resulting in its willing recognition by employers, and acceptable to industrial capital by placing it in a position to compete favourably in the world's markets.—I am, Sir, yours, etc.,

London, Jan. 10. R. PERCY SELLON.

THE JURIDIC SIDE OF THE MUNICIPALISATION OF TRAMWAYS.

BY GEORGE BEYNON-HARRIS.

That the abstract theory of the municipalisation of public works is, in popular estimation, almost entirely based on the doctrine of utilitarianism, is probably beyond question. That the true touchstone of the wisdom or insanity of municipalising a particular undertaking is the balance-sheet of the works to be municipalised, appears to be equally incontestible. But it is not with the theory in the abstract, nor the wisdom in particular instances, that we here have to deal. Our business is solely with the means to that end—*videlicet*: the legal machinery which requires to be put in motion to enable a corporation to take over and to municipalise a tramway undertaking. And when we make use of the words "take over" and "municipalise" we do so advisedly; because, as will hereafter be made clear, neither the mere process of transfer, nor the actual possession by a corporation, necessarily means municipalisation.

There are several means by which a corporation may find themselves in possession of the tramways: in some cases, by an active exercise of their corporate desires in that direction; in others by force of circumstances. Let us then first enquire by what means, and under what circumstances, a corporation may find themselves in possession of the tramways; and, secondly, being in possession, when the corporation can be said in strictness to have municipalised the undertaking. To this end let us first take the Tramways Act of 1870, which is the great substantive Act on this subject (referred to hereafter as the principal Act), and what do we find? We find that a corporation may become possessed of tramways:

1. By themselves obtaining from the Board of Trade a provisional order, on their own account, in which case they are the promoters. The provisional order, though granted, is, however, wholly inoperative, and cannot be acted upon by the corporation until it has been confirmed by an Act of Parliament procured at the instance of the Board of Trade, and which may, and invariably does, include within its confirmatory province a number of provisional orders obtained by various towns respectively. But even when a corporation has succeeded in obtaining a provisional order, they are by no means safe of obtaining the confirmatory Act; for it is when the Bill for this purpose is before Parliament that the stage of opposition arrives; and it is now that "petitions against" any provisional order comprised in the Bill may be presented. In the event of such a petition, the Bill will in all probability be referred to a Select Committee; and the opposition will be heard in precisely the same manner as in the case of a Bill for a special Act; notwithstanding that the Bill, when it eventally goes through, is deemed a general Act.

2. By a similar process, obtaining jointly with another authority a provisional order empowering the two local authorities respectively jointly to construct the whole, or separately to construct parts, and separately to own the whole, or parts thereof.

3. (It is presumed; but doubtful.) By license from the Board of Trade under the following circumstances: If at any time after a tramway has been for three years opened for public traffic, it shall be represented to the Board of Trade, by 20 inhabitants who are ratepayers, that the public are not deriving the full benefit of the tramway, the Board of Trade may grant licenses to any "company or person" to use such tramway in addition to the owners, or their licensees thereof. The operation of this method is doubtful, because the word "person" is not defined in the interpretation clause of the Act. Whether the word "person" would be held to include a corporation (in this particular connection) is uncertain; but in view of the fact that under some public statutes (albeit for the most part penal) "person" includes a corporation, it might not be altogether wise here to omit a reference to this possibility, however dubious or remote it may be.

4. By compulsory statutory purchase within six months after the expiration of a period of 21 years from the time the power to construct the tramway was obtained, not from the time the lines were actually laid down.

5. By compulsory statutory purchase within six months after the expiration of every period of seven years *subsequent* to the 21 years aforesaid.

6. By private treaty (where both parties are agreed) without reference to any term of years. Here the promoters of a tramway which has been opened for traffic for a period of six months are legally competent to sell their undertaking to a corporation, or to any other body or person.

7. Where the promoters discontinue the use of the tramways, and the Board of Trade make an order declaring the powers of the promoters to be at an end.

8. Where the promoters have become insolvent and the Board of Trade make an order declaring the powers of the promoters to be at an end.

If therefore No. 3 method should be held to be legal, there are, under the principal Act alone, eight methods by which a corporation may become possessed of the tramways.

Beyond the methods under the principal Act, however, the provisional orders themselves almost invariably contain provisions by virtue of which (when confirmed by Act of Parliament) the tramways may become vested in a corporation. Let us take some one provisional order which will serve as an example of all those throughout the country, and for this purpose that of Cardiff will be the best possible example; because the tramway system there is not only a most extensive undertaking, but also because the Corporation there have not yet exercise any powers of purchase. We find then that the Cardiff Corporation, under an enabling section of the Cardiff Tramways Orders, 1871, may at any time after seven years from the date of the passing of the Act confirming the order (1871) purchase the tramway, and

"the promoters *shall* assent thereto and *shall* accordingly *sell* the tramways." The Cardiff Tramway Order, 1873, the Cardiff Tramway Order, 1878, the Cardiff Tramway (Extension) Order, 1884, the Cardiff District and Penarth Harbour Tramways (Extension) Order, 1885, and the Cardiff Tramways (Extension) Order, 1885, all contain similar provisions: and these powers of purchase are in addition to the powers conferred by the principal Act. As we have pointed out, the provisional orders of other towns contain almost identical provisions, and so what we may say of Cardiff can be taken to be of general applicability. It will, of course, be borne in mind that the provisional orders are not those of the corporation, but belong to and were obtained by the tramway promoters; and provisions for purchase are usually concessions wrung by the corporation from the promoters at the time the provisional order was applied for, or when it was in contemplation.

The questions therefore now arise: (1) Can the powers of purchase contained in the provisional orders be exercised independently of the Act and without regard to the period of 21 years? (2) What are the actual powers of a corporation over the tramways after they have obtain possession thereof, either under the principal Act or under the provisional order? (3) Is the mere purchase of the tramways by the corporation a municipalisation of the tramways.

First, then, as to compulsory purchase independently of the principal Act and without regard to the period of 21 years. For this purpose we must most carefully examine the principal Act itself and the provisional orders. What, then, does the principal Act say? The provision of Section 22 thereof is as follows: "All the said provisions of this Act, *save so far as they shall be expressly varied or excepted* by any such provisional order or Act, shall apply to the undertaking authorised thereby." That being so, let us see how far the provisions of any provisional order do expressly vary or except that portion of the principal Act relating to compulsory purchase. By the principal Act, Section 43, the earliest time at which a corporation may compulsorily purchase *is six months after the expiration of 21 years*, calculated from the time when the promoters were empowered to construct the tramway! This, then, is the provision which must be varied and accepted in order to take the purchase out of the principal Act. The provisional order provides that "In case the corporation shall *at any time after seven years* from the date of the Act confirming this order desire to purchase, the promoters shall assent thereto, and shall accordingly sell the tramways and premises to the corporation. Provided that nothing in the order shall *disentitle* the corporation to the benefit of Section 43 of the principal Act (that is, the power of purchase after 21 years, etc), if they have not previously exercised the power of purchase conferred upon them by the order. Moreover, the provisional order states that "the provisions of the Tramway Act, 1870, are hereby incorporated with this order, *except where the same are expressly varied* by this order." Then, strangely enough, after all this express variation of the principal Act the order contains this section (and all the orders make the same provision): "Nothing in this order contained shall be deemed or construed to exempt the tramways from the provisions of any general Act relating to tramways now in force or which may hereafter pass during this or any future session of Parliament." Must this provision be taken to mean a deliberate nullification of the words above quoted, which expressly varies the principal Act, as to times of purchase? Of course the true meaning is that, except in the instance where the principal Act is expressly varied, the order shall not be otherwise construed to exempt the provisions of the principal Act. Notwithstanding, therefore, some immature and hypercritical opinions, based upon the apparent irreconcilability of these sections, which at one time cast some fleeting doubt upon the independent nature of the powers of purchase conferred by the provisional order, it seems now to have been clearly settled in favour of the provisional order; and that a corporation may purchase the tramways under the powers contained in the order without reference to the 21 years in the principal Act.

So far, therefore, we have dealt with our first point—the means by which a corporation may become possessed of a tramways undertaking. The second point, as previously indicated, is: having become possessed, what are the actual powers which mere possession of the tramways undertaking confers upon the corporation? And to this, therefore, our attention will next be directed.

(To be continued.)

GUTTAPERCHA.*

BY DR. EUGENE F. A. OBACH, F.I.C., F.C.S., M.I.E.E.

(Continued from page 22.)

Isoprene is a very remarkable compound. Dr. Tilden succeeded in reconverting it into caoutchouc by treatment with concentrated hydrochloric acid, and later on observed that this polymerisation could also take place spontaneously in the presence of acetic or formic acid. We, therefore, have a product here which, since it can also be obtained from other sources, may on some future occasion form the stepping-stone in the synthetical production of caoutchouc and gutta from the lower terpenes. Quite recently two Russian chemists cleared up the constitution of isoprene, and found that four of the five carbon atoms are doubly linked together, and that it is asymetric methyldivinyl having the formula: $CH_2 = C\ (CH_3) - CH = CH_2$.

We will now consider the behaviour of guttapercha towards acids and various other menstrua. On the table before me I have a number of glass jars, containing 1in. cubes of raw guttapercha of good quality, which have been immersed in various liquids few days ago. It will be observed that the weak mineral acids, nitric, sulphuric, and hydrochloric (1 part acid and 20 parts water) have had no action whatever, whereas concentrated nitric and sulphuric acids have strongly attacked the material, the former completely oxidising and the latter charring it; on the other hand, strong hydrochloric and acetic acids and strong alkalies, such as liquid ammonia, specific gravity ·880, and caustic potash, specific gravity 1·28, show no appreciable action. It will further be noticed that ether, alcohol, acetone, petroleum-spirit, turpentine, and benzole, have had a more or less solvent action on the guttapercha, extracting chiefly resinous substances, whereas carbon disulphide, chloroform, and carbon tetrachloride have completely dissolved it, leaving only the woody and mineral impurities, which partly float and partly sink to the bottom of the jars.

BOTANICAL DERIVATION.

Let me now say a few words on the botanical derivation of guttapercha. In his first communication to the Bengal Medical Board in March, 1843, Dr. Montgomerie states that the specimens which he submitted with his letter were the product of a large forest tree indigenous to Singapore, but being prevented from proceeding to the spot he himself did not see that tree. He offered a reward for specimens of the flower and fruit, but it appears did not succeed in obtaining any at the time. In 1844 an amateur collector, the Rev. Edward White, chaplain of Singapore, sent a dried branch of the tree to the eminent botanist, Dr. William Griffith, of the Madras Medical Service, whose short but brilliant career was so soon after abruptly closed.

From the small branch Dr. Griffith was enabled to classify the plant as belonging to the natural family of Sapoteæ, or Sapotaceæ, as it is now commonly termed, and he believed it to be related to chrysophyllum, but was unable to decide this point in the absence of either flowers or fruit. In the following year, Mr. White himself gave a description of the guttapercha plant, and sent it to Dr. Griffith; however, it reached Malacca on the very day of his death, and was subsequently published by Dr. Mouat. Mr. White here also related the plant to the Sapotaceæ and Ebenaceæ. His description of the foliage and flowers is excellent, but he did not attempt to give the plant a name, nor did he venture to decide to which of the known genera it bore the greatest affinity.

The guttapercha plant having thus early been allotted to the Sapotaceæ—a place, I may at once state, it has retained ever since—I should like to say a few words about the general characteristics of this particular family of plants.

All Sapotads are either trees or shrubs, and nearly all natives of the tropics of India, Africa, or America; a few, however, are found in the southern parts of North America and at the Cape of Good Hope. They are characterised by the secretion of milky juices, apparently a waste product, which may possibly serve to heal any wounds made in the plant, either by sealing them up or else antiseptically protecting them, but their true functional importance is not yet fully understood.

This milky juice or latex is contained in single cells or sacs—arranged in longitudinal rows like the tannin sacs of the hop and the mucilage sacs of the Tradescantia—which are located chiefly in the inner parts of the bark, but also occur in the pith and the loose tissues of the leaf (in the merenchyma), but not in the wood.

The Sapotads have round branches, and their leaves are

* Cantor Lectures delivered before the Society of Arts.

alternative, simple, entire, and petiolate; they are destitute of stipules. The foliage of some of them is remarkable for its beauty, the leaves being of a bright emerald-green colour on the upper side and possessing a brilliant metallic lustre like gold or copper on the under-surface due to the presence of a silky or downy pubescence. The inflorescence is axillary, and the hermaphrodite flowers are regular and united. The calyx is free and persistent, divided into four to eight segments or petals, which are sometimes disposed in a double series; the corolla is monopetalous, and has the same number of segments, or sepals, as the calyx; the fertile stamens arising from the corolla are equal in number and opposite to the sepals, the anthers being usually turned outwards, there is one style with an undivided and usually lobed stigma. The fruit is a fleshy berry, containing several one-seeded cells; in some of the species it is considered edible—for instance, that of Achras Sapota, known as the Sapodilla plum, or Naseberry, of Chrysophyllum Cainito, called Star-apple, and of Lucuma mammosa, called Marmalade plum. The seeds are nut-like and coherent, frequently containing a concrete oil, which is used by the natives for cooking purposes in place of butter—the so-called Galam butter, for instance, being derived from Bassia butyracea. (Specimens of these fruits were exhibited, also seeds, and the concrete oil obtained from them.)

The Sapotaceæ are closely allied to two other natural families, likewise yielding important economic products—viz., the Ebenaceæ, to which the tree producing ebony wood belongs (Diospyrosebenum), and the Styraceæ, some of which yield useful gum-resins—for instance, gum-benzoin (Styrax benzoin). The three families form together one natural order, to which the name of Ebenales (Dyospyrinæ) has been given. It is, perhaps, useful to state that, botanically speaking, there is no direct relationship between the Sapotaceæ and the different families to which the caoutchouc plants belong, although the latter likewise produce milky juices in abundance, whereas neither the Ebenads nor the Storaxworts, so closely related to the Sapotads, contain any latex at all.

The affinities of the three families and the number of genera and species of each, according to Durand's "Index Generum Plantarum" of 1888, are shown in the following diagram:

GAMOPETALÆ.
HETEROMERÆ.
EBENALES.

Sapotaceæ	Ebenaceæ	Styraceæ
(Sapotads)	(Ebenads)	(Storaxworts)
40 genera	6 genera	7 genera
400 species.	250 species.	235 species.

Mr. M. Hartog, from the anatomical study of the development of the flower, expresses his ideas as regards the relations of Sapotaceæ to the allied orders as follows—viz.:

OLACINEÆ. TERNSTRŒMIACEÆ. GUTTIFERÆ.

Ebenaceæ Styraceæ Sapotaceæ

Myrsineæ Ægiceraceæ.

Primulaceæ. Plumbagineæ.

But even this more extended relationship does not include any caoutchouc-yielding plants. However, I must not digress any further into these purely botanical regions, and will now return to our own subject.

In 1846 Mr. Thomas Lobb, who was on a botanical mission in the Malayan Archipelago for Mr. Veitch, of Exeter, sent several well-dried branches of the guttapercha plant from Singapore to Kew Gardens. Unfortunately, they were without corollas, and Sir Wm. Hooker was unable to decide definitely whether the plant belonged to the genus bassia, to which it seemed to have such close affinity. On looking up these specimens in the herbarium at Kew a short time ago, Mr. Helmsley and I noticed on one of them (No. 290) a curious-looking object, which at once reminded me of a passage in Sir Wm. Hooker's paper of January, 1847, which had always puzzled me, and which runs as follows: "Mr. Lobb judiciously sent small sections of the wood, which is peculiarly soft, fibrous, and spongy, pale-coloured, and traversed by longitudinal receptacles or reservoirs filled with the gum, forming ebony-black lines."

This description was in direct opposition to all I had otherwise read on the subject or seen myself, the wood of the guttapercha tree being neither particularly soft nor spongy or pale-coloured, and the gum would certainly not form ebony-black lines in the wood, even if it should be visible there, which, however, as I have already pointed out, is not likely, as it is contained in the inner bark and the pith, but not in the wood. We therefore examined the dubious specimen more closely, and

found it to be a piece of guttapercha, cut either from a
walking-stick ornamented with black stripes, such as the
used to make in the early days, and a specimen of which
before me. Mr. Hemsley placed a small fragment in
water, when it softened like guttapercha: and I took a
little chip with me and tested its solubility with the same
The result of our tests was corroborated by a penci
evidently in Mr. Lobb's handwriting, which I detected
next visit to Kew; it stated that "from the juice of th
the enclosed whip is made." This specimen also had
of the light-coloured material affixed to it like N
That a man like Hooker should have been misled in th
is very remarkable, and I only mention it here to show t
description of the specimen in the Tradescants' mus
"Mazer wood" is no argument against the assumption
really may have consisted of guttapercha. I have bro
few specimens of guttapercha with me to-night, which
each close resemblance to certain kinds of wood. Here
Lobb's original specimen, and you can judge for yourselv

The botanical material supplied by Lobb being insu
Sir Wm. Hooker wrote to Dr. Oxley for some flowering b
of the plant, and shortly afterwards received from him
with flowers and young fruit contained in a tin box w
and bottom made of the gum itself. One of these c
still in existence, and is exhibited to-night. We shall r
it later on.

FIG. 1.

Oxley's specimens at last enabled Sir William to desc
plant adequately, and to give it a "station and a name
himself expresses it. They also enabled him to have a
made of it by W. H. Fitch, which is reproduced on the
Fig. 1 in all its pristine simplicity, and I think beauty.
referred the plant to Dr. Wight's new genus of Sap
and gave it the name of Isonandra gutta. Oxley's
specimen was appropriately placed in an ornamental
made of guttapercha for exhibition in the museum
where it could be seen till May, 1885, when it was tra
to the Herbarium. It thus happened that Prof. Pie
great authority on guttapercha plants, on his visit
missed seeing the specimen, judging from his remark
the Société Linnéenne of Paris on June 3, 1885, when
"Je n'ai pu voir à Kew les échantillons pourvus d
envoyés par Oxley à W. Hooker et dont il est question
London Journal (vi. 463)." This specimen I am also
show you to-night. I was sorry to observe that it had
suffered from the long exposure in the museum; t
flowers are discoloured and so much shrivelled up that
scarcely discernible, even from a short distance; but if
kindly look at the wall diagram (Fig. 1), you will see
flower is constructed, and observe that both calyx and
are each divided into six segments. However, on refe
Wight's description of the genus Isonandra we find
flowers are stated to be four-parted, so there is a dis
somewhere. This was already noticed by Hooker him
apparently he did not consider the difference su
important to justify him in establishing a new genus
purpose, and he evidently knew of no other existing

ave answered better. Nevertheless, the name originally the guttapercha plant by Hooker has now been aban- r that very reason, and that of Dichopsis gutta Benth. et l., substituted in its stead in England, and of Palaquium rck on the Continent. The structural difference in the f the genus Isonandra on the one hand, and that of the)ichopsis or Palaquium on the other, is shown by the agram (Fig. 2), which represent ideal sections through

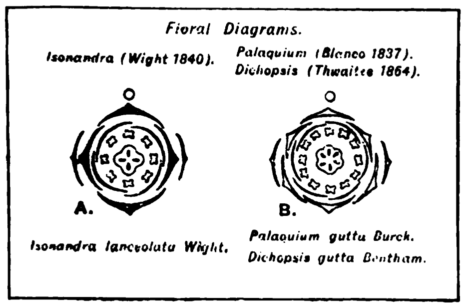


FIG. 2.

-parted (tetramerous) flower of the one, A, and the six- (hexamerous) flower of the other, B, and I need hardly than call your attention to it, but I ought not to omit ion that besides the difference in the structure of the here exists also another distinction of equal import- iz., the respective presence or absence of albuminous in the seeds. I have gone somewhat fully into this because I wish it to be clearly understood that ra gutta, Dichopsis gutta, and Palaquium gutta are only t names for one and the same plant, and that this change does not in itself signify, as some people seem to think, kind of plant formerly existing is now extinct, and has placed by another species.

llow me to complete the description of the guttapercha which is called by the natives Taban merah in Perak and alm tembaga (or abang) in Sumatra. It is a lofty tree, perfectly straight cylindrical trunk, and has, when fully a height of from 60ft. to 80ft. and a diameter of 2ft. to t it appears that in some localities—Perak, for instance—onsiderably over 150ft. high and 4ft. to 5ft. diameter een met with.

FIG. 4.—Palaquium Gutta.

rding to M. Sérullas, the tree attains maturity at s, and then measures about 45ft. from the ground to the est branches, the circumference being 3ft. at about the of a man. It is somewhat remarkable that no illustra- the entire tree appears to have been published anywhere, ave therefore asked some friends at Singapore to have otographed for me, if possible, in the jungle, or, failing one of the botanical gardens, either at Singapore nzorg. This has been done, and I will now show photograph of the Taban merah growing in the gardens at Singapore on the screen, reserving others on. The picture gives you some idea of the general of guttapercha trees, but I must tell you that this particular specimen is not in a very vigorous condition, as it is too much exposed to the sun and has, perhaps, too little moisture to draw upon.

The leaves are crowded together at the ends of the branches and are placed alternately; their form is obovate-lanceolate, and they have a small projection or beak at the apex. Leaves from old trees measure about 4in. to 5in. in length and 1¾in. to 2½in. in width at the middle, whereas those from young trees are much larger, reaching a length of 9in. and a breadth of nearly 3in. I purposely mention this in order to show that variations in the size and shape of the leaves are not alone sufficient to indicate a difference of species, as has sometimes been supposed. The upper surface of the leaves is bright green and the underside golden brown, when the trees are young, and reddish brown when old, this colour being due to the presence of a dense layer of silky hairs, which also cover the mid-rib and the petiole; the latter is usually about 1in. or a little more in length. The secondary veins branch out laterally from the mid-rib, nearly at right angles, and are not very conspicuous, being sunk in the substance of the leaf. They number 20 or 30 on each side, which is of some importance to know, as we shall see in the next lecture. The flowers, of which there are four, grouped together in the axil of the leaves, are white, the calyx being of a golden brown colour; there are 12 stamens in single series, inserted into the throat of the corolla with sagittate anthers, turned outwards. The ovary is superior and six-celled, terminating in a single style, which is much longer than the stamens. The fruit is a fleshy egg-shaped berry about 1½in. long and 1in. in diameter. (See Figs. 1 and 4.)

I have here some exceptionally fine specimens of leaves, and a twig from the tree in the botanical gardens at Singapore, of which you have just seen the photograph. I have also some branches with flowers and young as well as ripe fruits, preserved in alcohol and formaldehyde. Specimens of the flower and fruit were, as you have heard, already scarce 50 years ago, when guttapercha trees were plentiful; but are still more so now, when the trees are less frequently met with. I have, therefore, every reason to thank Prof. Sérullas and my Singapore friends for the beautiful specimens which I am able to show you this evening.

(To be continued.)

A COMBINATION GENERATOR.

A patent has just been issued to Prof. S. H. Short, of Cleveland, United States, for a combined gas and carbon electric generator. Some time back Prof. Short filed in the United States Patent Office a description of a method for generating electricity, a process wherein carbon, coal, or carbonaceous material is subjected to the action of an electrolyte which is capable of receiving oxygen and transferring the same electrochemically to the carbonaceous material to effect an oxidation thereof, such action resulting in the generation of an electric current. Later Prof. Short recognised that this method of electric generation may be most economically and efficiently carried into practical commercial effect in conjunction with a gas generating plant, and this conception forms the basis for the present apparatus, a description of which appears in the *Electrical Engineer* of New York. He found that when the carbon is maintained in a heated condition the nascent oxygen of the electrolyte, or resulting from the electrochemical action of the electrolyte, will attack the carbon more vigorously and freely, and hence result in a more efficient electric generation. Therefore, in the present apparatus, as fast as new coal is supplied to the gas-retort to produce illuminating or heating gas, that which has been previously exhausted—that is, the coke product, which the new or fresh coal replaces—is fed into the electric generating apparatus or carbon-holder while still in its heated condition, and is therefore consumed or oxidised in the process of electric generation by the electrochemical action of the electrolyte. The carbon-holder is made of iron, and perforated to permit the electrolyte to gain access to the carbon. He therefore combines a gas generating plant with an electric generating plant, thus reducing the cost of electric generation to the lowest possible point by utilising the coke while in its heated condition for the electric generation, and by utilising the heat products required for the gas generation to maintain the electric generation cell at the required degree of temperature for the most effective results.

INSTITUTION OF ELECTRICAL ENGINEERS, Jan. 13.

At last night's meeting of the Institution the following were the candidates balloted for:

Foreign Members.—R. B. Bumiller, Antwerp Telephone Co., Berchem, Antwerp; F. M. N. Dresing, Great Northern Telephone Co., Shanghai; Don Pedro Lopez, Inspector-General of Posts and National Telegraphs, Buenos Ayres, Argentine Republic; I. Nakahara, Tokyo Electric Light Co., Tokyo, Japan; Don Alfredo Zinder, Engineer, Telegraph Service, Buenos Ayres, Argentine Republic.

Members.—Capt. D Brady, R.E., Adjutant, Electrical Engineers Volunteers, 5, Victoria-street, S.W.; W. Dixon, 164, Great Vincent-street, Glasgow, N.B.

Associates.—E. J. Brothers, 155, Friern-road, East Dulwich, S.E.; P. H. Cole, 270, Devonshire-road, Honor Oak Park, S.E.; E. C. Cox-Walker, Darlington; W. M. L'Estrange, Edison-lane, Brisbane, Queensland; D. O. Evans 89, Charlton-lane, Old Charlton, S.E; G. H. Green, 633, Calle Reconquista, Buenos Ayres; E. N. Gulich, 11 and 12, Great Tower-street, E.C.; F. Harrison, Fernley Villa, Kempston, Bedford; C. F. Higgins care of Thos. Richardson and Sons, Hartlepool; R. H. Houghton, B.Sc., Redcot, Mulgrave-road, Croydon; F. A. Jackson, Priory Lodge, Tunbridge; A. A. Jenkins, care of Messrs. Lloyd, Read, and Jenkins, 63, Broad-street, Bristol; J. P. Lawrence, Knaresborough; G J. Lloyd, care of Messrs. Lloyd, Read, and Jenkins, 63, Broad-street, Bristol; W. Manson, Natal Telephone Co, Durban; W. Phillips 33, Poplar-grove, West Kensington Park, W.; C. D. Schofield, 102, Swan arcade, Bradford; W. V. Scott, 118, Cromwell-road, S.W.; J. M'F. Smyth, Corporation Electricity Works, Blackburn; H. J. Spencer, 52, Dunsmure-road, Stamford Hill; H. E. Stobie, Grand Junction Railways, Capetown; S. G. Willmott, 43, Dunsmure-road, London; H. H. Wright, 8, Park-road, Halifax, Yorks.

Students.—W. S. Boyd, 20, Talbot-square, Hyde Park, W.; D. A. Brown, 29, Foxham-road, Tufnell Park, N.; J. G. Bruce, care of Messrs. Clarke, Chapman, and Co., Gateshead-on-Tyne; S. L. Cazeaux, Castilla, Plaistow, Bromley, Kent; H. H. Clements, 61, Barry-road, East Dulwich, S.E.; W. M. Cobeldick, 110, Stockwell-road, Brixton, S.W.; A. J. Cridge, Walpole, Hendham-road, Upper Tooting, S.W.; J. Denham, 34, Hornsey-street, Holloway, N.; A. Eddington, New-street, Chelmsford; A. P. M. Fleming, Queen's-road, Hersham, Surrey; Alfred A. Godfrey, Haslemere, Staines; J. C. Guthrie, Hawthorn House, Penarth, near Cardiff; R. P. Howgrave Graham, 12, Willow-road, Hampstead, N.W.; H. C. Hastings, 112, Portland-road, Notting Hill, W.; J. W. Johnston, 25, Vernham-road, Plumstead, Woolwich, S.E.; P. A. Jones, 42, Grove-lane, Camberwell, S.E.; J W. Keefe, 29, Abernethy-road, Lee, S.E.; F. C. Kidman, Ormesby House, near Yarmouth; G. R. Madge, 8, Highlever-road, North Kensington, W.; J. F. Magoris, 93, Edgware-road, W.; A. C. Manuel, 5, Aubrey-road, Holland Park, W.; C. B. Nixon, 38, Bidston-road, Birkenhead; D. Ockenden, 135, Coningham-road, Shepherd's Bush, W; E. H. Partridge, 20, Hornsey Rise-gardens, Crouch End, N.; A. E Payne, 91, St. Augustine's-road, Camden-square, N.W.; F. V. Pipe, 55, Lennox-road, Finsbury Park, N.; A. R. Powell, 14, Springfield-road, New Southgate; E. L. Robinson, 29, Beacon hill, Camden-road, N.: W. G. Royal-Dawson, 3, Kenilworth-road, Ealing, W.; J. A. Seager, Central Electric Light Station, Hastings; E. R Spence, 102, Lewisham-road, S.E; O. A. Tuxen, 175, Camberwell-grove, Denmark Hill, S.E.; F. P. Whitaker, 17, Farmdale-road, East Greenwich, S.E; L. Wood, 90, Rothbury-terrace, Heaton, Newcastle-on-Tyne.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We shall also in future give *two shillings and sixpence* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared, and should be written on one side of the paper only. Questions may be sent at any time.

Questions.

28. What are the advantages and disadvantages of the two systems of distribution by alternate currents: (A) transformers in consumers' houses; (B) transformers in sub-stations? Give figures.—Nemo.

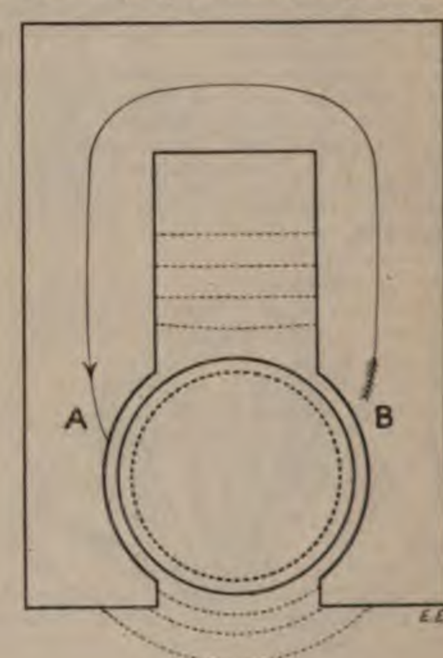
29. Compare the advantages and disadvantages of polyphase *versus* continuous-current motors for distribution of power in factories.—Jas. F. Moore.

Answers.

Question No. 23.—What are the chief advantages and disadvantages of slot-wound continuous-current armatures as compared with the smooth-core type?

Best Answer to No. 23 (*awarded* 10s.).—The chief advantages of slot-wound continuous-current armatures are: They are much more mechanical; the conductors are enclosed and shielded from injury by the teeth. There is practically no drag on the conductors, and for this reason the difficulties of positive driving experienced with smooth-core machines are absent. Even if there were a large drag on the conductors, the teeth would provide perfect driving horns. The difficulties due to centrifugal force are obviated when the core teeth are splayed towards the surface, and no exterior binding is necessary, as the resistance to the conductors flying out is provided by the teeth cheeks. All these are the mechanical advantages which go to stamp the slot-wound armature as a piece of mechanical engineering, whereas the smooth-core armature always looks and is an "electrician's job."

We now come to the electrical advantages, and the smooth core must have many or its use will not be justified, all the mechanical advantages being in favour of the slot-wound. In the first place, the space taken up by the conductors in the smooth-core type can be taken up by iron in the slot-wound type, reducing the clearance, and with it the reluctance of the magnetic circuit. In smooth-core machines the excitation required by the air-gap is usually 80 per cent. of the whole, while the slot-wound one requires about 45 per cent. Further, to get the larger windings on the fields the field circuit must be longer, as the reluctance of both iron and air is larger with the smooth than with the slot core armature. In the second place, there is much less magnetic leakage with the slot winding. This is easily seen in a simple diagram. The

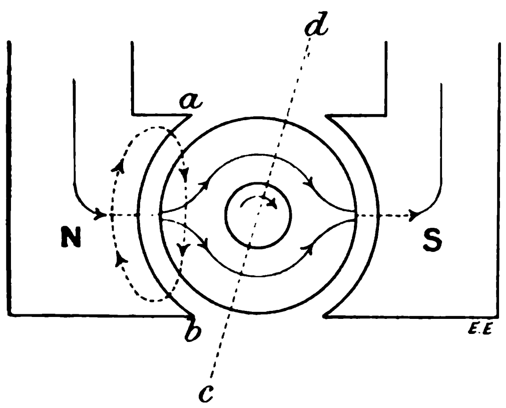


magnetic flux has two paths, from A to B: (1) through the iron core, (2) through the air. If the reluctance of the path through the core is high, as it is in the smooth core owing to the air-gap, more will escape the core and go through the air. In the diagram the dotted circle represents the size of the iron in the smooth-core, and the full circle that in the slot-wound. Put briefly, the slotted core short-circuits the magnet, and so the leakage is small, as the potential (magnetic) between A and B is less; result, less flux through air outside core. The fact that there is a high magnetic leakage with the smooth core renders it necessary to provide more magnetising force than would send the useful flux through the circuit. Evidently, as far as the magnetic circuit is concerned, the slot-wound armature has again the whole advantage, at least when there is no current flowing in the armature.

There are no eddies in the armature conductors with the slot-wound type (or very little) as the field is very weak, the flux being taken by the teeth, and for this reason the conductors may be made solid, and slightly smaller and much cheaper. Again another increase in efficiency, as no power is wasted in eddy currents.

The last technical advantage is that the armature may be run at a higher current density, owing to the increased facilities for cooling given by the teeth. It does seem very ridiculous to wrap conductors in shellaced cotton, which is a good insulator of heat, and, what is more important, is a bad radiator, and to have the conductor near iron on one face only. With the slot winding the insulation is in contact with iron all round, and therefore the heat is carried away far more rapidly. Now a good dynamo should have its capacity limited by heating rather than anything else—sparking or drop in voltage; and if arrangements can be made to obviate these two latter, it is evident that the slot winding will be (1) more efficient in itself; (2) will need less magnetising force and less iron and copper in the fields; (3) much cheaper.

It is on the rocks of sparking and bad regulation that the slot-wound armature comes to grief—*in ordinary dynamos.* Armature reaction is the cause of the trouble. The currents in the conductors of an ordinary armature tend to set up a field at right angles to the main flux, as shown by the dotted line in the diagram. This will



increase the flux at *a* and decrease it at *b*. This distorts the field, and makes the neutral plane—viz., the part where the amount of flux entering the armature from outside equals that leaving it—inclined at an angle to that when there is no current in the armature. Shortly, as the coil to be commuted should be in a weak field, this necessitates the moving of the brush rocker. This moving of the rocker is greater than that indicated, as the coil should be in a reverse field at time of commutation. Now the angle through which this plane is shifted is proportional to the distorting effect of the armature, and this is proportional to the goodness of the cross magnetic circuit. It is very good in the slot-wound armature if the gap is small, and here the mischief steps in. Thus there are great troubles with sparking if the gap is small. Further, the total effect of this cross field is to reduce the flux as a whole and to increase magnetic leakage, so more wire has to be put on the fields to make up for this in the shape of series coils, as the effect is proportional to the current. Thus the great advantage in the magnetic circuit is discounted. The only way to prevent sparking and distortion of field is to make the field flux very strong compared with the armature flux, and this means less efficiency. Another disadvantage is that the teeth get eddy currents set up in them owing to the sudden changes of flux as they pass through the field, caused by the gaps, but this is reduced by having a tunnel winding or splayed teeth. There is in my mind little hope of the slot windings being used with the present type of machine, as the difficulties with sparking and bad regulation are too great; but we have now in the Sayers, Thompson, and Ryan, and perhaps the Mordey compensation arrangements, ways of neutralising the cross field, and we shall soon see slot windings and either more efficient machines at the same price or cheaper machines with the same efficiency as at present. The smooth core is in any case doomed; or perhaps it would be safer to insert "I think."—W. FENNELL.

Answer to No. 23 (*awarded* 2s. 6d.)—The question of smooth and slotted cores has been rather a vexed one among our English engineers. Generally speaking, slotted cores up to the present have been more frequently adopted in the United States, while they are the exception here, although one or two English firms of repute have been manufacturing them for some years.

The advantages that slotted cores possess over smooth are (1) reduced excitation; (2) eddy currents practically negligible, and therefore the armature conductors need not be laminated; (3) comparatively little drag on the conductors; (4) the armature is a more mechanical structure, and capable of withstanding greater strains; (5) improved dissipation of heat. The qualities possessed chiefly by smooth cores are (6) sparklessness and lesser armature reaction.

Reviewing the above: (1) With well-designed slotted armatures the air-gap can be much reduced, and consequently the exciting power required, although so much has not been attained in this direction as is possible, owing to armature reaction troubles—the leakage loss is also less with reduced air-space. (2) There being a very weak, and, in fact, with good design no field in the slots, the eddy-current loss in conductors will be a very small quantity; solid bars can then be used, thus reducing cost and making a more mechanical armature. (3) The magnetic drag on the conductors is very much smaller than with smooth cores, and according to some authorities is absent, thus avoiding the necessity of driving horns, etc. (4) The armature undoubtedly is very much stronger and more mechanical, and its life (this is especially so with motors) is very much increased; no such thing as stripping of the winding, which used to and even now does sometimes occur with smooth cores, being possible. (5) Not being covered by a quantity of heat-insulating substances, but having an exposed metallic surface, the dissipation of heat is materially assisted, and it is usual to find the temperature of the slotted type very low. Turning now to the smooth variety. (6) In practice it has been found that armature reaction and its allied troubles are much less than with slotted cores, unless increased gap space is employed, when advantage No. 1 of the slotted type is materially sacrificed, and until some methods for preventing these losses become more practicable and common the smooth core will undoubtedly maintain this advantage. The serious inconveniences occasioned by sparking are, of course, included in this.

The question of cost is one about which there is some dissension, but with the improved machine tools and facilities which we are now getting the slotted type is becoming, if anything, the cheaper. The size of machine and purpose for which it is intended should be the biggest guide in choosing machines of these respective types. For small dynamos and for motors the slotted core undoubtedly holds the advantage, but for very large units the risk entailed by sparking and reaction troubles makes it somewhat doubtful which to adopt, and the greater experience we have had with smooth cores may influence us somewhat in favour of them.—H. BELL.

Question No. 24.—Compare the relative advantages of hand and mechanical stoking for central stations, with special reference to economy and the smoke produced.—A. D. J.

Best Answer to No. 24 (*awarded* 10s.).—Mechanical and hand firing have both many points in their favour, and whether it would be more economical to use one or the other system depends on several conditions, such as the size and location of station, price of coal in the district, whether smoke is prohibited or not, etc. The boilers used will also help to decide the question, as mechanical stoking is a greater success on some than on others, but as a general rule mechanical firing will be found more suitable for large stations, and hand firing for small stations.

Taking the advantages and disadvantages of mechanical stoking, we find that: (1) It is much cheaper in the cost of labour, and is therefore almost a *sine qua non* in large stations, as with mechanical stoking a leading fireman and six stokers can attend to 20 500-n.h.p. boilers, working at full pressure, whereas with hand firing one man would be required for each boiler during top load. (2) A cheaper coal can be used with mechanical firing, which is very important in London and the South of England, where good steam coal costs 20s. per ton or more, while small coal which gives excellent results with mechanical stoking can be bought for 10s. per ton. Of course, this coal will not evaporate so many pounds

of water per pound of coal as the coal at 20s. will, but it will evaporate a good deal more than half as much, and is therefore, cheaper. (3) Smoke may be practically done away with by properly adjusting the feeds on a mechanical stoker, as the fires are fed at one uniform rate. This is an important advantage in London and most towns. (4) As the fire-hole doors seldom require to be opened, rushes of cold air to the furnaces are avoided, thus maintaining a more even temperature and increasing the life of the boiler.

The chief disadvantage of mechanical stoking is, of course, the liability of the machinery to break down or get out of order, as a boiler house with coal dust and cinders always blowing about is not the best place for it to work in; but by having the stoker gear made simple and strong, and keeping it well oiled and as clean as possible, very little trouble is experienced with it. There should always be a spare motor or engine to work the stokers in case of a breakdown, as it is very difficult to hand-fire boilers fitted with mechanical stokers. (2) The first cost is more, but it will save its cost in two years. (3) The boilers cannot be forced so hard with mechanical stokers as with hand firing, which necessitates more boiler power.

Hand firing is more economical for small stations having, say, not more than six boilers, than mechanical firing, as it is cheaper in first cost and fewer boilers are required, as they can be forced harder and steam can be got up quicker than with mechanical stokers. The amount of smoke made depends chiefly on the fireman, and also on the kind of coal used. With Welsh coal and a good fireman, who fires the furnaces alternately a little at a time, very little smoke will be made. A bonus should be given to the firemen for smoke prevention, which will make them much more careful. Hand firing is not economical for central stations on a large scale on account of the cost of labour and coal required, and the fact that it is almost impossible to hand-fire a number of boilers hard without making a good deal of smoke. Another disadvantage is that every time the fire-door is opened cold air is admitted, which is bad for the furnace or tubes, and also tends to make smoke. For small stations loco. type boilers, but with fewer and larger tubes than locomotive boilers, can be used successfully with hand firing, as they make steam very quickly and can be forced to a great extent, but they require a very good draught.

It will thus be seen that mechanical stoking is most economical and best for large stations and in towns where labour and coal are dear, as in London, and where smoke is prohibited, but that for small stations or medium-sized stations in towns where labour and coal are cheap, as in the Midlands and North of England, and where the production of smoke is not noticed, hand firing will hold its own.

Results of Test of [illegible] with Mechanical Stoking.

Duration of test	[illegible] hours.
Price of coal per ton	[illegible]
Coal consumed	[illegible] tons.
Per cent. of ash and clinker	[illegible] per cent.
Water evaporated	[illegible] gallons.
Water evaporated per hour	[illegible] gallons
Pounds water evaporated per pound coal under actual conditions	[illegible]
Pounds water evaporated per pound combustible under actual conditions	[illegible]
Pounds water evaporated per pound coal from and at 212deg. F.	[illegible]
Pounds water evaporated per pound combustible from and at 212deg. F.	[illegible]
Fuel cost of evaporating 1,000 gallons under actual conditions	[illegible]
Ditto from and at 212deg. F.	[illegible]
Average steam pressure	[illegible]
Average temperature flue gases	[illegible] deg. F.

This was a test on a 500-i.h.p. boiler working under ordinary conditions, with a good sample of small coal, and with a natural draught of [illegible] of water. With forced draught and a greater coal and bar feed on the stoker, the boiler could be made to do half as much again, but a good deal of smoke would be produced, and the bars would get too hot.—R. S.

Answer to No. 24 awarded 2s. 6d.—In the majority of central stations hand stoking is most in vogue, but as the stations grow larger and the boilers increase, the public will not tolerate the nuisance caused by smoke, [illegible] can easily be remedied by adopting mechanical [illegible] with the following advantages: economy in f[illegible] smoke produced, and saving in wages. It is admi[illegible] by very careful hand stoking and good coal the s[illegible] be reduced to a minimum; but we cannot al[illegible] careful stokers, and the majority don't care a rap [illegible] as they can keep the steam up. Also engineers li[illegible] their working cost as low as possible, and they will [illegible] the best coal when they can get slack for 5s. o[illegible] 6s., which can be used with advantage with m[illegible] stokers. The reason for the economy of fuel [illegible] smoke produced is partly due to the fires being [illegible] clear and the fire gases do not carry so much sm[illegible] them, so that the greatest heat is obtained in the [illegible] That economy does exist is shown by the following

Hand Firing v. Mechanical Stoking.

Duration of trial	10 hours	10 hours.
Description of fuel used	slack	slack.
Price of fuel used	about 6s. per ton	about 6s.
Fuel consumed per hour	492[illegible]lb.	5[illegible]lb.
Water evaporated per hour	4[illegible] gallons	624 gall[illegible]
Temperature of feed water	7[illegible]deg. F.	70deg. F.
Steam pressure	5[illegible]lb.	5[illegible]lb.
Water evaporated per pound of fuel at 212deg. F.	[illegible]	12·43lb.
Cost of evaporating 100 gallons	1s. 4d.	1s.

The wages question is also a large item. With me[illegible] stokers one man can attend to the firing of five [illegible] whereas one man can't be expected to fire more th[illegible] boilers—or six furnaces—so the saving would [illegible] men's wages against six, £8; against this there is [illegible] of working the stoker and maintenance, 16s. 6d.; [illegible] £4 [illegible] saved per week independently of any s[illegible] using cheaper coal. Some engineers prefer the sp[illegible] stoker to the coking stoker. In the former the fir[illegible] [illegible] as it ought to be in hand firing, and the [illegible] thrown on in small quantities each time in a differe[illegible] and the machine can be forced, as the amount of [illegible] be adjusted from 15lb. to 50lb. per square foot [illegible] per hour, and thus able to compete with varyi[illegible] The latter machine pushes the coal on at the front [illegible] the fire-grate and gradually carries the fuel to [illegible] end, the fire gradually tapering down to nothin[illegible] back end. The following tests may be interesting [illegible] readers—there are many of a similar nature.

	Coking stoker [illegible]	[illegible]
Duration of trial	10 hours	[illegible]
Description of fuel	slack	[illegible]
Price of fuel	[illegible] per ton	[illegible]
Fuel consumed per hour	[illegible]	[illegible]
Steam pressure	[illegible]	[illegible]
Water evaporated per hour	[illegible]	6[illegible]
Water evaporated per pound of fuel	[illegible]	[illegible]

T[illegible]

Answer to No. 24 awarded 2s. 6d.—In replyi[illegible] question much of the same ground must be [illegible] again as in answer to No. 22 query, for in dis[illegible] advantages and disadvantages of mechanical st[illegible] must necessarily make reference to hand fi[illegible] advantage claimed by mechanical stoking over ha[illegible] is that where slack coal is used it is a more e[illegible] way of burning it, for with hand firing the use [illegible] [illegible] requires more boiler power. But, as was sa[illegible] good quality coal is used hand firing is preferab[illegible] system of mechanical stoking. The following [illegible] show the economy of mechanical stokers where [illegible] used.

Hand Firing v. Mechanical Stoking.

Duration of trial	[illegible]	[illegible]
Description of coal	[illegible]	[illegible]
Price of fuel	[illegible]	[illegible]
Fuel consumed per hour	[illegible]	[illegible]
Water evaporated per hour	[illegible]	[illegible]
Temperature of feed water	[illegible]	[illegible]
Steam pressure	[illegible]	[illegible]
Water evaporated per pound of fuel from and at 212deg. F.	[illegible]	[illegible]
Cost of evaporating 100 gallons	[illegible]	[illegible]

As regards the prevention of smoke, much [illegible] thickness of fire, type of boiler, etc. Each case sh[illegible]

fore be judged on its merits before a remedy is applied. One cannot overlook the fact that mechanical stokers effectually prevent smoke, but a systematic way of hand firing would soon overcome that difficulty. By careful firing, and admitting a sufficient quantity of fresh air directly to the hydrocarbons, nearly any kind of semi-bituminous steam coal can be burnt without smoke. The plan to prevent smoke by closing the damper, and so reducing the draught at the time of firing, is useless. The draught should be increased instead of diminished for a little time after firing to give the most economical result. Smoke may be greatly reduced as follows: Suppose the fire to be in an incandescent state, and it is required to put on more coal. Do not throw on more fuel in the usual way, but push back the fire from the front part of the fire-grate on to that behind, nearer the bridge, leaving the front of the grate bare. Now charge the front part of the furnace with fresh coal; this will gradually coke, and the various gases, etc., which form smoke will be liberated at a slow rate and give time for the air passing up through the firebars to become heated, and mingle with them, so promoting combustion. With this plan, with ordinary steam coal and fairly open firebars, sufficient air will pass up through in the front of the grate and consume the gases; and great volumes of smoke need never be made, as in the case where large quantities of coal are thrown on a hot fire. In the latter case, owing to the incandescent fire acting quickly on the coal, the combustible gases or hydrocarbons are rapidly released, and sufficient air is not admitted to the firebox and heated fast enough for it to combine with and consume the liberated gases, hence the production of smoke. This system of coking gives the most economical, but not the most rapid evaporation.

With regard to firemen, it is rather a difficult matter to obtain three shifts of men who are equally competent. Corporations and companies should bear in mind that it is the best plan in the long run to employ only experienced men, and to pay them a fair wage. Employing inexperienced men for low wages is a case of "penny wise, pound foolish." There are many firemen who lay claim to abilities which they do not possess, and are ready to do a thousand and one things out of their own sphere, with the result that they do nothing well. Such men are to be avoided, and only those who can show good references as firemen should be employed.—F. BRUTON.

SOUTH STAFFORDSHIRE MINES DRAINAGE.

PUMPING AND ELECTRICAL POWER.

A meeting of the South Staffordshire Mines Drainage Commissioners was held last week at the Offices, Trindle-road, Mr. J. B. Cochrane presiding.

The **Chairman** said he understood there was an Electrical Power Distribution Company applying for powers to supply the whole of that district, and they had stated that they would undertake to supply electrical power at, he believed, 1d. per Board of Trade unit, which was equal to 1·3 h.p. This proposal had come before the various local authorities, but many of them were opposing it, on the ground that they would like to retain the monopoly of supply in their respective districts. This opposition was reasonable if the authorities referred to were really prepared to supply manufacturers and others with electrical power, and would also undertake to do so at a rate like that offered by the Distribution Company. The Dudley Corporation, who had been approached by the Distribution Company, had stated that they could not supply electrical power under 2½d. per Board of Trade unit. This was a very important point, because whilst a supply of electrical power at 2½d. per unit might be useless to manufacturers, a supply at 1d per unit might be of great advantage to them. The difference in the prices was very considerable, and should operate in furthering the proposals of the Distribution Company, in which he had not the slightest personal interest. The Distribution Company proposed to supply electrical power to the whole of that district, in which there were 18 local authorities, so that they could put down a much more economical plant than an individual authority, which confined its supply to home purposes. He was convinced that the local authorities did not desire to interfere with the progress of manufactures in their own districts, and if they could be satisfied that they were unable to produce electrical power at less than 150 per cent. more than the Distribution Company could supply it, he thought that, in the interests of the manufacturers, they should withdraw their opposition. If the Commission could get an electrical power supply in the 30 or 40 low-lying districts to which he had previously alluded, and they were to put down small pumps to deal with the water, the cost of draining those areas would be very small. He believed that if they could deal with the water successfully in this way it would in all probability save a contemplated expenditure of £30,000 or £40 000. In the Tipton district the mines were overloaded with water, and the Commission scarcely liked to spend a large sum of money on pumping because of the uncertainty of the results, but if they could get at the water now going into the mines, and dispose of it economically, they would overcome a great financial difficulty which they had had to face in the past, and which would otherwise prove a great hindrance to the success of their operations in future.

Mr. J. Hughes pointed out that if the Dudley Corporation had the option of supplying electric power to all the districts referred to by the chairman, they would be able to do it at the same rate as the proposed company. Where electricity was limited to a certain minimum quantity it could only be produced at a certain cost, and that accounted for the difference in cost between the supply of a large and a small area He should be glad if electrical power was brought into the district, as there was no doubt it would be a great boon in emptying swags.

The **Chairman** said if Dudley could persuade the surrounding local authorities to supply them with electricity at as cheap a price as the company, well and good, but was there a probability of it? He was afraid not.

The reports were then adopted.

COMPANIES' MEETINGS AND REPORTS.

HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY, LIMITED.

An extraordinary general meeting of this Company was held on Wednesday at Winchester House, E.C., to confirm the following resolution, which was passed on Dec. 28: "That the agreement dated Nov. 29, 1897, and made between the Company of the one part, and the several persons, corporations, and firms executing the same in the schedule thereunder written (thereinafter called 'the holders of founders' shares) of the other part, be approved and confirmed; and that having regard to the terms thereof the capital of the Company be reduced from £200,000, divided into 40,000 shares of £5 each, of which 27,900 are ordinary shares, 12,000 are preference shares, and 100 are founders' shares, to £199,500, divided into 39,900 shares of £5 each, of which 27,900 are ordinary shares and 12,000 are preference shares; and that such reduction be effected by cancelling the whole of the said founders' shares—that is to say, the shares in the Company numbered 1 to 100, both inclusive."

The resolution was confirmed.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Rochdale.—The Corporation invite tenders for steam dynamos, balancer and booster, etc. Tenders by February 19. For further particulars see our advertisement columns.

West Hartlepool.—The Corporation invite tenders for various work in connection with their electric lighting station in West Hartlepool, for particulars of which refer to our advertisement columns.

Blackburn.—The Corporation are prepared to receive tenders for 500 kw. continuous-current steam dynamo and 100-kw. steam alternator, for particulars of which refer to our advertisement columns.

Braila (Roumania).—Tenders are invited for the electric lighting of the town. The deposit required is £600. Specifications are to be obtained from, and tenders addressed to, the Municipal Authorities at Braila by Feb. 20 (March 4), at 4 p.m.

Wallasey.—The Urban District Council invite tenders for the supply and erection at their electricity supply works of a five ton hand-power overhead travelling crane. Tenders by 4 p.m. on January 20. For details see our advertisement columns.

Tarifa (Spain).—Tenders are advertised for the lighting of the town for 20 years. Specifications are to be obtained from, and tenders addressed to, the Municipal Authorities of the above town, province of Cadiz, Spain. Tenders by February 1.

Wimbledon.—The Urban District Council invite tenders for the supply, delivery, and erection of various works in connection with their electric lighting scheme, full particulars of which will be found in our advertisement columns. Tenders by February 2.

Novorossisk (Russia).—Tenders are invited for the construction, etc., of an electric lighting installation for the town. The deposit is 5,000 roubles. Specifications may be obtained from, and tenders addressed to, the Municipal Authorities of the town by March 1 (13).

Burnley.—Tenders are required for the plumber, slater or plasterer and painter's work required in connection with the extension of the electric light station. Send names to the borough surveyor, Mr. G. H. Pickles, A.M.I.C.E., Town Hall, Burnley, by 25th inst.

Ashton-under-Lyne.—The Baths Committee invite tenders for the installation of the necessary wires, fittings, etc., for the electric lighting of the Corporation baths. The current will be supplied from the town mains. Tenders by 12 noon on February 2. For further particulars see our advertisement columns.

Edinburgh.—The tender of the India Rubber and Gutta Percha Company, of Silvertown, of £8,844, has been accepted for the supply and erection of the steam dynamos and accessories, and the necessary switchboard and storage batteries, for the electric lighting scheme in the burgh.

Harrogate.—A tender, amounting to £72, from Messrs. Siemens Bros., for meter-rating apparatus, and a tender, amounting to £16, from the National Telephone Company, Limited, for proposed telephone from the engineer's residence to the electric light station, through the exchange, have been accepted.

Plymouth.—The Electric Lighting Committee have accepted the tender of Pethick Bros., at £15,844, for the construction of the electricity station, subject to its revision in accordance with a bill of additions and deductions to be prepared by the engineers with the object of reducing the cost of the work by £2,500 or £3,000.

Burnley.—Tenders have been accepted by the Corporation for the mason and bricklayer's and carpenter and joiner's work in the extension of the electric lighting station, and it has been decided to accept the following: Messrs. J. and J. Lee, masons and bricklayers, £1,707. 3s. 7d.; Messrs. G. Smith and Sons, carpenters and joiners, £659.

Barrow-in-Furness.—The following tenders have been accepted by the Corporation: (Section A) boilers, pumps, steam and water pipes, tank, crane, economiser, ironwork, Babcock and Wilcox, Limited, 174, Queen Victoria-street, E.C.; (B) engines, generators, switchboards, instruments, accumulators, motor-transformers, sub-station equipments, Brush Electrical Engineering Company, Limited, 49, Queen Victoria-street, E.C.; (C) high and low tension feeder and distributor cables, house connection boxes, and (D) conduits, drawing-in boxes, British Insulated Wire Company, Limited, Prescot, Lancs.

Blackburn.—The following are the tenders to Mr. E. M. Lacey's specification for eight 60-passenger cars for the Corporation:

Crompton and Co., Limited	£6,620	0	0
Electric Construction Company, Limited	6,087	0	0
British Thomson-Houston Company	5,579	15	3
Laing, Wharton, and Down	5,557	11	0
R. W. Blackwell	5 450	0	0
Siemens Bros. and Co.	5,444	0	0
Westinghouse Electric Company	5,296	0	0

The accepted tender is that of Messrs. Siemens Bros. and Co., who are already supplying the generating plant and are erecting the overhead line.

BUSINESS NOTES.

Bedford.—The electric light has been introduced into the Howard Congregational Church.

Barrow.—The construction of an electric lift at the town hall is being considered by the Council.

Wimbledon.—The Local Government Board have sanctioned the borrowing of £32,000 for the purposes of electric lighting, etc.

Ventnor.—The Ventnor Electric Lighting Company have arranged for the purchase of the land on which to build their works.

Copper.—A Paris report states that the visible supply of copper on Dec. 31, 1897, was 31,955 tons, against 34,927 tons on Dec. 31, 1896.

Dissolution of Partnership.—We notice that the firm of Mawsons and Peel, Gildersome and Morley, has been dissolved by mutual consent.

Scarborough.—The members of the Town Council have visited Cambridge this week in order to gain further information about refuse destructors.

Wallasey.—It has been decided to reduce the charge for electric light by 1d. per unit, from 7d. to 6d., with proportionate reductions for large users.

St. Pancras.—The Vestry have decided to extend the electric light to the whole of the Highgate part of St. Pancras at an estimated cost of £7,585.

Personal.—Mr. Charles Mason, A.R.I.B.A., surveyor to the St. Martin-in-the-Fields Vestry, has been elected a vice-president of the Society of Engineers.

Harrogate.—The engineer is preparing a plan showing a proposed additional main cable from the corner of Spa Gardens to the High Harrogate district.

Fort-William.—The gasworks are to be discontinued at the end of this month. The burgh will now depend entirely on electric light for illuminating purposes.

Bromley.—The Rural District Council have given formal notice of their final approval of the Chislehurst electric lighting order, which has already been passed by the Parish Council.

Coseley.—The interest shown by the District Council in the draft provisional electric lighting order is so intense that no quorum could be obtained at their last (adjourned) meeting.

Walsall.—The Rural District Council have under consideration the advisability of opposing the proposals made on behalf of the Midland Electric Corporation for Power Distribution, Limited.

Wandsworth.—The lighting of the large and scattered premises known as the Ram Brewery has been entrusted to Mr. Leo Sunderland, agent to the Brush Company. This installation comprises an equivalent of 750 8-c.p. lamps and seven arc lamps.

Calendar.—We have received a wall calendar from Messrs. Croggon and Co., Limited, which serves at the same time as an illustrated catalogue of electric bells, indicators, and accessories.

Bacup.—A letter from the Municipal Electric Supply Company, enclosing terms of a proposal for dealing with the electric lighting of the borough, has been deferred for enquiry by the Town Council.

Chester.—At the last meeting of the Guardians it was stated that if the electric light had been in use at the lecture hall, the unfortunate burning fatality to Nurse Ashcroft would not have happened.

Chelsea.—The surveyor to the Vestry has received instructions to prepare a detailed report as to the advisability of purchasing 15 dust motorcars. Estimates and particulars are to be obtained from about six firms.

Horsham.—The Urban District Council have appointed a committee to consider the advisability of making application to the Board of Trade for a license or provisional order for the supply of electricity to the district.

Bexhill.—Mr. G. W. Willcocks, Local Government Board inspector, has held an enquiry into the application of the Urban District Council for a loan of £20,000 for the purpose of supplying electric light to the town.

St. Luke's (Middlesex).—The Works Committee have been instructed to enquire into and report to the Vestry upon some scheme or schemes with a view to the better lighting of the parish, with electric (or other) light.

Burnley.—It has been resolved by the Corporation that advertisements be issued inviting tenders for high speed engine and dynamo, and that the Council be recommended to authorise the committee to accept a tender or tenders.

Leicester.—The Council have adopted a resolution of the special committee upon the use of the rooms vacated by the School of Arts Committee, which contains a proposed expenditure of £451. 10s. for an electric light installation.

Bristol.—Memorials from inhabitants of Stoke's-croft and Cheltenham-road dealing with the proposed extensions under the Tramway Bill, 1898, to the Sanitary Committee have been referred to a committee for consideration and report.

Poplar.—The District Board have decided to formally oppose the application of the Brush Provincial Electric Lighting Company without at the same moment binding itself to continue such opposition without further consideration.

Marylebone.—In relation to the question of the erection of a dust destructor, the Vestry intend to approach Lord Portman with the view of purchasing from his lordship a portion of land in the vicinity of the stoneyard for that purpose.

Derby.—A committee has been authorised to employ an engineer to advise on the tramways question. Application is to be made to the Local Government Board for sanction to borrow £5,500 for the construction of a new depôt for the Corporation.

Waterford.—The Finance and Law and Street Committees have under consideration a proposal from Mr. J. E. Palmer, of Ballybrack, asking for a lease in perpetuity of the sole right to construct a working electric tramway in the city of Waterford.

Crieff.—Another report has been received upon the electric lighting of the town, with utilisation of the Turret Falls water power, this time by Mr. F. Yorke, of Glasgow. The report will be discussed at the next meeting of the Town Council.

Burton-on-Trent.—At the monthly meeting of the Town Council the question of the recent failure of the electric light was discussed. It was shown that it was due to the breaking down of the india-rubber insulation, and had absolutely nothing to do with the works.

Smethwick.—The Midland Electric Corporation for Power Distribution, Limited, have applied for the Council's consent to their provisional order, but the Council will not give that consent, as it would defeat their own application for a provisional order.

New Swindon.—A letter from the Municipal Electric Light Company, Limited, stating the terms on which they would take over the New Swindon electric lighting order and work the same, has been referred to the Electric Light Committee of the Urban District Council for their consideration.

J. H. Pickup and Co., Limited.—A new company has been registered under this title, with a capital of £50,000, to take over the business of Messrs. J. H Pickup and Co. The first directors are Messrs. F. J. Green, W. O. Pickup, J. H. Pickup, J. Byron, J. Cronshaw, J. Parks, and A. Ashworth.

Oldbury.—The District Council have decided to oppose the application of the Midland Electric Corporation for Power Distribution, Limited, for the consent to their draft provisional order under the Electric Lighting Acts and Board of Trade rules, as it would tend to defeat their own application for a provisional order.

Penarth.—The District Council have consented to the scheme proposed under the Penarth electric lighting provisional order, conditionally on certain clauses being inserted, notably one giving the Council the right to purchase the undertaking as a going concern at any time after five and within 28 years from the date of the order.

Gloucester.—At a special meeting of the Gloucester City Council the subject of the electric light installation was down for discussion, but the Mayor explained that a site was still undecided upon, and the matter was consequently deferred. The County Council have agreed to the plans for extensions of the Bristol Tramways Company.

Boston (Lincs.).—The question of lighting the town by electricity was raised at the Town Council meeting by a communication from the Municipal Electric Supply Company. The Town Council were in favour of electric lighting if undertaken by the Corporation.

Kensington.—At a meeting of the Vestry held on the 12th inst. notices and plans were received from the House-to-House Electric Light Supply Company relative to extensions of their mains in Harley-gardens, Milborne-grove, Gilston-road and Warwick-road, and permission was given for the works being proceeded with, subject to the usual conditions.

Swansea.—The Streets Committee of the Corporation have received an offer from the Swansea Harbour Trust, stating that, if the Corporation would agree to bear the cost of extending the Trust's electric lighting installation on the town side of the North Dock and bear the cost of maintenance, the trustees would supply the current free of charge.

New Firm.—Mr. J. Foxcroft and Mr. W. J. V. Duncan, late of the firm of Paterson and Cooper, Dalston, have started in business under the title of Foxcroft and Duncan, as electrical and mechanical engineers, at 24, Queen's-road, Dalston, N.E., where they propose manufacturing electrical instruments, arc lamps, switchboards, indicators, etc.

Removals.—We are informed that the National Electric Free Wiring Company, Limited, have removed to larger premises, opposite their former offices. Both their offices and London stores will now be at 8 and 10, Charing Cross-road, W.C.—The offices of the *Railway World* have been removed to Amberley House, Norfolk-street, Strand, London, W.C.

Calendar.—We have received from Messrs. Verity's, Limited, a gaily illuminated wall calendar, which bears an illustration of one of the electrical appliances of their manufacture upon each leaf. The pictures appear in blue and the date in red, so that both the purpose of advertising and that of providing a calendar is achieved by the same means.

Cheltenham.—The Electric Lighting Committee's report states that in 1897 the net income was £1,400, as compared with £830 net income for the corresponding quarter last year. The street-lighting had cost £307. The engineers' strike had meant a loss to them of £800. As soon as they could get their machinery, the would-be customers in waiting would be supplied.

Oystermouth.—The District Council are treating with an offer of Mr. Weaver to light a large area of the district with electric light, at an annual cost not exceeding that at present paid by the Council; the Council to either obtain powers themselves and transfer to him at his cost, or they to give their consent to his application in the event of his applying for such powers.

New Paper.—The *Newsowner and Manager*, which made its appearance on the first of this month, is devoted to the interest of the classes named, and, if it comes up to its prospectus, should be a very valuable help indeed to proprietors and managers of every kind of newspaper. We heartily agree with its remarks upon the much-needed reform in the charges for newspaper postage.

Camberwell.—At the Vestry meeting on the 12th inst. the Finance Committee considered the communication from the Commissioners of Sewers in regard to underground telephone wires. The matter was referred to the General Purposes Committee, and the committee passed a similar resolution to that contained in the recommendation of that committee already referred to by us.

Keswick.—A Local Government Board enquiry will be held next month referring to the proposed purchase of the electric lighting company's works by the Urban District Council. At the last meeting of that Council the Clerk read a letter from the electric light company stating that they were now prepared to take up the provisional order in accordance with the agreement.

Reading.—The contract for supplying the handsome electroliers and other fittings, including the wiring of the large town hall, small town hall, art gallery, museum, public library, municipal offices, comprising in all an equivalent of 2,500 8 c.p lamps, has been placed in the hands of Mr. Leo Sunderland, of 39, Victoria-street, S.W., agent to the Brush Electrical Engineering Company.

Bethnal Green.—At the last meeting of the Vestry a special committee recommended that the Vestry should apply for a provisional order for electric lighting, and also arrange for an electrical engineer to report upon the provision of electric lighting for the parish. An amendment to refer the report back was lost, as was also a motion to adopt the report. The matter therefore fell through.

Bury.—At the last meeting of the Town Council it was resolved on the report of the engineer that the cables be extended from Stanley-street to Moorgate, and that the requisite notice be given to the Postmaster-General. The Asylums Board at Prestwich asked whether the committee could supply the electric light to the Prestwich Asylum, but it was resolved not to entertain the question.

City of London Electric Lighting Company.—Notice is given that all outstanding forms of application (with the banker's receipt for the payment upon application) and all certificates for fifths of a share of the issue of 10,000 ordinary shares November, 1897, Nos. 90,001 to 100,000, must be lodged with the Company on or before the 31st inst., otherwise the same will be liable to cancellation or forfeiture at the discretion of the Board.

Southport.—The Corporation have adopted a report dealing with the extension, etc., of the tramways. Six additional routes at a cost of £27,000 are contemplated. The overhead electric system is advised, being the best in regard to mechanical construction, elasticity of working, freedom from breakdown, facility of repair, and economy of maintenance. The committee recommend that the Corporation should undertake the work themselves.

Wakefield.—At the last Town Council meeting complaints were brought forward as to the delay in supplying the electric light to the city. The delay was said to be due to the non-delivery of the engines by Messrs. Fowler and Co., of Leeds, in consequence of the dispute in the engineering trade. Works for the centralisation of the heating station and an installation for the supply of electric light are to be carried out at the West Riding Asylum, at an estimated cost of £16,500.

Aberdeen.—The new trunk-line telephone between Aberdeen and Inverness has been opened to the public. The line is under Government management, and the National Telephone Company act practically as the collectors of rates for the Government, the only advantage to the company being that their subscribers can, by arrangement, have the use of the trunk line from their own offices. The exchanges between Aberdeen and Inverness are at Peterhead, Banff, and Elgin.

Douglas.—The Isle of Man Electric Tramway Company have now entered into possession of all the land required for the extension of their line from Laxey to Ramsey. Arbitration will be resorted to with respect to the price to be paid for land where the company have been unable to arrange with the owners privately. The company, being unable to obtain in the island all the workmen required, are advertising for some hundreds, as the directors are determined to have the line completed for opening for July 5.

Chiswick.—A letter from the New Mutual Telephone Syndicate, Limited, asking the Council to pass a resolution favouring the growth of competition in the telephone service, with a view to the demolition of the monopoly of the National Telephone Company, has been referred to the Law and Parliamentary Committee. The Council was asked, *inter alia*, to support the claims for licenses to start a telephone service now being made by the New Mutual Telephone Company, of Manchester, and by the Corporation of Glasgow.

Salford.—The Town Council have definitely decided to apply to the Local Government Board for authority to borrow £50,000 to cover the cost of the land, buildings, and machinery to extend the electric light undertaking in accordance with the estimate submitted by the engineer, an amendment, "That the question be deferred until the Electric Lighting Committee have formulated their scheme, and decided upon the amount required under expert advice contemplated by the committee, and submitted a full report in writing to the Council," having been defeated.

Hammersmith.—At the last meeting of the Vestry the Electric Lighting Committee reported that having received tenders from contractors for excavating the site of the proposed extension of the electric lighting buildings, they had accepted the tender of Mr. Wheatley at 1s. 10d. per yard. Having carefully considered the tenders for engines, alternators, etc., received by the Vestry at the last meeting, they recommended the Vestry to accept the tender of Messrs. Robey and Co. for the two engines, with spare parts and tools, at the sum of £4,610. The report was adopted.

International Trading Company.—We are informed that this company have been appointed sole representatives in the United Kingdom of the Maschinenfabrik für Kabelfabrikation (Conrad Felsing, jun.), Berlin, O., manufacturers of cable-making or wire-covering machinery. A circular just issued by the latter states that Mr. J. Löhausen retired from this company on the 1st inst., and that the firm will in future be carried on by Mr. Conrad Felsing, jun., as sole proprietor, who will take over all the assets and liabilities of the company, Mr. Löhausen remaining, however, in a consulting capacity.

Liverpool.—At the last meeting of the Lighting Committee of the Corporation, it was resolved that two sets of electrical plant be ordered from Messrs. Willans and Robinson at a cost of £1,727, and that the work be proceeded with as early as possible, for the Oldham-street and Paradise-street stations. It was decided to approach the Health Committee and Water Committee to obtain in Lodge-lane and Smithdown-road the necessary ground for substations. It was also resolved that the electric main be extended along Scotland-road, at an estimated cost of £741, thus completing the system in that neighbourhood.

Leeds.—At the last meeting of the Corporation Sub-Highway (Tramways) Committee it was reported that four new electric cars had been delivered at the car-shed, that their equipment was not yet quite completed, but that it was expected they would be ready for running in the course of a few days. It was resolved to carry out the extensions of the offices in Boar-lane, already referred to. A deputation was appointed some time ago to visit Glasgow and obtain information with reference to the system of management pursued there, and it was mentioned that the members would leave for Glasgow on this Friday afternoon.

New Catalogue.—We have received a copy of the new catalogue issued by the Newton Electrical Works, Limited, of Taunton. The specialities of the list are the now well-known Taunton dynamos and motors, of which sizes, weights, and prices are given. We also notice a "photograph of 20-b.h.p. electrical and haulage plant working at six miles an hour, with friction brake and clutch," in which, if the inscription is correct, the engraver must have supplied a quantity of detail. A description of an automatic motor starting switch shows that the arrangements are likely to give every satisfaction in preventing rushes of current.

Lynn.—The report of the committee has been adopted by the Town Council. This stated that they had considered the resolution of the Hall of Nov. 10 as to putting in force forthwith the King's Lynn Electric Lighting Order, 1896, and

after a lengthened discussion it was agreed that in the opinion of the committee it would be advisable for the Corporation themselves to undertake the lighting of the town by electricity; and that it be recommended that the committee be empowered to engage the services of an expert to advise and report upon the best means of carrying out a scheme of electric lighting in the borough and the cost thereof.

Middlewich.—At a meeting of the Urban Council, a letter was submitted from the secretary of the General Electrolytic Patent Company, dated St. Helens, stating that the company were preparing a subsidiary public company to work some of the Hargreaves Bird electrolytic patents in Great Britain. They were giving favourable consideration to a site at Cledford-road, Middlewich. The communication asked what concessions the Council were prepared to give to induce the Board to decide on a site in their district. It was decided to authorise the clerk to write, stating that the Council were prepared to give concessions to encourage trade, which had been much depressed in the district.

Llandudno.—It appears that a serious hitch has occurred in the proposed electric tramway scheme for Llandudno. Mr. Johnson, solicitor to the District Council, stated at the last meeting of the Council committee that Lord Mostyn absolutely refused to allow the tramway to go along any of his land, and even declined to receive a deputation. Under the Tramways Act the Council cannot compulsorily acquire land without a special Act of Parliament, although the promoters under the Light Railways Act can do so. Messrs. Johnson, Marks, and Stevenson have gone to London to interview the Board of Trade on the subject, the Council having given notice to apply for a provisional order next session.

Matlock.—At the monthly meeting of the Urban District Council, the Chairman introduced the question of an electric lighting company who are seeking parliamentary powers to establish a centre at Warsop, and supply electric power within a radius of 25 miles from that place. The clerk had written to the Darley, Bakewell, Wirksworth, and Matlock Bath Councils on the subject, but had not as yet received replies. If the powers sought by the company were granted, they would have a monopoly in their hands. This would be placing a monopoly in the hands of entire strangers, and if it were obtained by the company the Council could not do anything for themselves in the way of electric lighting. The Council decided to oppose the scheme, and for the present the matter is to be left in the hands of the Parliamentary Committee.

Whitechapel.—A short time ago the District Board decided to spend £5,000 in the acquisition of land adjoining the destructor in George-yard for the purpose of erecting an electric lighting station. Since then the Electric Lighting Committee have been considering the question, and have refused offers from various private companies. Last week the committee journeyed to Brighton to view the electric lighting works there. The committee made a thorough inspection of the works, and were most favourably impressed with the Brighton system, which is said to be different to that in many other provincial towns which have adopted electric light. The charge is 7d. for the first unit and 1½d. per unit after for each day's consumption. The committee will embody the report of their visit in a special report to the District Board, which will be considered at an early meeting.

West Hartlepool.—An enquiry was held on behalf of the Local Government Board at West Hartlepool last week into the proposal of the Corporation to borrow £30,000 for the purposes of electric lighting. Colonel Luard, R.E., conducted the enquiry, and Mr. Brown, C.E., borough surveyor, and Prof. Kennedy, electrical expert, were also present. There was no opposition to either project. Prof. Kennedy went exhaustively into details respecting the proposed installation and completion of the necessary arrangements to complete the scheme for lighting the town as proposed. He said that would require three boilers with five engines, and that the power could be employed for purposes of traction as well as lighting; that provision would also be made for securing a light load without the aid of engine power, and that a railway siding would be put in to connect the depôt with the North-Eastern Railway system. The Mayor said that both the Corporation and the town entirely favoured the scheme.

Winchester.—The Council have adopted the following report of its committee: "The Winchester Electric Light and Power Company, Limited, have deposited plans showing the manner in which the undertakers propose laying the mains for the supply of energy under the electric lighting order of 1895 transferred to them, together with the description of the system proposed to be adopted. The Board of Trade have also written, stating that they intend to approve of the scheme subject to their regulations for securing the safety of the public, and for ensuring a proper and sufficient supply of energy and also subject to any observations which the Corporation may wish to offer. The Council is advised to retain the services of an expert. It is thought that a visit of a few days would be sufficient for that purpose. It is felt desirable that the Guildhall should be connected with the telephone system, and the Council are recommended to enter into a contract for two years certain with the National Telephone Company, Limited, at the annual charge of £8."

Westminster Electric Supply Corporation.—An issue at par is announced by the Westminster Electric Supply Corporation, Limited, of £200,000, out of a total of £250,000 3 per cent. first mortgage debentures of £100 each. The Corporation, which has a capital of £399,500, in £5 shares, fully paid, was founded in 1888, and is authorised to supply electricity in the districts of Mayfair, Westminster, Belgravia, and Pimlico. The debentures now issued will be redeemable on March 1, 1920, but the directors may pay them off before that date at a premium of £5 per cent. The prospectus states that arrangements have been made with Barclay and Co.'s Bank, 1, Pall-mall East, S.W., in connection with the present issue, to carry out the redemption of the 5 per cent. and 4½ per cent. first mortgage debentures and premium thereon on March 1 next. The balance received will be applied in the extension of existing stations, and in the provision of plant and machinery to meet the increase of business. The figures given show that the company's business has steadily progressed during the past four years. The subscription list opens to-day, closing on Monday both for town and country.

Airdrie.—The Town Council have considered the proposals of the Scottish House-to-House Electricity Company, Limited, and of the Electric Extension Company, Limited, as to transferring the Town Council's electric light order, but have deferred coming to any decision until they know what the company who may work the proposed tramways may require. At the meeting of the Sanitary Committee a letter was read from the Electric Construction Company, Limited, together with relative outline of proposals, *inter alia*, for the erection of a dust destructor to be equipped in connection with the proposed electricity generating station for the purpose of the destruction of house refuse. The meeting deferred consideration of the matter, it being stated that it was considered too high a price to pay when they could get rid of the refuse without much trouble. A letter was read from Mr. G. D. Shearer, secretary of the Airdrie Landlords' Association, referring to the announcement of the application by the Council to the Board of Trade for a provisional order for the electric lighting of the streets and public places, and requesting that the Council should take over at once streets that were not yet taken over, and save extra expense coming upon the landlords afterwards. The matter was referred to the Lighting Committee.

Greenwich.—At the last meeting of the District Board of Works, the Greenwich Committee reported that they had had under consideration the question of erecting a dust destructor in the parish and the provision of a suitable site, and had had submitted to them a site lying at the rear of land adjoining the west side of the approach road to Blackwall Tunnel, and bounded on its western side by the back of the Thames Soapworks. The land was about nine acres in extent, and had three entrances from the main road, and the fee simple, the committee were informed by the agent, could be acquired at the rate of £600 per acre. The committee were of opinion that the land would be of great value to the Board, and recommended that the Board acquire it, and that the London County Council be asked for a loan for the purpose. The report was adopted. The secretary of the County of London and Brush Provincial Electric Lighting Company having written asking the consent of the District Board to their application for a provisional order for the lighting of the Board's district by electricity, and adding that, in the event of consent being given, the company would be prepared to give the Board the right to purchase the undertaking on favourable terms at the expiration of 7, 14, or 21 years, the Board decided to adjourn the consideration of the matter until a copy of the order had been obtained.

Blackpool.—At a meeting of the Town Council, Major Cardew's report on his enquiry as to the proposed alteration in the mode of electric traction on the Blackpool Corporation tramways was referred to the chairman of the Electric Lighting and Tramways Committee, the town clerk, and the borough electrical engineer for report thereon. That committee recommended that under the authority of the Blackpool Corporation Tramways Order, 1896, a tramway be forthwith constructed from the westerly end of Cocker street along the road in front of Carlton-terrace, and along Queen's Drive, Claremont Park, to the road known as the Gynn; that the borough surveyor be instructed to prepare the requisite plans and descriptions of the permanent way for the tramway referred to in the last resolution for submission to the Board of Trade for their approval; that application be made to the Board of Trade for the approval of the Board to the adoption of the overhead trolley system of electric traction on the Corporation's tramways from Talbot-square to the Gynn, and the borough electrical engineer be instructed to prepare the necessary drawings and description for the Board. The confirmation of the minutes of the committee was agreed upon by the Town Council after a lengthy discussion. In consequence of the above decision it has been decided to give notice to the owners of lands and buildings in Claremont Park to discontinue for 10 years the tolls hitherto in force.

Oldham, Ashton, and Hyde Electric Tramway.—The Electric and General Investment Company have offered this week, for subscription at par, the whole of the share capital of the Oldham, Ashton, and Hyde Electric Tramway, Limited—namely, £80,000 in £10 shares, divided into 4,000 5 per cent. cumulative preference and 4,000 ordinary. There will also be an issue of £40,000 debentures as occasion requires. The prospectus states that the company has been formed to construct and work an electric tramway eight miles in length from the boundary of Oldham, through Ashton-under-Lyne, Audenshaw, and Denton, to Hyde, as authorised by a provisional order granted to the British Electric Traction (Pioneer) Company, and which continues in force in perpetuity subject to the right of the local authorities to purchase the undertaking under the Tramways Act. The electrical energy will be supplied by the Corporation of Ashton under an agreement. About £10,000 per annum net profits are estimated. The permanent way is being laid, and the whole of the equipment and rolling-stock will be provided by the British Thomson-Houston Company. The total purchase price is £105,362, which includes

the cost of the parliamentary powers and all preliminary expenses up to the first general allotment and the benefit of parliamentary and other temporary deposits of £2,175. The contracts provide for the completion of the works within 10 months, and the tramway will be formally transferred to the company, subject to the approval of the Board of Trade, upon the expiration of six months from the date of opening.

Canterbury.—The City Council will consider to-day the report of the Electric Lighting Committee embodying the report of the consulting engineer, Mr. Robert Hammond, upon the tenders recently submitted for the supply and erection of plant and mains on the low-tension system for the municipal electricity supply undertaking. The committee's recommendation is as follows: The committee (acting upon the advice of the electrical engineer) recommend that the following tenders be accepted, and that the corporate seal be affixed to the necessary contracts and bonds: (Section A) boiler-house plant—Lancashire boilers and accessories, mechanical stokers, feed pump, injector economiser, electric motor, R. Taylor and Sons, £1,512; (B) engine-house plant—steam dynamos and accessories, condensers, oil filter, steam, exhaust, feed, blow-off, and sundry pipes, valves, feed-water and storage tanks, etc., India Rubber and Gutta Percha Telegraph Works Company, Limited, £3,773. 13s.; (C) overhead travelling crane, J. Spencer and Co., £235; (D) switch-board and instruments, Crompton and Co., Limited, £999; (E) accumulators, Chloride Electrical Storage Syndicate, £1,165; (F) mains—insulated cables and trenching Fowler-Waring Cables Company, Limited, £5,336; (G) public lamps—arc and incandescent street lamps, lamp posts, and brackets, Crompton and Co., Limited, £1,400; (H) meters, S. Z. de Ferranti, Limited, £262. 10s. Total, £14,683. 3s. In addition to the plant included in the above sections, the estimate laid before the Local Government Board inspector included connecting consumers to mains £1,000, and reinstatement of roads and footways £500. The estimated expenditure in respect of the above items was £15,850, as against the totals of the recommended tenders, etc., of £16,183. 3s., the difference of £334. 13s. being more than covered by the amount included in the estimate for contingencies.

Newcastle-under-Lyme.—At the last meeting of the Town Council the General Purposes Committee recommended that the corporate seal be affixed to the objections to the proposed tramway from Stoke to Newcastle. Alderman Briggs thought it due to the public to explain this action of the Council. In the latter part of 1896 a scheme was proposed for extending the tramway from Hanley to Newcastle by a new electric tramway company, but on an enquiry by the Local Government Board, the contention of the Newcastle Corporation that the scheme did not give sufficient facilities for Newcastle unless the line was continued to Silverdale, Chesterton, and Wolstanton, was allowed. From some reasons, not quite explainable, a fresh scheme had been suddenly brought forward by the old tramway company, to run from High street, Stoke, to the top of George-street, Newcastle, and then to diverge from the original track and proceed by way of Albert-street and King street to Nelson-place. The object of this scheme, he thought, was to connect Stoke and Hanley with Newcastle without carrying out the agreement to continue the lines to Silverdale, Chesterton, and Wolstanton. The Council fought very hard 12 months ago for these privileges, and it was felt that they should not allow their streets to be broken up unless they could get an all-round advantage. A deputation from the Stoke Corporation had consulted with the General Purposes Committee, and had agreed that if the tramway was constructed to Newcastle it should run by the direct route to Nelson-place instead of the proposed route. They would therefore withhold their sanction to this alternative scheme. The old plan, he submitted, had been thoroughly considered, and while they were willing to agree to a tramway from Stoke, they were not prepared to abandon the concession they had wrung from the Electric Traction Company to run to Silverdale, Chesterton, and Wolstanton. The resolution was then unanimously adopted.

Sheffield.—On the 12th inst. the Corporation unanimously agreed to the following resolution: "That the chairman and deputy-chairman be authorised to negotiate with the representatives of the Sheffield Electric Light and Power Company on the following terms—namely, £220 of Sheffield Corporation 2½ per cent. redeemable stock for every £100 of the sum properly expended by the company upon their undertaking and chargeable to capital account, provided that the basis be that the sale take effect as from Sept. 29 last, and not from Dec. 31, as mentioned in the letter of Messrs. Broomhead, Wightman, and Moore, and that the amount of such capital expenditure shall not in any event exceed £112,000, any further expenditure properly made being repaid to the company with 5 per cent. interest from the date of payment." A sub-committee of the Tramways Committee have selected a site for a power station for electric traction at Kelham Island, and have recommended that steps be taken to purchase the property. The city surveyor has been authorised to proceed with the getting out of plans for the power station. The Tramways Committee have considered 40 applications for the position of resident electrical engineer, and recommended the appointment of Mr. A. Llewellyn Fell, M.I.E.E., of Cork, at a salary of £400 per annum, to be increased by annual increments of £25 to £500 per annum. The committee have recommended centre standards instead of side standards from the Moorhead to Brunswick Chapel, and on the Attercliffe section, where the city surveyor considers necessary. The committee have also recommended the Council to oppose the application to Parliament, by a a company called the General Power Distributing Company, for an Act to empower the company to produce, store, supply, and sell electrical energy for public and private lighting, motive power, and other public and private purposes, in an area comprising so much of the counties of Derby, Nottingham, Lincoln, and the West Riding of Yorkshire as is contained by a circle drawn at a radius of 25 miles from Warsop, Sheffield being within that area.

Glasgow.—At the last meeting of the Corporation the new tramcars came in for a considerable share of the debate. Mr. Chisholm moved: "That the Tramways Committee be instructed to consider and report as to the kind of car to be used on the Springburn route, and, in view of the fact that it is understood that single-decked cars alone are in process of erection, the committee be specially instructed to consider and report as to the use of double-decked cars as well." The Lord Provost said Mr. Chisholm was, of course, aware that in the month of September the general manager reported to the committee on the equipment of this route, and in that report he recommended that single-decked cars should be adopted. That report was approved of by the committee, and it was afterwards approved by the Corporation. It was perfectly competent, therefore, for the Corporation to approve of the introduction of double-decked cars, but they could not upset the resolution at which they had already arrived. Mr. Wallace said it was not in the intention of the Tramway Committee to introduce single-decked cars on any other route on which electric traction might be adopted by the Corporation except the Springburn route. If this motion was carried, the Board of Trade would not sanction the opening of this line. They had got a reminder from the Board of Trade that there would be difficulty in this matter. As he had told them before they had difficulty in getting sanction to run cars drawn by horses under the bridge, and when they introduced the electric motor they intensified the difficulty very greatly. He believed they would not be permitted to run double-decked motorcars. The committee had acted on the minute of the Corporation, and 20 cars were already nearly completed. They would not, therefore, at this stage turn right about and face the other way; but again he gave the assurance that the committee had no intention of introducing single-decked cars on any other route. After considerable discussion, the Lord Provost asked Mr. Chisholm not to press his motion. Let them have a trial of the single-decked cars. He did not think very much harm would be done were the motion accepted. But he did not like forcing the hand of a committee which was making an honest endeavour to solve a difficult question. Mr. Chisholm said that had his proposal been an instruction to the committee he would cheerfully have complied with the Lord Provost's request. He considered it was an aggravation on the part of the convener to decline to consider and report. Therefore he declined to withdraw. At this stage the discussion was brought to a close by the Lord Provost intimating that Mr. Wallace had conveyed to him the information that he would accept the motion. In answer to a question when the tramway line would be laid down the High-street, Mr. Wallace said the matter was under the consideration of the Tramways Committee, along with other extensions. He did not state it officially, but his impression was that the High-street line would be one of the first lines undertaken. Dr. Dougan said he had put the question in the committee, and he was told that the specifications were nearly ready.

Hereford.—Mr. Thos. L. Miller, consulting engineer, Liverpool, has been appointed to advise the City Council on their electric lighting scheme. At the last meeting of the Council a letter containing the following questions to the chairman of the Finance Committee was referred to: (1) What progress had been made in the matter of the provisional order since the special Council meeting on Dec. 14? (2) What effect would the installation of the electric light by the Corporation have upon the gasworks undertaking? (3) Whether the present manager of the gasworks could also manage the proposed electricity works without an assistant manager? (4) Whether it was intended to submit Mr. Miller's report and figures to an independent expert for examination and report before acting upon them? (5) Whether, before proceeding with the scheme the Council would ask the views of the ratepayers? And (6) would the provisional order stop private installations. The Chairman of the Finance Committee said, as to question No. 1, he could say that the papers had been deposited and had been found to be in regular form, and the matter awaited the pleasure of the Board of Trade. He must beg for the second and third questions to be put to the chairman of the Gas Committee. With regard to No. 4 he thought that question involved a fallacy, because it was clearly put to the Council when they submitted Mr. Miller's estimate for adoption that it did not bind them to any future policy in any way whatever. That estimate was wanted for a particular purpose—to submit to the Board of Trade with their other papers, in order to bring their application in proper order, but they were by no means committed to that scheme, and before they spent any of the ratepayers' money it would be open to them to consider the whole question again. As to question No. 5, he thought it would be obvious that it was hardly for him to anticipate the action of the Corporation in that matter. His private opinion as to what should be done was that, as soon as they had obtained the order, they should have plans made and a careful estimate prepared as to what it would cost them to provide the principal streets with the electric light. They should then submit their estimate to the occupiers of the various streets (not confining it at all to the compulsory area). If they had been misinformed, and the people did not want the electric light, and would not pay the cost, he thought they should then, at all costs, abandon the scheme and leave it open for someone else to take up. But he thought there would be a considerable number of tradesmen in the leading streets who would have it. As to the last question,

ner the provisional order would stop private installations, he certainly not. He did not think it would prevent anyone lishing private installations. It was stated that the difficulty the point that before the Corporation could get their light incipal tradesmen would have installed their own.

nsgate.—The committee of the whole Town Council at the eeting instructed the town clerk to apply to Messrs. Webb o. for 24 copies of the order proposed to be made by the Railway Commissioners authorising the construction of the railways in the Isle of Thanet. It was unanimously resolved orm the Electric Supply Corporation, Limited, that the Council decline to grant an interview to a representative of mpany on the subject of the company's application for a pro- al order with regard to the borough, and that the Council that they will strenuously oppose the making of the order. mmittee, having considered the draft of the order which the Railway Commissioners propose to make authorising the uction of light railways in the Isle of Thanet, it was resolved e Light Railway Commissioners be requested to omit from ler that part of the proposed line of railway which extends ard from the junction of the Plains of Waterloo with gton-crescent. The Mayor, Aldermen Wood, Sykes, Emett, and Bradley, and Councillors Gwyn, Port, Poole, Dowling, aylor voted for the resolution; and Councillors Stock, rd, Hawkes, Jaycock, Bear, Hodgson, Bannister, Cook, , and Barnett against it. The committee then pro- to go through the various clauses of the draft order, tructed the town clerk to insert certain amendments, and uest the Light Railway Commissioners to adopt the same. lowing amendment was carried: "That the report of the g of the committee of the whole Council of Dec 30 last be ed, with the exception that no alteration whatever be made ion 4 of the draft order of the Light Railway Commissioners, t Clause 5 of Section 28 be altered to read as follows: The y, before completing the construction of railways Nos. , shall acquire sufficient land for the purposes of making a ad of the minimum width of 60ft. from Thanet-road to -avenue, Broadstairs, on which part of railway No. 6 and railway No. 7 is to be constructed, and shall, to the reason- tisfaction of the road authorities, make on the land so d, along the whole length of such new road, a properly d carriageway on part of its width and a suitable footway side on the whole remainder of its width, and shall dedicate e, or any part thereof, to the use of the public so soon as d authority agrees to adopt it, subject to the provisions of ler, and this provision shall be deemed to be in agreement e meaning of the Public Health Act, 1875; that such road completion become a highway repairable by the inhabitants ."

rhampton.—The town clerk has received an application e Midland Electric Corporation for Power Distribution, d, for the consent of the Town Council, as the local ity, to the draft of the provisional order of the company, sing the supply by the company of electrical energy for and private purposes, as defined by the Electric Lighting 82, within (amongst other places) the area of this borough. anation of the application the chairman of the directors of mpany has submitted a letter which stated that, provided olverhampton Corporation give their assent to the applica- the Board of Trade, the Midland Electric Corporation agree to supply electricity for lighting purposes without the t of the Corporation; (2) not to supply electricity for either or light to any public concern, such as the tramway, inside rough of Wolverhampton, which the Corporation has or ave acquired, except with the consent of the Corporation; t the Wolverhampton Corporation shall have the option of sing that part of the undertaking that the Midland Electric ation shall have inside the borough of Wolverhampton at 14 fter the date of the order being granted and at each subse- period of seven years—the price to be arranged on a fair to be settled as part of any agreement entered into; (4) the per Board of Trade unit for power and manufacturing purposes to exceed 1d. Competition would not, the letter continues, with the Corporation, as they would be supplying, as it were, rent article, and to an entirely new class of customer. While g 1d. per unit at the present time, the company look upon gure as a maximum price. The Lighting Committee in their state that they have reason to be satisfied with the success is attending the management of the undertaking under their d. The demand for electrical energy for lighting purposes ly increasing. The committee are quite prepared to y electricity for motor power. When a fair demand arises is purpose, they have no doubt that they will be able ke a considerable reduction in the prices for a day Whilst the committee are most anxious to encourage evelopment of local industries, they nevertheless must the interests of the ratepayers of the borough. The report ms: It is obvious that if a competitor is allowed to supply city for manufacturing purposes within the area over which rporation have at the present time virtually a monopoly, at r price than that at which electricity for lighting purposes g supplied by your committee, great causes of complaint e, which it will be difficult to remove without probable f injury to the undertaking of the Corporation. They, e, are of opinion that the consent of the Council, as the thority, should not be given to the grant of the provisional f the company, and that if any steps should be taken by is with the view of asking the Board of Trade to dispense ch consent, steps should be taken to resist it. The committee, therefore, recommend that the town clerk be authorised to communicate with the Board of Trade, intimating the decision of the Council, and to take such further steps as may be necessary.

PROVISIONAL PATENTS, 1898.

JANUARY 1.

16. Improvements in the manufacture of diaphragms for electrolysis. John William Towers, "Brantwood," Allerton, near Liverpool.

26. An improved construction of and method and means of laying underground electrical cables or conductors. Thomas Frederick John Truss, 10, St. George's-crescent, Liverpool.

45. Electric switch appa-atus for railways to enable train to receive currents from signal station when in contact with its electric curr-nt conductor (especially useful during fog). William Thomas Brain, Odessa Russia.

58. Improvements in rail joints for electric railways. Max Barschall, 47, Lincoln's-inn-fields, London.

67. An improvement in holders for electric glow lamps Henry Charles Gover, Charles Faraday Proctor, and William George Pipkin, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

80. Improvements in e'ectrical advertising devices. Gustave Alfred Lesieur, 22 Glasshouse-street, Regent street, London.

JANUARY 3.

121. Improvements in electric meters. Emile Batault, 21, Ely-place, London.

122. Improvements for separating stable or other salts and generating electricity. Douglas Frank Sinclair, Trafalgar-buildings, Northumberland-avenue, London.

124. Supporting e'ect ic accumulators for electric traction purposes and the like. Kerbey Bowen, 8, Great Portland-street, London.

125. Speed-regulating switch for electric traction. Kerbey Bowen, 8, Great Portland-street, London. (Complete specification.)

143. Imp ovements in electric arc lamps. William James Davy and George Thomas-Davies, 40, Chancery-lane, London.

143. An improved electrical termina'. Leonard Ridout, 124, Regent-street London.

156. Improvements in the method of fixing and suspending bare e'ect ic conductors. Alexander Bewicke Blackburn and Newton Hall White, 47, Lincoln's-inn-fields, London.

JANUARY 4.

166 Improvements in dynamo-electric machines. Charles Brooke Crawshaw and Claude William Hill, Hubert-street, Leeds-road, Bradford.

192. Support for electric lamps or other fixtures. Samuel Sidney Bromhead, 171, Queen Victoria street, London. (Otto Converse White, United States.) (Complete specification.)

235. Improvements in or relating to dynamo-electric machines. Reginald Belfield, 322, High Holborn, London. (The Westinghouse Electric and Manufacturing Company, United States.)

242. Improvement in electric timepieces or clocks. Frederic Richard and Theodore Leutz, 8, Quality-court, Chancery-lane, London. (Complete specification.)

JANUARY 5.

264. "Aurora" patent electric pipe, cigar, and cigarette lighter. Frederick William Whittle, 105, Liverpool-road, Patricroft, Manchester.

305. Device for preventing the displacement of the roller receiving the current from the cables of electric railways with overhead conducto's. Paul Meyersfeld, 111, Hatton-garden. (Complete specification.)

331. Improvements in preventing sparking when making and breaking electric circuits. Adolph Müller and Henri Tudor, 4, South-street, Finsbury, London.

JANUARY 6.

358. A new process for the preparation of electric paste accumulators. Emil Kosel and Frederick Frentzel, 73, Albert-street, London.

373. Improvements in insulated and protected conductors for the transmission of electrical currents. George Wilkinson, 73, St Stephen's-road, Upton Park, London.

383. Improvements in switches for starting motors. John Grice Statter and Chamberlain and Hookham, Limited, 18, Southampton-buildings, Chancery-lane, London.

398. An improved electrically-propelled bicycle. Stanes Prem, 321, High Holborn, London.

435. Improvements in and connected with primary batteries. Samuel William Maquay, 55, Chancery-lane, London.

JANUARY 7.

462. Improvements in or connected with electric mains. George Hinde Nisbett, 15, Water-street, Liverpool.

468. Improvements relating to enclosed motors or dynamos. Percy Rosling and Harry Walton Appleby, Sunbridge-chambers, Bradford.

494. Automatic rheostat for use in starting electromotors. Alfred Emrich, 111, Hatton-garden, London. (Complete specification.)

525. Improvements in electric signalling. Silvanus Phillips Thompson, Morland, Chislett-road, West Hampstead, London.

JANUARY 8.

533. Improvements in electric arc lamps. Arthur Jefferys Hills, Plymleigh, Guildford.

571. Improved means for making electrical connections upon railway trains. Wynford Brierley and Robert Foster, 4, St. Ann's square, Manchester.

584. Improvements in underground conduits for electrical conductors. Edwin Stanley Clark, 322, High Holborn, London.

586. Improvements relating to the mounting of dynamo-electric machines. P. R. Jackson and Co., Limited, and Joseph Slater Lewis, 322, High Holborn, London.

591. Improvements in telephone transmitters. Alfred Graham, 46, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED.

1896.

25631. Means employed in the electrolytic production of the chlorates of sodium and potassium. Parker.

28678. Pendants for gas, electric, oil, and other lights. Hateley.

28955. Means of telegraphing or telephoning without wires. Brown and Neilson.

29379. Electric arc lamp. Beaumont.

29702. Prepaid electric meter. Soames and Crawley.

29804. Apparatus for propelling fans or other machines or appliances by means of electricity. Pickup, Pickup, Ashworth, and McClellan.

1897.

171. Electric light and power fittings, especially adapted to boxes used in connection with armoured conduit systems of wiring. Bathurst.

851. Brush-holders for dynamo-electric machines. Jackson and Co., Limited, and Lewis.

1203. Secondary battery plate. Handcock and Dykes.

1430. Electrical storage batteries. Wade.

2578. Arrangement of field coils of shunt motors for use with storage or other batteries, and method of connecting such coils with the batteries. Parker.

2710. Method of and apparatus for the electro-deposition of copper and other metals on rotary mandrels. Heys. (Dumoulin.)

3722. Grooved frame carriers or supports for holding or suspending accumulator plates, photographic plates, and other plate-like articles. Thompson. (Kayser and Co.)

4313. Carriages. Clubbe, Southey, and the Electric Motive Power Company, Limited.

4391. Electric heating devices. Heys. (Chedville.)

5526. Firing device for internal-combustion engines. Clubbe, Southey, and the Electric Motive Power Company, Limited.

6246. Electric arc lamps. Dobson.

7870. Dynamos or electric motors and apparatus for driving fans by electricity. Gibbs.

17081. Electrical furnaces. Patten.

17113. Underground systems of electrical distribution for electric railways and the like. Wise. (Krotz, Allen, and Kelly.)

23057. Electric railways on a sectional conductor system. Crocker and Howe.

24131. Electric controllers. The British Thomson-Houston Company, Limited. (Reist.)

25307. Drum armatures for dynamo-electric generators and motors. Fynn.

25369. Electromagnetic circuit breakers. Heys. (Spruance and Waddell.)

25400. Electrolytic process and apparatus for the separation of metals from their ores and solutions. Motz and Welch.

25723. Alternating electric current meters. Scheeffer.

25811. Sockets or holders for electric lamps. Russell.

25998. Automatic circuit breakers. Fairweather. (The Crocker-Wheeler Electric Company.)

26040. Construction of electrical transformers for use in three-wire systems. The British Thomson-Houston Company, Limited, and Hobart.

26441. Preparation of accumulator plates. Bennert.

26640. Electrical resistance apparatus. Hughes.

26752. Flexible conduits for electrical conductors. Greenfield.

TRAFFIC RECEIPTS.

Dover Tramways.—The traffic receipts for the weel January 8 were £117. 11s. 10d. The mileage open at p 2½ miles.

South Staffordshire Tramways.—The traffic returns week ending January 7 were £541. 5s. 5d., as compa £569. 5s. 2d. in the corresponding week of the previous y

Bristol Tramways.—The traffic returns for the weel January 7 were £2,463. 7s. 7d., compared with £2,012 for the corresponding period of last year, being an in £451. 0s. 10d.

Birmingham Tramways.—The traffic receipts for th ending January 8 were £3,548. 0s. 7d., as compar £3,077. 2s. 0d. in the corresponding week in 1897, b increase of £470. 18s. 7d.

Liverpool Overhead Railway.—The traffic receipts railway for the week ended January 9 amounted to £ compared with £1 265 in the corresponding week of the year, being an increase of £173.

City and South London Railway.—The returns for ended January 9 were £1,124, compared with £1,111 for t sponding period of last year, being an increase of £13. T receipts for the half-year amount to £2,174, compar £2,188 for the corresponding period last year, being a of £14.

S.D. Tramways, Dublin.—The traffic receipts for t ending December 17 were £366. 6s. 10d., as compa £414. 10s. 0d. in the corresponding week in the previo being a decrease of £48. 3s. 2d. The number of pa carried was 63,574 in 1897 and 63,798 in 1896. The a returns up to date are £15,035. 8s. 3d., as compar £15,853. 18s. 1d. last year, being a decrease of £818. 9s. 1 mileage open is the same as last year—viz., eight miles.

COMPANIES' STOCK AND SHARE LIST

Name.	Paid.
Birmingham Electric Supply Company	5
Brush Company, Ordinary	3
—— Non. Cum., 6 per cent. Pref.	2
—— 4½ per cent. Debenture Stock	100
—— 4½ per cent. 2nd Debenture Stock	100
Callender's Cable Company, Debentures	100
—— Ordinary	5
Central London Railway, Ordinary	10
——	6
—— Pref. Half-Shares	1
—— " "	5
Charing Cross and Strand	5
—— 4½ per cent. Cum. Pref.	5
Chelsea Electricity Company	5
—— 4½ per cent. Debentures	100
City of London, Ordinary	10
—— Prov. Cert.	10
—— 6 per cent. Cumulative Pref.	10
—— 5 per cent. Debenture Stock	100
City and South London Railway, Consolidated Ordinary	100
—— 4 per cent. Debenture Stock	100
—— 5 per cent. Pref. Shares	10
—— " " " '96	10
County of London and Brush Provincial Co., Ordinary	10
—— 6 per cent. Cum. Pref.	10
Crompton and Co., 7 per cent. Cum. Pref. Shares	5
—— 5 per cent. Debentures	—
Edison and Swan United Ordinary	3
—— 5 per cent. Debentures	5
Electric Construction, Limited	2
—— 7 per cent. Cumulative Pref.	2
Elmore's Copper Depositing	1
Elmore's Wire Company	2
W. T. Henley's Telegraph Works, Ordinary	10
—— 7 per cent. Preference	10
—— 4½ per cent. Debentures	100
House-to-House Company, Ordinary	5
—— 7 per cent. Preference	5
India Rubber and Gutta Percha Works	10
—— 4½ per cent. Debentures	100
Kensington and Knightsbridge Ordinary	5
—— 6 per cent. Pref.	5
London Electric Supply, Ordinary	5
Metropolitan Electric Supply, Limited, Ord. No. 101-50,000	10
—— " " " 50,001-82,500	10
—— 4½ per cent. First Mortgage Debenture Stock	100
National Telephone, Ordinary	5
—— 6 per cent. Cum. First Pref.	10
—— 6 per cent. Cum. Second Pref.	10
—— 5 per cent. Non. Cum. Third Pref, No. 1-119,234	5
—— " " " 119,235-250,000	4
—— 3½ per cent. Deb. Stock, Red.	100
Notting Hill Company	10
Oriental, Limited, £1 shares	1
—— £5 Shares	5
—— £4½ shares	4½
Oriental Telephone and Electric Company	1
Royal Electrical Company of Montreal	—
—— 4½ per cent. First Shares Mortgage Debentures	100
South London Electric Supply, Ordinary	2
St. James's and Pall Mall, Limited, Ordinary	5
—— 7 per cent. Pref.	5
—— 4 per cent. Deb. Stock, Red.	100
Telegraph Construction and Maintenance	12
—— 5 per cent. Bonds	100
Waterloo and City Railway, Ordinary	5
Westminster Electric Supply, Ordinary	5
Yorkshire House-to-House	5

NOTES.

Book Received.—We have received from Messrs. Longmans a copy of "Practical Electricity and Magnetism," by J. Henderson, B.Sc. The book is published at 6s. 6d.

Proposed Iceland Cable.—It is reported that, with a view to encourage the project, the Danish Government have promised the telegraph company an annual subsidy of £5,000 for 20 years. As we have notified before, the cable would connect Iceland with the Shetland Islands.

"Journal of the Chemical Society."—The current issue of this *Journal* is rather rich in electro-chemical notes. Several of the abstracts we give, such as new cells, determination of resistance, copper voltameter, etc. All our notes giving abstracts on chemical subjects are extracted from the *Journal*.

Dr. Ramsay's Lectures for Juveniles.—The course of lectures on "Fire" now being delivered by Dr. Ramsay at the Society of Arts is drawing together numerous and interested audiences. The subject in question lends itself to many experiments, and of this the lecturer avails himself most fully. In his first lecture he showed an interesting experiment of burning a diamond which was ignited by means of a platinum wire heated by electricity.

Institution of Mechanical Engineers.—The next meeting of this institution is to be held at 25, Great George-street on Feb. 10 and 11. The interesting and somewhat heated discussion on Mr. Philip Dawson's paper on the "Mechanical Features of Electric Traction" will be resumed. The other papers to be read are "The First Report of the Gas-Engine Research Committee," by Prof. F. W. Burstall, and "Steam Laundry Machinery," by Mr. Sidney Tebbutt.

Photographic Exhibition.—The Royal Photographic Society is organising an International Exhibition of Photographic Apparatus and Photographs, which will open at the Crystal Palace on April 27. In addition to the usual displays of pictures, etc., the leading firms, manufacturers, and dealers will be largely represented. There will also be extensive loan collections, illustrating not only the history of photography, but its enormous scientific and commercial applications, photo-mechanical processes, photographs in colours, photographs by means of the X-rays, and kindred exhibits.

Webb Testimonial Fund.—It is intended to make the presentation of the testimonial from the various members of the Institution of Electrical Engineers to the retiring secretary, Mr. F. H. Webb, at a subscription dinner to be given to Mr. and Mrs. Webb by contributors to the testimonial fund on Monday, Feb. 14, at the Whitehall Rooms of the Hôtel Metropole. Tickets may be had from the hon. secretary of the fund, Mr. Henry Edmunds, [illegible], Victoria-street, Westminster, the price of single tickets being £1. 1s., and that of double tickets (for a lady and a gentleman) being 36s.

The Maximum-Demand Indicator.—The use of this indicator to adjust the reduction of the charges for electrical energy to regular consumers is growing rapidly, but in some cases its introduction is attended with distrust. This is especially the case at St. Pancras. To insure that the Vestry shall not at any rate lose much by the introduction, no reduction will be made until a three hours' average supply at the maximum rate has been taken. This renders the system useless to the large bulk of the consumers, who will never attain to the reduced rate, but they will have to pay a yearly rent for a piece of apparatus to tell them how much current they may have used when they burn most of their lamps at the same time. If the Vestry wish to increase the number of their consumers more rapidly, they should adopt a reasonable scale to give more general reductions.

Telephones.—The following towns are now agitating through their town councils and members of Parliament to obtain licenses to work municipal telephone exchanges: London, Glasgow, Manchester, Edinburgh, Norwich, Middlesbrough, Sheffield, Aberdeen, Huddersfield, Hull, Bedford, Bristol, Leicester, Tunbridge Wells, Portsmouth, and Brighton. This is in accordance with the Treasury minute of May 23, 1892, which also laid down that all companies should have the use of the trunk lines. It was stated then that no licenses would be granted until the trunk lines had been taken over by the Post Office, which has now been done. The way, therefore, is clear, but until the result of the Glasgow commission is made known the policy of the Government in this matter is only to be guessed at.

Changing Alternating to Direct.—Leo Graetz discusses an electro-chemical method of changing alternating into direct currents, his conclusions being given in the following abstract: "An electrolytic cell, one of the electrodes of which is composed of aluminium, causes a great decrease in the strength of any current sent through it when the aluminium electrode is the anode, and the separation of oxygen takes place on it, but leaves the current unaffected when the aluminium is the cathode. If through a series of such cells an alternating current is sent, and the number of cells is so chosen that the anode-polarisation balances, or is greater than the tension of the current, the positive portion of the current, for which the aluminium would act as anode, is checked and only the negative current passes. On this principle, a method of converting an alternating current into a direct current is based."

The Inter-relation of Light and Thought.—The following is interesting reading after our note in the issue of Dec. 17 on the discovery of Mr. Howard Swan. Prof. Scripture, of Yale, writes us to the effect that he has found reason to think that the faint light which we can see in darkness, or with closed eyes, and which appears in the form of rings, waves, and irregular figures, is due, not as is generally supposed, to chemical changes going on in the retina, but to something occurring in the brain, and he proposes to call it "cerebral light." It appears to be located "in those higher centres of the brain which are connected with visual memories and imaginations." A close connection has been observed between these cerebral-light figures and the contents of dreams, and Prof. Scripture suggests that the hallucinations produced by drugs, like hashish, may be simply modifications of such figures.

Fog and Light.—The dark days before Christmas required special arrangements on the part of the engineers responsible for artificial lighting in the various towns in this country, and it is worthy of note that the electric light was not found wanting on those days. In this respect the gas engineers have a great advantage, as the gasholders are always sufficient in capacity to meet the first rush of any sudden demand. In the event of the extraordinary demand being continued, however, the electric light asserts its superiority. Few gasworks possess generating plant of sufficient capacity to give off gas equal to the demand, and reliance is placed on the storage in the gasholder to tide over the periods of heavy load. However, as was the case at Wolverhampton this last Christmas, an insufficient reserve at the beginning of the dark days means failure of the light, which results in great complaints and loss of trade on the part of the consumers.

The Electrical Engineers' Corps.—The recruiting for the Electrical Volunteer Corps of the Royal Engineers

is not being pressed forward, owing to some difficulties over the provision of headquarters. We understand, however, that the officers of the corps are receiving instructions so that all may be ready when the rank and file are enlisted. We have seen and admired the officers' uniform, which is that of the Submarine Miners, and which looks most business-like and neat. An old castellated building near Greenwich Park was at first selected as suitable for headquarters, but owing to a better offer having been received, the owner has taken a marked dislike to search-lights—in fact, he will be only too pleased for the Electrical Engineers to take the castle, but on no account whatever must they use search-lights in it or the grounds. The urgency of the matter makes one wish that such obstructive members of society could be summarily dealt with.

Electro-Harmonic.—The next smoking concert is fixed for next Friday evening, when the following will be the programme: Part I.—Humorous part song, "The Menu" (MS.), the Lyric Vocal Quartette; song, "The Scent of the Lilies" (G. F. Cobb), Mr. Charles Strong; pianoforte solo, "Galop" (Raff), Mr. Alfred E. Izard; sensational novel, Mr. Frederic Upton; song, "When Bright Eyes Glance" (W. W. Hedgcock), Mr. Wingrove Ives; plantation melody, "De Ole Folks at Home" (specially arranged), the Lyric Vocal Quartette; cornet solo, "Non è Ver" (T. Mattei), Mr. Arthur Smith; humorous sketch, Mr. Edward Kent. Part II.—Quartette, "Rub-a-dub" (Dr. Vincent), the Lyric Vocal Quartette; song, "Mary of Argyle" (S. Nelson), Mr. Thomas Powell; sensational novel, Mr. Frederic Upton; song, "The Wonders of the Deep" (W. H. Jude), Mr. Wingrove Ives; humorous part song, "Simple Simon" (Macy), the Lyric Vocal Quartette; cornet solo, "Killarney" (Balfe), Mr. Arthur Smith; humorous sketch, Mr. Edward Kent.

The Average Age.—The report by Dr. Tatham on the mortality rate in the various trades and occupations is most interesting. This report is based on the last census. Mr. G. N. Barnes, speaking recently on the engineers' dispute, ventured the statement that "the average age of the workman in this country was 38 to 39," and that this "was murder in the fullest sense of the word." The difference between maximum age and mean age does not seem to have been considered by the above speaker, as the average given denotes favourable rather than unfavourable conditions. The most striking feature in Mr. Tatham's report lies in the fact as to the death-rates amongst men having no occupation. The rates are given for several ages. Disregarding the ages under 20, concerning the accuracy of which there appears to be some doubt, it is seen that, as compared with those of occupied males, the death-rates of unoccupied males at ages 20 to 25 are nearly six times as great, at ages 25 to 35 nearly $3\frac{3}{4}$ times as great, and at ages 35 to 45 more than $2\frac{1}{2}$ times as great.

The Employers' Liability Act.—The following interpretation of a point arising from the new Workmen's Compensation Act has been given by Mr. Chamberlain in reply to a correspondent. The question raised was as to the chance of workmen obtaining compensation in the case of a large explosion taking place in a mine heavily mortgaged to debenture holders. Mr. Chamberlain may be summarised as follows: If the employing company has insured under Section 5-1 of the Act, the workmen have a first charge upon the insurance money in the event of the company being wound-up, and they are secured against any possible loss. If the employing company has not insured, and the assets have been mortgaged to debenture holders, then the debenture holders take priority of the execution creditor. In other words, the workman is, in the latter case, in the same position as any other execution creditor, and, therefore, in this respect no worse off than before the Act; while if the employing company has insured, he is in a better position than any other creditor.

The Indiarubber Supply.—The British Consul at St. Paul de Loanda says there are only two products of the Upper Congo, as far as its resources are known at present, which are valuable enough to pay the cost of transport. These are ivory and indiarubber, both of them, unfortunately, limited in quantity and slow of growth. It is a mistake, however, to regard the exhaustion of either as inevitable. There is sufficient indiarubber in the forests of the Haut Congo to yield rich harvests for many a year, even at a much greater rate of exportation than the present, which has attained an average of 100 tons a month. Nothing could possibly repay cultivation better. The preservation of the climbing plants from which the elastic juice is obtained, and the introduction of trees containing it in greater quantities, is, therefore, a labour of forethought to which too much attention cannot possibly be given. Already something has been done in this direction by a few officers of superior intelligence, but others have caused wide stretches of forest to be stripped of wealth with little regard for the needs of the future.

The Overhead Trolley. — We have repeatedly referred to that where the overhead trolley system of electric traction has been introduced by responsible firms, there is nothing to complain of in the matter of unsightliness. We are glad to see that this view is at last being shared by a number of the municipal authorities contemplating electric traction, and we are sure that in the course of a few years this point of opposition will be abandoned. On the other hand, it is becoming a regular custom for the local authorities, before giving their consent to electric traction schemes, to impose clauses as to regrading and widening the streets to be traversed. These terms in certain cases are so onerous as to entail an amount of capital expenditure which will seriously handicap the traction industry. A case was brought before us recently in which a macadamised road was to be doubled in width, regraded, and paved with wood at the expense of the tramway company, where the cost of the extra la[...] reached considerably over four figures. The sooner the local authorities understand that a system of rapid trans[...] between the centre of a town and its suburbs is a dai[...] necessity, to be encouraged rather than obstructed, the better.

Telephony in London.—The following is not o[...] comment, but that of a financial contemporary: "T[...] Telephone Company's service is becoming absolute[...] unendurable. Last night at five minutes to eleven [...] attempt was made to communicate with our offices, and [...] connection could be obtained. Repeated rings till 11.[...] were unavailing, and when a call made through anoth[...] exchange compelled an answer, the young lady in charg[...] at "Gerrard" explained that she had been too busy [...] attend in the meantime. The correspondent who w[...] endeavouring to communicate informs us that he does n[...] send the usual present of gloves or game to the cle[...] in-charge of the Gerrard exchange, and this doubtle[...] explains the young lady's preoccupation. Complaints [...] the telephone officials are absolutely useless; the questi[...] therefore, resolves into sending presents to the subordina[...] officials or remaining unserved. How long London w[...] put up with this nuisance it is impossible to say, but t[...] sooner a league is formed to remedy the abominable ev[...] at present existing the better it will be for all concerne[...] As complaints to the officials avail nothing, it may be [...] well to try what publicity will do, and for this purpose [...]

will gladly place our columns at the disposal of our readers."

Transmission of Power.—Mr. H. W. Ravenshaw read a paper before the South Staffordshire Institute of Iron and Steel Works Managers, at Dudley, on Saturday last, on "The Application of Electricity to the Transmission of Power." Mr. Ravenshaw pointed out that the old methods of transmission of power from the engine to the machinery are extremely wasteful as compared with the electric motor, and that immense quantities of coal are uselessly consumed in wearing out belts and bearings, and in raising steam which is to be condensed in long lines of pipes and perhaps re-evaporated in the cylinders without any useful purpose. In order to reduce these losses as far as possible, electricity is being employed in many cases with great success, a central station being established in the works, and electric motors being employed to drive the machinery. With this arrangement the boilers could be concentrated, high pressure could be safely used, and the labour and coal consumption reduced to a minimum; short steam-pipes carried the steam to economical engines which drive dynamos supplying the necessary light and power to the works. The author proceeded to quote detailed cases where saving had been effected, and to give particulars of the electrical equipment required.

Dies Hard. — Three-quarters of a century ago the people of this country—that is, the rulers—were anxious about such questions as the "emigration of artisans," "combination laws," "exportation of machinery," and similar things. It is singular that from then till now, through evil report and through good report, certain views as to the turnover of English workmen have held their ground. We are told by leaders of strike fanatics that although the workman here is to get higher pay and shorter hours, he makes up for it by a greater output. Just read what Mr. Alexander said in his evidence now over 70 years ago: "The great difference, however, is that the same number of English workmen will turn out 16 machines in this country, when an equal number of French workmen will not turn out in France four of the same description." This conceit has made Englishmen more pugnacious than they naturally would be, and yet we doubt if it ever was true, at any rate to the extent supposed. The increase of machinery, however, has averaged the output all along the line, and mere thews and sinews do not occupy the same position as they did when the aids to moving weights were few and far between. The pulling of a string sets a machine in motion, the machine does the work; the string puller is only the highly-educated lord of creation, who in combination arrogates infallibility, and demands control of not only the wheels of the nation but of the universe.

Educational.—It is interesting to see the great interest taken by some members of municipal bodies in things educational. Hastings, as a seaside resort, possesses a good record, but matters connected with electrical subjects have not always received the attention they ought. Councillor Boutwood, however, is determined that his constituents shall know something about electrical traction, so he has given a lecture on the subject. He had plans prepared to show the front at Hastings as it would be with lines constructed and trams running. This is a very effective way of removing some objections. The use of lantern slides of electric tramway equipments in other towns showed that the lecturer had not drawn on his imagination only when stating that the front would not be disfigured by the introduction of the overhead system. He alluded to the fact that the 'buses had carried nearly a million and a half of passengers, and that the 'bus company had paid a 15 per cent. dividend. Still, the service was insufficient, and the wear on the road excessive. Mr. Boutwood then gave details of the three tramway schemes proposed from three separate quarters to serve Hastings and St. Leonards, and advocated the acceptance of that suggested by Mr. W. Murphy, of Dublin. The choice was made because of that scheme being the most extensive. We admire the lecturer's energy and forethought in enlightening his fellow-townsmen on the subject, and trust that the short-sighted policy of the opponents to electric trams will be defeated.

Brisbane.—According to a correspondent, things seem to be moving pretty briskly in Brisbane just now. The authorities there have been expending a lot of money latterly upon public improvements, etc., and would appear to be keeping well abreast of these go-ahead times. The electric tramway, which, it will be remembered, was not long since completed, has now fairly established itself. In connection with this, by the way, some of the horses of the town exhibited decided symptoms of jealousy when the regular service of cars was first started, but they soon came to recognise (intelligent animals) the fruitlessness of open resistance to the advance of science, and now, we learn, pass a car with an air (somewhat dejected) of dignified resignation to the new order of things. Apart altogether from joking, however, it is a thousand pities that labour troubles at home preclude our manufacturers from giving closer attention to the requirements of our Colonies; for progression in certain of them is more rapid at the present moment than it has been for a long time past, and demand generally, especially for electrical apparatus—both for central-station and tramway equipments—is certain to be an increasing one. All patriotic Englishmen, whether at home or abroad, must feel exceedingly bitter at seeing large orders for electrical apparatus, etc., emanating from our own Colonies, going to Continental firms. And it is especially galling to know that the proportion of orders secured by home firms, as compared with those which go elsewhere, is a rapidly decreasing quantity. But any amount of talking will not alter this unsatisfactory state of affairs; we only wish it could, then the trouble would soon be at an end.

Theory of Accumulators.—This is an abstract of a paper by Fritz Foerster. The author discusses the rival theories of the action taking place in a lead accumulator, supported on the one hand by Le Blanc, on the other by Liebenoff and Löb. According to Le Blanc, the lead peroxide passes into solution during the discharge, in the form of hydroxyl ions and quadrivalent lead ions; the latter then give up half their charge to the anode and are converted into bivalent lead ions. During the charging, salts of quadrivalent lead are formed at the anode, which are hydrolysed, depositing lead peroxide. According to Liebenoff, solutions of lead salts contain some $Pb\bar{O}_2^-$ ions, which simply lose their charge at the anode, being converted into lead peroxide, the reverse change occurring during discharge. The author supports Le Blanc's view on the grounds that quadrivalent lead ions really are formed at the anode when lead salts are electrolysed [the salt $(NH_4)_2PbCl_6$ may be prepared by the electrolysis of a solution of $PbCl_2$ and NH_4Cl at 0deg.]. Further, according to the theory, the process of discharge is not a complete reversal of the charge, which explains the fact that the whole of the electrical energy used in charging cannot be recovered, and finally reactions in which an ion loses part of its charge are very numerous; a summary of such reactions is given. On the other hand, if Liebenoff's theory be accepted, we should expect solutions of zinc oxide or copper oxide in alkalies to deposit peroxides in the same way as a solution of lead oxide. The difficulty is avoided

by assuming the formation of quadrivalent lead ions, because neither zinc nor copper is capable of forming ions of higher valency than two.

The Foyers Storage Works.—By the completion of the large storage works at Gorthleck, the final step in the scheme connected with the utilisation of the Falls of Foyers for the production of aluminium has now been taken. The reservoir, as was fully described by us in 1896, is situated about three miles from the turbines at Loch Ness, and has been formed by throwing a dam across the valley below the two natural lochs Garth and Farraline, the level of the former being raised 20ft. and of the latter 10ft., a fine sheet of water $5\frac{1}{2}$ miles long being thus created. An interesting part of the work consisted in diverting the River E., draining a mountainous district, about 12 square miles in extent, into the reservoir. The total capacity of the reservoir is about 4,000 million gallons, which, it is expected, with the unequalised portion of the watershed of the River Foyers, will produce a continuous 5,000 h.p. at the factory. The surface of the reservoir when full is 640ft. above sea-level, and the impounded water will be discharged into the old outlet from Loch Garth, to pass along the old river course, being diverted into the tunnel supplying the turbines at a height of 400ft. above sea-level. As the height of the turbines is about 50ft. above sea-level, an effective fall of 350ft. is obtained. During the past year, as the reservoir works have been approaching completion, storage sufficient to keep the present machinery at work continuously has been provided, and the business of the British Aluminium Company in making aluminium and of their tenants, the Acetylene Gas Company, in making calcium carbide, has been vigorously proceeding. The completion of the works places the company in a position still further to enlarge the output of the metal, the demand for which is rapidly increasing. The works, originally designed by the late Mr. Peregrine Birch, M.I.C.E., have been carried on and completed by his successor, Mr. W. Vaux Graham, M.I.C.E., the present engineer to the company.

New Galvanic Cells.—Two cells are described by H. Pauling, with remarks on them by F. W. Küster. The abstracts may be combined. The first cell described has carbon electrodes immersed respectively in concentrated chlorine water and sodium thiosulphate solution, the liquids being separated by a porous pot soaked in brine. The E.M.F. fell on short-circuit from 0·64 volt to 0·47 volt, and then remained constant for five hours, the current passing being 0·7 ampere. Sulphur separates out in the thiosulphate solution. In the second cell the electrodes are iron and carbon respectively, and the electrolyte a concentrated solution of ferric chloride, the reactions which take place, according to the author, being $3FeCl_3 = 3FeCl_2 + 3Cl$ and $Fe + 3Cl = FeCl_3$. The ferrous chloride formed is reconverted into ferric chloride by means of chlorine gas. The E.M.F. of the cell is 0·9 volt, and its principal advantages are its freedom from smell and cheapness. A simple mode of construction is described in which a constant flow of ferric chloride solution is maintained through the cell so as to ensure efficient depolarisation. On the above Küster says the process occurring in the cell described by Pauling is better represented by the equation, $2Fe''' + Fe = 3Fe''$, the dashes indicating the number of positive charges of electricity. Since the iron is always contaminated with finely-divided carbon or iron carbide, local galvanic action must occur of the same kind as the main reaction taking place in the cell. That this is the case was proved by an experiment, in which the iron plate lost 1·66 grm. in weight, whereas the loss corresponding to the quantity of electricity produced should have been 0·31 grm. That the iron dissolves as ferrous chloride and not as ferric salt was shown by immersing the iron plate in a solution of sodium chloride and the carbon plate in a solution of ferric chloride. After allowing the current to pass for some time, the solution in the vicinity of the iron plate was found to contain ferrous salt alone without a trace of ferric iron.

The Engineering Dispute.—This costly struggle is now apparently on the verge of settlement. The financial strain compelled the men's representatives to withdraw on Saturday last the strike notices which were the cause of the dispute, and Mr. Barnes expressed the hope that this course would enable work to be resumed without further discussion. This hope is not to be realised, as the employers do not wish to throw away the advantage gained at so much cost. We are informed by a member of the Employers' Federation that it is some 30 years since a general strike ended by the men giving way, and on that occasion the men were allowed to return to work on individually accepting certain terms. The terms were afterwards repudiated by the men's societies, and then by the men collectively. The following letter, sent on Wednesday last to Mr. David Brown, the secretary of the joint committee, shows that the same error will not be made this time. It reads: "Sir,—Your letter of the 15th inst. has been submitted to a meeting of the executive committee of the Federated Engineering Employers, held to-day. They are pleased to note the withdrawal of the demand for a 48-hour week. In reply, we are instructed to say that, subject to hearing from the allied trade unions confirming the acceptance of the conditions of management, mutually adjusted at the recent Westminster conference, and on the understanding that there will be resumption of work simultaneously in all workshops of the federated employers, the employers are prepared to reopen their works to members of the allied unions on Monday morning, 24th current, at the usual starting hour. In the first instance the employers can only restart a portion of the men, but whenever they are in a position to do so the remaining vacancies will be filled up as rapidly as possible. In order to enable us to make the necessary arrangements, it is necessary for us to hear not later than noon on Friday, 21st current, at the Hotel Métropôle, Northumberland - avenue. — (Signed) Thomas Biggart, James Robinson, joint secretaries of the Employers' Federation."

Wireless Telegraphy.—Mr. John Gavey, assistant engineer-in-chief to the General Post Office, London, lectured before the Cardiff Naturalists' Society at the Cory Hall on the 13th inst. on "Telegraphy Without Wires." Dr. J. Tatham Thompson, president of the society, presided. Mr. Gavey, having referred to early experiments in telegraphy, said many years ago, when the subject was not in such an advanced state as now, the electric disturbances which were observed when delicate apparatus began to be used caused a great deal of trouble in London. It was found that these disturbances were so pronounced as to enable operators to read messages dispatched on other wires working in quite a different direction and situate many yards away. Mr. Gavey referred to the experiments he carried out at Lavernock in 1892, when signals were transmitted with remarkable success from the mainland to the Flat Holms. By way of illustration, some interesting experiments were made by the lecturer and Mr. J. W. Leyshon (the electrical engineer at the Cardiff Post Office). The electromagnetic action of one wire upon the other was demonstrated by means of a loud telephone. Prof. Hertz's researches in this field were referred to, and the lecturer said it was a great pity that Prof. Oliver Lodge had been prevented from carrying out

still further his interesting discoveries relating thereto. Charts showing the geographical positions of the various places where experiments had been tried, and diagrams illustrating the nature of the apparatus which had been made famous by Signor Marconi, were exhibited. Although signals were certainly transmitted by Mr. Gavey in the room, yet owing to atmospheric conditions of the hall they were only partially successful. But enough was shown to demonstrate the nature of the principle involved. The lecturer said that exaggerated reports were industriously circulated as to the capabilities of the new system. Among others, was the notion that by it a vessel could be blown up in the time of war. Such a thing was manifestly impossible unless those on board were obliging enough to provide the necessary receiving apparatus. Obviously the best use for the system was in establishing communication between the land and the lightships, for it was found that the system worked better over water than over land.

Teslaic.—In the issue of the New York *Electrical Review* for Jan. 5 is a communication by Mr. Nikola Tesla. He has added his latest advances in vacuum-tube lighting. We are only restrained from giving his communication in full because of the photographs which illustrate it. To reproduce these would detract from their clearness. The author refers to his experiments of a few years ago, which were for a time laid aside, but examples of figures are given with tubes of moderate illuminating power, whereas he is enabled to produce tubes of much greater candle-power—in fact, illuminating power equal to that of hundreds and even thousands of ordinary vacuum tubes; and he says "What is more, I believe that I am far from having attained the limit in the amount of light producible, and believe that this method of illumination will be eventually employed for lighthouse purposes. This probably will be considered the oddest and most unlooked-for development of the vacuum tube." He points out that at the time of his previous experiments an endeavour was made to introduce vacuum-tube lighting into this country. He thought it was bound to fail, as indeed it did. The power consumption was very large for the amount of light produced. The reason of this, he says, is not far to seek. "A vacuum tube, particularly if it be very large, offers an immense radiating surface, and is capable of giving off a great amount of energy without rising perceptibly in temperature. What still increases the dissipation of energy is the high temperature of the rarefied gas. Generally it is supposed that the particles are not brought to a high temperature, but a calculation from the amount of the energy consumed during a given period of time, and the amount of matter contained in the tube, leads to results which would seem to indicate that, of all the means at disposal for bringing a small amount of matter to a high temperature, the vacuum tube is the most effective. . . . As compared with these disadvantages, the incandescent lamp, crude and inefficient as it undoubtedly is, possesses vastly superior features. These difficulties have been recognised by me early, and my efforts during the past few years have been directed towards overcoming these defects, and have finally resulted in material advances, so that I find it possible to obtain from a tube of a volume not much greater than that of a bulb of an incandescent lamp about the same amount of light produced by the latter, without the tube becoming overheated, which is sure to take place under ordinary conditions. Both of these improvements, the increase of candle-power as well as degree of efficiency, have been achieved by gradual perfection of the means of producing economically harmonical electrical vibrations of extreme rapidity." Mr. Tesla tells us that his experiments have been made from an Edison direct-current supply circuit, and the frequency he estimates it about 2,000,000 a second. The illuminating power of the tube approximated to about 1,000 c.p.

Dangerous Low-Tension Shocks. — Mr. Emil Kolben has written to the *Elektrotechnische Zeitschrift* on the subject of the deaths from low-voltage shocks which we gave details of in our issue of the 7th inst. He understands from the article describing the accidents that in the factory where the four fatal cases occurred low tension only is used, and that high tension with reduction by transformers is not employed. If this latter method had been in use, leakage from the high tension might have explained the fatalities. On the other hand, we learn from the report that the installation is worked by a three-phase system, with a combined pressure of about 230 volts, and that the lighting is supplied probably by the individual phases, which in this case would give 130 volts. In the case of an earth on a lighting wire which is not connected with the zero or central conductor, either of the other two lighting conductors may have a pressure of 230 volts to earth. Mr. Kolben concludes, therefore, that all the cases cited, as they occurred in consequence of an earth contact, the shock was at 230 volts, and not at 130 volts. At any rate, in his practical experience, ranging over many years, he has not met with a single fatal case with three-phase current at 200 volts, and to illustrate this subject he mentions a case which occurred very recently in a large engineering establishment. A workman employed on the traveller of the works stood on the beams supporting the running rails, at a height of about 21ft. from the ground. In turning his head quickly, he touched with his forehead one of the three bare contact wires for the travelling crane. Although there was practically no earth on the system, yet the man was frightened by the light shock he got, and would have fallen if he had not instinctively caught hold of two of the contact wires. Since these two wires had 200 volts between them, the man was unable to let go. He hung in the air by the arms, which were drawn up as if by cramp, and yelled inarticulately until the crane attendant came to his assistance. The latter tried in vain to get the man off, but he could not be released until these particular wires had been switched off. Consequently the man was for several minutes exposed in that position to the full pressure of 200 volts, yet he was able to descend the ladder afterwards unassisted, and only fainted when he reached the ground. He quickly recovered after swallowing a few drops of an ether stimulant. In this special case the contact between the hands and the wires supported the weight of the whole body, and hence was an excellent one. The incident occurred quite suddenly, and yet it had no fatal issue. It is possible, however, that it would have been worse if the contact had been between hand and foot, as in that case the current might have passed through the spine and caused paralysis or suffocation. At any rate, from personal experience, Mr. Kolben says that shocks between foot and hand are always more disagreeable than those between the two hands. The above facts from Mr. Kolben's experience are most useful on account of their definiteness. We, after perusal of the above, adhere to our previous conclusions, that there must have been some special process going on at the chemical factory where the four fatal accidents occurred which tended to reduce the resistance of the skin on the hand, and of the wooden shoes worn by one of the victims. It is well known that the atmosphere in an accumulator-room tends to do this, and hence special precautions have to be adopted by workmen handling the secondary batteries to prevent them receiving unpleasant shocks.

THE GLASGOW DISTRICT SUBWAY.

Before starting the description of the electric gear used in connection with the working of the Glasgow District Subway, it will be of some interest to our readers, doubtless, if we give a few details as to the general features of the undertaking; and also to the various schemes that led up to it, and the general reasons for the form it has finally taken.

It is now just 10 years ago since the first scheme was promoted—viz., in 1887—and the proposals then put forward was for a line to be worked by cable, and embracing only the northern half of the present circle—that is to say, the station from St. Enoch-square to Byars-road. This scheme proposed that the stations should be exactly equidistant one from another, and that the trains should be fixed to the cable at certain set distances apart so that they would all be at the stations at the same moment when the cable would be stopped, and when started again it would move each train on to its next station. However, the Bill was thrown out in the Commons. Nevertheless, in the following year another scheme was put forward which practically was identical with the present undertaking, but owing largely to the opposition of the Clyde Trustees, who objected to the tunnels being driven under the bed of the river, this Bill was also rejected. However, in 1889 a company obtained powers to make a tunnel under the River Clyde at Finnieston, and therefore in the following year, with this precedent in their favour, the subway company again put forward their 1888 scheme, which this time was passed and the necessary powers granted.

The route of the line is, generally speaking, a circle, tapping the chief business and residential portions of the city and passing twice under the Clyde. The total length of the line is 11,527 yards, or, roughly, 6½ miles of double track. Starting from St. Enoch-square Station, the line passes up Buchanan-street to Buchanan-street Station; on along Cowcaddens to Cowcaddens Station; following on along New City-road and Great Western-road to Byars-road, with stations at St. George's Cross, Kelvinbridge, and Byars-road; then passing south, with stations at Partick Cross and Merkland-street, it passes under the river to Govan Cross, Copeland-road, Cessnock, Kinning Park, Shields-road, West-street, and Bridge-street Stations, repassing under the river again back to St. Enoch. The tunnels consist of two endless tubes 11ft. diameter, laying side by side, and at the stations merging into one larger arch of 28ft. span. The tunnelling consists of circular brickwork in part, and also partly of cast-iron section work; this latter being partly done under air pressure and partly without.

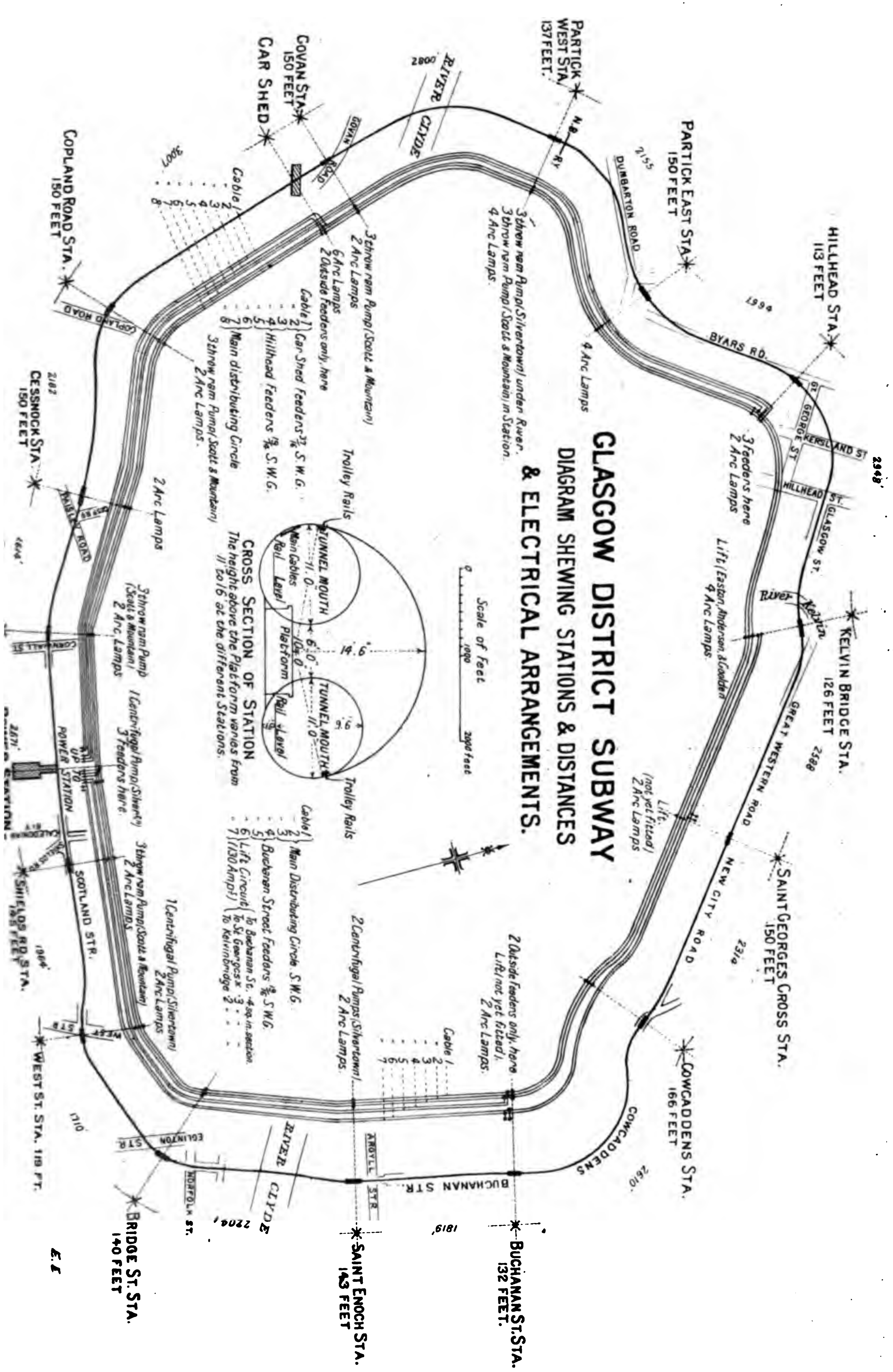
Since the conception and completion of this line, the system of traction adopted—viz., by cables—has been a fruitful source of wonder and discussion among the adherents of electrical traction, and certainly from general views this appears to be an ideal line for the adoption of electrical haulage. However, the reasons put forward by the promoters and the chief engineers of the road (Messrs. Simpson and Wilson) for adopting cable traction might be quoted. When the line was originally planned the cable system wss adopted, and although the Act of Parliament gave them powers to use any system of traction with the exception of steam, the engineers did not wane in their ideas; still, it was deemed advisable to obtain further expert evidence on the subject, and therefore in 1893 Mr. David Hume Morton, A.M.I.C.E., M.I.M.E., was appointed as consulting mechanical engineer to study the best systems of traction both at home and in the United States. To quote from a most interesting "Souvenir of the Glasgow District Subway," compiled by Mr. Morton, jun.: . . . "The result of his exhaustive investigations was that no solid body of evidence could be obtained that the difficulties would be fewer, or the financial results better, by adopting the only other system which, in the opinion of the directors and engineers, is at present available—that is, electric traction. Many considerations influenced the engineers in their decision, and the brief mention of a few of them may not prove to be entirely without interest. Whenever electricity is used, traction is by adhesion—that is, the trains are dependent for motion entirely on the grip of the wheels on the rails. This, on the subway, would entail the cars or motors being made sufficiently heavy to surmount the steep gradients under the river, and, therefore, unnecessarily heavy for traction on the rest of the road. It being well-nigh impossible to get sufficiently powerful motors underneath the cars in the small available space, electric locomotives would be the only other alternative, and these would have to weigh at least 15 tons. Heavy rolling-stock would require heavy permanent way, which, under traction by adhesion, would require more frequent renewal than would be necessary under traction by cable; and the renewal of 13 miles of track is a matter not to be lightly contemplated. On the other hand, the cable system has several advantages peculiar to itself. All the cars on any one cable are thereby linked to each other, so that the cars going downhill at one point assist in pulling the cars which, at the same time, may be going uphill at another part of the line, thus very greatly reducing the demands on the hauling engine. The greater number of cars the more perfect this compensation becomes, and to run more cars on a cable line does not entail by any means as great an additional expenditure of engine power or of capital as would the same increase of service of an electric line; and it is comforting to the shareholders to know that experience everywhere proves that on cable road with traffic such as the promoters of the subway were perfectly justified in expecting, the working expenses are lower than for an electric road under similar conditions."

The above reasons being those that induced the engineers to adopt cable in preference to electric traction, are naturally distinctly favourable to the former system. However, we think that advocates of the electric system would be able to put forward some very strong counter arguments, which would put a different complexion on the matter, although at the same time we are sure that Mr. Morton must have most carefully considered both sides of the question. We speak with a certain degree of confidence upon this point, as we know that when Mr. Morton was first appointed he entered into the investigation with a perfectly unbiassed mind, and was quite as ready to be convinced of the merits of electric traction as he was of cable traction. It is clear, therefore, that either some very strong arguments must have been put forward on behalf of cables, or else the advocates of electricity failed to come forward with any degree of confidence and to bring sufficiently practical arguments in its favour before the engineers; and we are strongly inclined to think that the final decision to adopt cable was largely due to this latter cause. It is more especially a pity that electricity failed to get this contract, on account of the manner in which the work was gone about. In the first instance, contractors were not told, "There is the line, quote for equipping it" but were asked to go into the matter, and lay before the engineer their ideas and proposals, and discuss the same with him. This the electrical contractors seemed very loth to do, while, on the other hand, the cable people came forward with all particulars and figures, and entered most fully into the matter. This enabled the engineer to lay before the directors a very complete scheme for cable traction, whereas practically all he could say with regard to electrical traction was that certain firms offered to carry out the contract in a satisfactory manner if placed with them. Had the electrical contractors come forward in a similar manner, we have a strong feeling that their information and experience, combined with Mr. Morton's sound mechanical ideas, and also with the large amount of experience he gained in America on traction plants of all kinds would have enabled him to draw up a specification for electrical traction that would have convinced, not only himself, but also the directors.

However, we have said enough about the portion of the undertaking where electricity failed to carry the day. To come, therefore, to the lighting, both of the cars and the stations, and also of the various other power requirements such as lifts, pumps, etc.

To look at these requirements from the director's point of view. First of all, as regards the car lighting, besides electricity, there was only one alternative—viz., Pintsch

id the objection to this was the necessity of laying pecial plant, besides the smell which is very pungent :harging points, and the heat that would be produced lay down a small plant here at any rate. As regards the 15 stations and the car-shed, it was quite possible to have lighted these with gas obtained from the Corporation, and



he cars themselves from this mode of lighting. Then the lighting of the power station itself, it was quite ... that the only proper way to do this was by ...ity, so from the beginning it was quite settled to we believe that they even went so far as to fit one of the stations experimentally with Wenham or some similar gaslight, but the directors thought that they would rather have the production of all their requirements in their

own hands. Then as to the lifts and pumps, the former happened to be at stations where the Corporation hydraulic supply was not available, so that as, besides electricity, this was considered the only satisfactory method for working them, it would have meant either running hydraulic pipes round 3½ miles of tunnel or else putting down special plant at a site adjacent to the station where the power was needed, but, seeing the cost of ground and other considerations, this was almost out of the question. Then as to the pumps, compressed air was considered, but, seeing its many disadvantages by the side of electricity, it was discarded. It is therefore seen that individually each section of the work under consideration appeared to point to the adoption of electricity, but when the whole of the requirements were considered together the balance in favour of electricity was so great that the directors quite decided to adopt this right throughout for all the auxiliary requirements such as we have referred to.

Towards the end of 1895, therefore, Mr. Morton issued his specification, which set out clearly the requirements that had to be considered, and also gave general specifications governing the class of machinery to be tendered for, but the scheme to be adopted was left to the various contractors to propose that which they considered the best under the circumstances. The general conditions set forth were as follows:

1. Power to be provided for the lighting of 15 stations placed on a circular route, as shown, of a total distance of about 6½ miles, the power required for each station being about 2,500 watts for arc and incandescent lighting.

2. Power to be provided for lighting the power station buildings with 12 seven-ampere arc lamps—say, 50 32-c.p. and 20 16-c.p. incandescent lamps, including the offices and 100 yards of tunnel at the cross-over, say 11,500 watts.

3. Power to be provided for lighting the car-shed at Govan with arcs and incandescents, say a total of 8,000 watts.

4. Power to be provided for working pumps at the following stations and of the sizes stated:

	Gallons per minute.	Total head in feet, including pipe friction.
St. Enoch's	220	25
St. Enoch's	5	8
Under the river	10	60
West-street	30	20
Power station	5	6
Shields-road	5	10
Kinning Park	20	25
Kinning Park	7	6
Copeland-road	30	30
Govan	220	25
Under the river	10	70
Partick West	25	30

say a total of about 14,000 watts.

5. Power for three electric lifts to be provided at Kelvinbridge, St. George's Cross, and Buchanan-street Stations; the amount of power to be provided for each lift being 25 b.h.p., or, say, 63,000 watts.

6. Arrangements to be made for effectively lighting 30 cars, providing, say, 12,000 watts.

7. An excess of power to be provided for in the mains amounting to 25 per cent. of the present maximum, to allow for the possible supply of current to tenants of buildings belonging to the company on the line of route.

8. A stipulation was made that whatever scheme was proposed it must be so arranged that one unit always acted as a stand-by; and it was further suggested that it would be preferable to have all the units of the same size.

It will therefore be seen that plant was required for the distribution of 146,000 watts + 25 per cent. extra for lighting, both arc and incandescent, and power work, over a distance of 6½ miles.

It is clear that the carrying out of this work could be done in various manners, all of which had its own merits and demerits. The low-tension direct-current system promised to cause the sinking of an excessive sum in copper conductors; the medium-tension direct-current system without transformers meant a greater difficulty with the insulation of the various fittings and fixtures although the initial outlay with the copper woul reasonable; an alternating-current system with tra required only a minimum outlay on copper for and also a simplified distribution, but, on the oth want of confidence was felt as to the working o and pumps on alternating current, not to menti lamps, which are generally supposed to give gre faction on a direct-current circuit. The other m could have been adopted was a high-tension dire system with motor-transformers, commonly know "Oxford" system," which, while having all the a of minimum outlay on mains, simplified di perfectly effective working of lifts, pumps, lamps, had the disadvantage of having moving in the motor-transformer at each station.

As was only to be expected, there were some offers sent in for this work, but it was easy wor engineers to cut them down to half the number f consideration. The next step was to consider t of the offers for each scheme, and in this way th were reduced to three—one for direct-current pressure without transformers, one for alternati with transformers, and one for high-tension dire with motor-transformers. After due considerati to the uncertainty in the one case of the mot satisfaction, and in the other case the objection machinery at each station, it was decided to medium-pressure direct-current system, and to a tender of the Indiarubber, Guttapercha, and Works Company, of Silvertown, Essex, who mitted the approved offer for the system sel adoption.

The system specified for in the accepted tender for a three-wire distribution, with 220 volts ac side, or 440 across the outside wires; three main be carried right round the circle, with four sets running to four points to keep the voltage cons this everything was to be taken with the except lifts, for which a separate pair of leads were arra

As regards the car lighting, this, although at f appears a matter for very simple achievement, ca trouble perhaps than all the rest of the installatio were obviously two ways in which this could be viz., by means of some kind of picking-up arrange a live rail, or by means of accumulators. The latt seemed to save a large amount of outlay in erectin of double conducting rail, but when it came t into, the weight of cells required was prohibitive, doubling the weight of the car, and when it is c that that additional weight on each car had t stantly hauled round, it is seen that it would ha a serious increase in the running charges. Thi altogether from the question of the life of the subjected to the more or less rough handling that bound to get. It was therefore decided to adopt system.

We now come to the description of the installa is at present fitted, and for this purpose we will in the following sub-sections and describe each viz., (1) the generating plant, consisting of stea and dynamos; (2) the main switchboard and inst (3) the cables and distributing network; (4) th lighting of stations, power-house, and car-shed train-lighting and trolley arrangement; (6) the p lifts; (7) the signalling arrangements and telepho

NOTES ON ACCUMULATOR CONSTRUC

BY DESMOND G. FITZ-GERALD.

LXI.

Before we can utilise the data now available the rationale of the action producing the effects in reversible lead couples, we must be able to a following question: What proportion of the originally present in the so-called positive plate posed during the useful discharge—viz., that dur

.F. falls from 2 to 1·85 volts, and after which there id fall to ·5 volt.

y experiments with plates of compact conductive le of lead (lithanode), contact with which was hed by means of a small surface of platinum, the tion of peroxide utilised was less than 25 per cent.* lower rate of discharge, however, somewhat more 5 per cent. could be utilised. Taking 25 per cent. mean, and supposing the proportion of sulphuric be sufficient only to convert the spongy lead into te, and that, moreover, none of this acid is absorbed luced peroxide, then the electro-chemical equation be:

$$b + H_2SO_4 + 4PbO_2 = PbSO_4 + 3PbO_2,PbO + H_2O,$$

e residual active material on the peroxide plate be two molecules of peroxide of lead and one of (red lead). But, with this proportion of acid, the . obtained is considerably below the normal two When two (or more) equivalents of acid are used, rmal E.M.F. is obtained, and the equation becomes:

$$2H_2SO_4 + 4PbO_2 = PbSO_4 + 3PbO_2 + PbSO_4 + 2H_2O;$$

idual active material ($3PbO_2,PbSO_4$) being probably ound analogous to $3Pb_2,PbO$.

hese experiments—the metallic surface of contact he active material being very limited (by reason of t of platinum)—a small portion only of the plate bject to the normal conditions of discharge; the loss ygen in this portion being approximately twice as s in the remaining portions. But when the contact tended over the whole of one of the surfaces of the its apparent capacity was found to be approximately d, even when the rate of discharge was increased rtionately to the increased metallic surface of contact. the rate of discharge was increased beyond a certain the resulting fall of E.M.F., whilst diminishing the gy efficiency," produced only an apparent diminution capacity, or the quantity efficiency. That is to say, final P.D. was diminished proportionately to the fall M.F., the capacity was approximately constant.

all cases when the extent of metallic surface—whether latinum or lead—in contact with the peroxide is ient, it is possible to utilise 50 per cent. of the ide in the useful discharge. Thus the equation ally applicable to lead storage batteries is:

$$+2H_2SO_4 + 2PbO_2 = PbSO_4 + PbO_2PbSO_4 + 2H_2O \ (\Phi).$$

he residual peroxide compound PbO_2PbSO_4 is, it will een, analogous to the compound Pb_2O_3 (red lead); molecule SO_4 being substituted for one atom of oxygen.

LXII.

t us now, being equipped with a mechanical analogy sufficient electro-dynamic and thermo-dynamic data, ider the case of a couple in which monad gramme ivalents are brought into play. Referring to LIX., equivalent of Pb is 103·2 grammes; and this, retically, is the weight of spongy lead in the so-called itive element, although, practically, the weight might about four times as much (III.). The weight of SO_4 is 98 grammes, to which may be added grammes of water to reduce the specific gravity 1·182. And the weight of peroxide will be 236·4 mes. With these weights, as we see by the table, shall obtain 96,600 coulombs, or 26·833 ampere-hours. erimentally, by testing against a Clark cell, we find the E.M.F., after the couple has been circuited for a ute or two through 10 times its own resistance, becomes ly at two volts; and we intend to discharge the couple til the E.M.F. falls to 1·85 volts. The mean E.M.F. will quite 1·93 volts, and the calorific equivalent of our ampere-hours × 1·93 volts = 51·7 watt-hours will be 7 × 857 = 44·3 kilocalories (LII.).

LXIII.

t now, guided by our mechanical analogy, we have to ether this last value, which is without doubt nearly e, is in accord with the calorific equivalents which have been built up, with an immense amount of patient labour, by Dulong, Andrews, Favre and Silbermann, Berthelot, Tscheltzow, Thomsen, Naumann, Pattison Muir, and Muir Wilson. The data furnished by these authorities have been tortured in every imaginable manner to make them give the equivalent of two volts or more for a reversible lead battery supposed to be run down, according to the equation $Pb + 2H_2SO_4 + PbO_2 = 2PbSO_4 + 2H_2O$, until the initial E.M.F. of about 2·2 volts falls to zero, or according to other equations, possible and impossible. This the data in question have steadily refused to do, and for a very good reason—viz., that the only equivalent they could correctly furnish would be that of a voltage neither the maximum 2·2, nor the minimum 0, but somewhere intermediate between these. Even in the case we have taken, that of the useful discharge corresponding to the equation Φ given above—in which the E.M.F. falls from 2 to 1·85 volts—we may clearly see that if our calorific equivalents give the maximum, or the minimum, or anything other than the true mean voltage, *something* must be wrong, either the calorific values or other data, or our reasoning. And although we must not expect all these to be rigidly accurate, the reader may reasonably expect, after all the trouble he has taken, to be landed somewhere near the truth.

* Journal of the Society of Telegraph Engineers and Electricians, ., No. 66, p. 180.

Applying to the equation (Φ) some of the data given in the table under section LX., and bearing in mind the analogy given under section LVI., we see in the first place that there is *accessus* between Pb and SO_4. The kilocalories generated by this "falling together" are 56·5, for which kinetic energy we are debtor to the potential energy intrinsic to the metal. But this SO_4 was combined with H_2; there is *decessus* between H_2SO_4, or H_2 has been pulled apart from SO_4. Is then this H_2 the electro-positive for which we have exchanged Pb? If so, we must credit $H_2 \mid SO_4,Aq. = 53·7$ kilocalories to potential energy stored up in H_2—leaving a very small balance in favour of kinetic energy evidenced as E.M.F. But the question must be answered in the negative; for the H_2 is never free, but passes from SO_4 to O, obtained from PbO_2. Although there is *decessus* between $H_2 \mid SO_4,Aq.$ there is *accessus* between $H_2 \mid O$; and clearly, therefore, the credit of 53·7 kilocalories to potential energy must be diminished by $H_2 \mid O = 34·2$ kilocalories (to which should, perhaps, be added the gaseous heat of oxygen, which I do not know). But there is another point: the compound PbO_2, which H_2 decomposes into $PbO \mid O$, is endothermic, and liberates energy in decomposing. Consequently, not only 34·2 kilocalories, but also − 6 kilocalories have to be subtracted from 53·7 calories.

But how about the second equivalent of $PbSO_4$ in formula (Φ)? Well, a little consideration of our mechanical analogy will show that it does not come into our thermo-dynamic equation at all. We have only (LVI.) to take "the difference between the calorific equivalents of the electro-positive bodies, of which one replaces the other in combination within the voltaic cell." This difference was, *prima facie*, $Pb \mid SO_4,Aq. - H_2 \mid SO_4Aq.$ But H_2 is not the electro-positive replaced by Pb in combination, since it combines with O derived from $2PbO_2$, and consequently H_2 cannot be the body corresponding to *m* in the diagram (LVI.), in which potential energy is stored. This body which we are seeking will be found in the electro-positive component which H_2, in its turn, replaces in combination. Now $H_2 + 2PbO_2$ becomes $H_2O + Pb_2O_3$, and *red lead* is the body which is ultimately replaced in combination by Pb. (A very poor electro-positive, hardly, indeed, worthy of the title, but this is precisely the secret of the high E.M.F. of the lead couple.) Now we require to know what is the potential energy stored up in Pb_2O_3 when this is liberated from combination with O. The answer is: less than none, since energy is evolved, instead of being stored, when PbO_2 is decomposed into $PbO + O$, and also, *a fortiori*, when $2PbO_2$ is decomposed into $Pb_2O_3 + O$. The fact that $Pb_2O_3 + H_2SO_4$ becomes—more or less rapidly, according to circumstances—$PbO_2 + PbSO_4 + H_2O$, has nothing to do with our thermo-dynamic equation, excepting insomuch as the presence of H_2SO_4, its readiness to combine with PbO, facilitates the evolution of the additional atom of O, or, in other words, augments the endo-

thermic character of PbO_2. But this has already been allowed for, though perhaps insufficiently, by the subtraction of -6 in our calorific equation. The formation of the second molecule of $PbSO_4$ is a secondary reaction; though it is subsidiary or adjuvant, provided it occurs *simultaneously* with the liberation of O from PbO_2.

Summing up, our thermo-dynamic equation is

$$H = Pb \mid SO_4Aq. - (H_2 \mid SO_4Aq. - H_2 \mid O - PbO \mid O). \ (\Omega);$$

or, giving the numerical values,

$$H = 56{\cdot}5 - (53{\cdot}7 - 34{\cdot}2 - 6) = 43 \text{kilocalories (instead of } 44{\cdot}3).$$

$$\text{Whence E} = \frac{43}{23} = 1{\cdot}87 \text{ volts (instead of } 1{\cdot}93 \text{ volts)}.$$

LXIV.

The value of E thus calculated from the calorific equivalents involved in the electro-chemical equation is undoubtedly too low. But it is satisfactory to be able to add that we can see a reason *why* it should come out too low. In equation (Ω) the expression $H_2 \mid O$ should represent the heat evolved in the combination of an equivalent of *fluid* hydrogen with an equivalent of *solid* oxygen. But we do not know—or, at least, I do not know—the amount of heat produced by this combination: I know only the calorific equivalent of *gaseous* hydrogen combining with *gaseous* oxygen (34·2 calories), which may be considerably less than the required value, since a portion of the energy of chemical affinity is expended in condensing the gases. Still, in this case it may reasonably be maintained that the energy expended in condensation, as well as the remaining energy of affinity, would be converted into heat. But there is another reason. The combining heat of $PbO \mid O$ is given by a high authority (Thomsen) as -6. But when PbO_2 is mixed with H_2SO_4 the endothermic character of the former compound, its tendency to decompose, and the quantity of energy evolved in its decomposition would probably be greater than in the case of the isolated peroxide. And, moreover, the decomposition of $2PbO_2$ into $Pb_2O_3 \mid O$ occurs more readily, as we know, than that of PbO_2 into $PbO \mid O$. So that the value -6, representing the heat of constitution of the last-mentioned compound, would, in the case under consideration, become $-(6+x)$. And the greater, within practical limits, the degree of concentration of the acid, the greater would be the value of x.

If we assume—which we have no right to do without further verified data—that $x = 1{\cdot}3$, then the E.M.F. will be

$$E = \frac{44{\cdot}3}{23} = 1{\cdot}93 \text{ volts exactly.}$$

LXV.

It must not be supposed that the formula (Φ) is in antagonism with that put forward by Messrs. Gladstone and Tribe in 1882, at a period when very few people had any definite notions as to the reactions which occur in the lead reversible couple. If the latter be taken as a theoretical formula, indicating the nature of these reactions, without any intention of defining the extent to which they would occur under given conditions of practice, and if the former be taken as a formula indicating the extent to which they take place during the period of useful discharge, it will be seen that they are in harmony. Messrs. Gladstone and Tribe stated that "the chemical action of the discharge is essentially what is expressed by the following theoretical formula:

$$PbO_2 \mid H_2SO_4 \mid H_2SO_4 \mid Pb = PbO \mid H_2O \mid H_2SO_4 \mid PbSO_4$$

which oxide of lead in the presence of sulphuric acid becomes sulphate of lead according to the equation:

$$PbO + H_2SO_4 = PbSO_4 + H_2O,$$

the final result being sulphate of lead on both plates."*
Thus, combining the two equations, their view is expressed by the formula:

$$Pb + 2H_2SO_4 + PbO_2 = 2PbSO_4 + 2H_2O.$$

The difference between this and formula (Φ) is that the latter is applicable to the ordinary conditions of practice. It may, indeed, be used to express quantitatively the exact conditions of practice in any given case; and its value for this purpose will become evident when we have considered the laws which determine the weight of dilute s
acid, of any given initial specific gravity falling
given final specific gravity, to be allowed for in the
tion of accumulators of which the effective capa
required rate of discharge, is known.

Let us take, for instance, an accumulator in w
weight of spongy lead is to be twice that requ
theory, that of peroxide being in accordance
practical formula, whilst the initial and the final
gravities of the acid are to be respectively 1·182 an
Let the atomic symbols represent monad gramm
lents, corresponding *practically* to the monad
equivalent of electricity, or 26·8 ampere-hours
our equation (Φ) modified to express the cond
practice in the given case, becomes:

$$2Pb + 4{\cdot}25\,H_2SO_4 + 69{\cdot}4\,H_2O + 2PbO_2$$
$$= Pb + PbSO_4 + 2{\cdot}25\,H_2SO_4 + 71{\cdot}3\,H_2O + PbO_2P$$

* "The Chemistry of the Secondary Batteries of Planté and Faure," p. 32.

INSTITUTION OF ELECTRICAL ENGINEERS,

The first meeting of the year was held at the Ins
of Civil Engineers, Great George-street, on the 13
After the usual formal business, the secretary an
the various donations to the library. Mr. Latimer
F.R.S., then presented to the Institution six
belonging to the late Mr. Jacob Brett. In a short
of the contents of these most interesting volum
Latimer Clark stated that they contained the co
proofs of the fact that submarine telegraphy was an
invention. This collection of papers made by M
Brett and his brother, giving full details of th
failures and successes in submarine cable laying, i
valuable addition to the library of the Institutio
regret that the remarks made by Mr. Latimer Cla
interrupted by a certain section of those presen
rebuked by Mr. Alexander Siemens for their
courtesy.

The formal business then being finished, Sir
MANCE, after a few well-chosen remarks, vaca
presidential chair.

Prof. W. E. AYRTON proposed a vote of thanks
retiring president, remarking that of all the well
Mance's methods, the method in which Sir Henry
had fulfil his duties as president was the best.

The vote of thanks was carried unanimously, a
Mr. J. W. Swan read the following address:

INAUGURAL ADDRESS.

BY J. W. SWAN, F.R.S., PRESIDENT.

Sixteen years ago I had the honour of bringing u
notice of the Society of Telegraph Engineers the ques
new mode of electric illumination by means of inca
lamps. Mr. Preece was in the chair. I am sorry h
with us to-night, and especially for the cause of his
may he soon return with renewed health! There wa
outside this building, at the back, a portable engin
farmyard type, and a Gramme dynamo, built—as
dynamos of that time were—for lighting one or two ar
This apparatus was managed by Mr. Radcliff Ward,
the not easy task, marvellously well accomplished, of run
dynamo at the exact speed required for the lighting
number of incandescent lamps attached to a kind o
that has since become generally known as an "elec
This, the first installation of incandescent lamps in
was carried out by Mr. Fleetwood. When the gas was
and the current was turned on, there was an audible
sion of surprise as the lamps lighted up; and when,
breathing space, it was realised that the room was for
time entirely lighted by incandescent lamps, the mani
of satisfaction was, I remember, very strongly pron
That occasion marked, in an emphatic manner, the be
or almost the beginning, of a movement that has gone
increasing activity, until now it may be truly said that
revolution in the means of producing artificial light for
use has been accomplished, a new and profitable indus
been created, and, incidentally, an impulse and ind
given to the larger and more general utilisation of ele
We are confronted at almost every turn with evide
beneficial change flowing, in some measure, from this
Such change, for example, as that from the de
darkness of the streets of London at night in t

light time, to the almost daylight brilliance of many now—a change, I admit, not wholly effected without of the arc light, nor even of the gas lamp; but that lamp shines with an unwonted brightness, and that lamps are there at all, are facts not distantly con- rith the very general use of these unobtrusive little iich were thought so wonderful at the time to which I ng back, and are such universally familiar objects now. years is not a long time in the history of industrial ı, and yet what changes have occurred in the last 16 The entire space is crowded with electrical invention ctrical work, not confined to electric lighting, but g over the wide and varied fields of electrical power sion, electric traction, and electro-chemistry. The ıl introduction of electric lighting, and the great inci- nprovements made in the machinery for transforming energy into electric energy, gave the impulse required ce the immense activity that we witness to-day. main of electrical engineering has broadened. When this on was founded, telegraph engineering was its principal later, there grew up the new branches of electric light- tric traction, and the electrical transmission of power. ave so flourished that, if they have not overshadowed r branch, they have at least sheltered and supported it; re is another branch vigorously growing and giving of immense enlargement—that of electro-chemistry. ngs me to a subject of great interest to the electrical , and especially to the young electrical engineer—"the all before him, where to choose"; and, in my belief, ate proportion of those who are aspiring to make their electrical engineers would choose wisely in making a cial study of that portion of the field within which lies fication of electricity to chemical manufactures. The wide one, and so far only a small corner of it has been ed, but that portion is already yielding rich harvests. re now three or four flourishing electro-chemical indus- capital importance—the electrolytic refining of copper, rolytic extraction of aluminium, the electrolytic recovery and the electrolytic production of chlorine and of soda. these, there are other successful chemical manufactures at on an electrical basis. Their importance is great even d is increasing. They afford opportunities for the advan- exercise of special knowledge and skill on the part of trical engineer, who may be called upon to design suit- paratus for carrying out known processes, or to invent improved means of effecting some unattained but e end. Considering the importance of this branch of al engineering, it seems to me—and I hope you may same view—that the time custom places at my disposal t will not be ill spent in a general review of the rise and s of electro-chemical industries.

Early Work in Electro-Chemistry.

years hence there should be celebrated, in the city of the centenary of Volta's great discovery, to which we origin of electro-chemistry. Electrical phenomena had ligently studied long before his time. But, if we except ion of the electric spark utilised by Cavendish to induce mbination of gases having an affinity for each other, arked electro-chemical effect had been observed up to time. There was, in fact, no knowledge of phenomena the sustained operation of an electric current, as dis- from those due to intermittent discharges. Closely follow- on the announcement of the discovery of the voltaic analytical power was made known through the electro- of water by Carlisle and Nicholson. But it was Davy who fully realised and demonstrated the transcendent power voltaic current to effect chemical decomposition. Davy for ever memorable the year 1806 by the electrolytic tion of potassium from potash. Distinctly prophetic as were of other far-reaching kindred discoveries, I suppose not even the imaginative mind of Davy ever entertained that out of this embryo would grow any of these great facturing processes that are to-day shaking the foundations of the oldest and most important of our chemical tries. The method used by Davy in his historic experi- has so close a bearing on my subject, and is so intensely ing in itself, that I think you will not grudge the moment take to read an account of it in Davy's own words. He "A small piece of pure potash which had been exposed seconds to the atmosphere, so as to give conducting the surface, was placed upon an insulated disc of , connected with the negative side of the battery of of 250 of 6 by 4, in a state of intense activity; and wire communicating with the positive side was brought contact with the upper surface of the alkali." . . . these circumstances a vivid action was soon observed place. The potash began to fuse at both its points of tion; there was a violent effervescence at the upper ; at the lower, or negative, surface there was no libera- elastic fluid; but small globules having a high metallic and being precisely similar in visible character to quick-silver, appeared, some of which burnt with explosion and bright flame, as soon as they were formed, and others remained, and were merely tarnished, and finally covered by a white film which formed on their surfaces."

Davy, fortunate in almost everything, was supremely fortunate in his assistant, Faraday. Never, surely, in the history of experimental science did the mantle of genius fall on worthier shoulders than when Faraday became the successor of Davy, and the inheritor of his methods and of his work. Great, immensely great, as is the debt owed by electrolytic chemistry to Davy, the debt is doubly great to Faraday. To Faraday we owe the discovery of the law of electrolytic conduction, without which knowledge industrial progress in the field of electro-chemistry would have been impossible; and, above all, it is to Faraday that we owe the first principles of the dynamo—principles applied to practical electrolytic work much earlier than is commonly supposed. Even as early as 1842 there were at work in Birmingham, for the electrolytic deposition of silver and gold, power-driven electric current generators, based on the dynamo-magneto-electric principle discovered by Faraday. One of these machines I saw not long ago, still doing duty at Messrs. Elkington's factory. These ancient machines were not called dynamos; the term "dynamo" had not issued from that mint which, by the coinage of a word, seems to create the thing signified. But these so-called magneto-electric machines were, to all intents and purposes, dynamos; they transformed mechanical power into electrical power through the medium of magnetism, and the dynamo of to-day is their direct descendant.

During the 30 years following Faraday's discovery of magneto-electric currents, and its primitive application to electro-plating, I cannot recall in this connection any of those striking events which make a moment memorable, but the tools were being fashioned wherewith the way was to be cleared and the work of progress carried on. Towards the end of that quiescent period Wilde was building powerful machines for the electro-deposition of copper, and those great incentives to electrical engineering enterprise and progress, the telegraph and electric lighting, were already beginning to quicken the pace along the collateral lines of scientific and industrial advancement. To speak only of electric lighting, it should be noted that in the fifties Holmes and De Meritens had designed efficient, if costly, magneto-electric apparatus for lighthouse illumination.

The principle of magnetic self-excitation in an electro-magnetic generator was made known in 1867, and four years later the first really practical continuous-current machine was constructed by Gramme. The two succeeding decades saw the evolution of the modern dynamo, and at the end of this period the critical point was reached when there was demonstrated, with sufficient clearness to captivate the commercial mind, the fact that for lighting, for transmission of power, and for effecting several important chemical operations, electricity, as produced through the dynamo by the steam-engine or by water power, was a thing of utility, and could be turned in all these ways to commercial advantage. These great uses of electricity been for several years established on the secure basis of commercial success. This result has been reached through the co-operation of many minds, and especially by the union of the skill of the mechanical engineer with the specialised knowledge of the electrician and the chemist. Out of this combination and concurrence of forces electrical engineering has grown, and, by making new demands, has reacted beneficially on purely mechanical engineering. The requirements of electric lighting have largely contributed to those great improvements and economies in electric power producing machinery, and in the steam-engine itself, which have materially assisted in bringing about the degree of success which has now been reached in electro-chemical industries.

Copper Refining.

At the outset, 60 years ago, the only electrolytic industry then in existence was comprised in that small and closely related group, electro-plating, electro-gilding, and electrotyping. Since then, and comparatively in recent years, the principle of electrotyping has been applied to copper refining. This has developed to such an extent that now one-third of all the refined copper required in the world is produced electrolytically. In 1896 the production was 137,000 tons. The product of one works alone—the Anaconda Works—was over 30,000 tons. One great advantage of electrolytic copper refining over the old method is the saving of the gold and silver from the unrefined copper. But there is a further advantage, and one that electrical engineers especially appreciate—viz., the higher conductivity of electrolytic copper. The first Atlantic cable was made with copper that had a conductivity only 40 per cent. of that of pure copper. At that time it was difficult to buy copper free from arsenic. So completely has the electrolytic method of refining copper altered the old state of things that lately, when I wanted a small quantity of arsenical sheet copper, I had much trouble in procuring it.

The process of electrolytic copper refining is as you know,

simply electrotyping on a grand scale. An impure copper anode is dissolved, and pure copper is deposited upon a cathode in an electrolytic bath of acid sulphate of copper solution. The amount of power expended in copper refining relatively to the product is small. In this respect it is greatly different from that other electro-chemical industry—perhaps next in importance to copper refining—the extraction of aluminium. In electrolytic copper refining almost the whole of the electric energy is expended in overcoming ohmic resistance, therefore the power required for a given output may be reduced to a small amount by increase of the size of the apparatus. Hence, the location of copper-refining works is not greatly influenced by the consideration of the cost of power; other considerations generally prevail in the choice of locality. The range of current density within which reguline copper can be deposited is extremely wide. The size of the apparatus—regulated by a law analogous to Kelvin's law of balance, of the cost of capital against the cost of power—is for a given output usually large. It is found most economical to use a low current density; the greater purity of the copper deposited under those conditions is an additional consideration determining that practice. In electrotyping, where power is a less important consideration than time, current density is usually much higher. In this connection I may mention experiments I made to ascertain how far it is possible to go in the direction of increase of current density without detriment to the physical properties of the metal deposited. I found that under proper conditions it was possible to obtain tough copper with a current density ranging from 1 ampere to 1,000 amperes per square foot of cathode surface. The conditions necessary to be observed were, to adapt the strength of the solution to the strength of the current, using, of course, the strongest solution with the largest current; and, when the current density was high, to take suitable means to obtain extremely rapid circulation of the electrolyte. I found that regularity and smoothness of deposit was almost entirely dependent on the absence of solid particles held in suspension in the electrolyte, and that excrescences could be entirely avoided by taking care that the electrolyte was free from solid floating particulars. I found also that an exceedingly rapid flow of the electrolyte over the cathode surface tended to the suppression of a crystalline condition of the deposit. This effect was most strikingly shown when the electrolyte was projected against the cathode surface with considerable force from a submerged jet. In the *Philosophical Magazine*, 1881, vol. xii., p. 300, Tribe published an exceedingly interesting series of observations on the distribution of the lines of conduction in a liquid undergoing electrolysis; these showed me the causes of the wasteful growths round the edges of electrotypes. By applying remedies suggested by Tribe's results, I was able almost wholly to prevent this waste, to obtain nearly complete uniformity in the thickness of deposits, and entirely to prevent excrescent marginal growths. The general principle followed was the restriction of the sectional area of the electrolytic bath to, as nearly as possible, that of the plate intersecting it, so as to prevent curvature of the lines of flow.

In considering this branch of the subject, the question occurs whether it is economically possible to take advantage of the greater purity and higher conductivity of electrolytic copper that has not undergone fusion after electro-deposition. The common practice is to fuse electrolytic copper and cast it into ingots, and then proceed to roll and draw the ingots into the various sizes of bars and wire required in electrical work. This treatment results in a slight loss of conductivity. Some years ago I worked out a process in which a copper wire stretched in an electrolytic bath was, whilst receiving a deposit of copper, continually subjected to the action of wire drawplates. This resulted in unlimited extension of the wire without increase of its thickness: all the deposit went to increase the length, and this might go on to an indefinite extent. The original wire formed a core, which, as the process proceeded, dwindled towards nothing. There are on the table some pieces of wire made in this way, in the different stages of its growth. I ascertained the possibility of producing wire in this manner; but even with a rapid rate of deposit, such as I was able to use, I found the apparatus would be excessively costly, relatively to the output; and, being allowed, by the kindness of Messrs. Bolton, to witness the method of wire drawing employed at their works, I was so impressed by the rapidity and simplicity of their process as to feel that, looking at the matter from a non-scientific point of view, unless there was something much more to be gained than 1 or 2 per cent. extra conductivity, the play was not worth the candle. I do not know whether, by the method proposed by Mr. Elmore of cutting a spiral from an electrolytically-deposited copper cylinder, a sufficient degree of economy of production can be obtained; but, so far, the ordinary process has not been interfered with by direct electrolytic methods of producing wire. Nevertheless, the greater purity and slightly higher conductivity of electrolytic copper that has not been subjected to the fusion treatment common in commercial practice, give to those attempts to produce wire from electrolytic copper that has not undergone fusion at least a scientific interest and value.

Before I leave this subject of copper deposition I m
your attention to this mirror—one of the latest r
industrially applied electrotyping. It is made by dep
thick backing of copper on a silvered glass matrix,
separation, coating the surface with palladium. This
mirror is intended as a substitute for the glass mirrors
used in light projection. It has the great advantage ov
mirror that a shot would not destroy, though it might d
The process has been worked out and patented by Mr.
Coles.

Similar methods to those used in copper refining
being followed in electro-zincing. The words "galvanis
"galvanised" are much abused in their application to t
material, galvanised iron. The coating of iron with
ordinary process of galvanising is, as we all know, no
by electrolytic action, but there are, in practical operat
galvanising processes, by which a hard and very
coating of zinc may be obtained without impairing the
of the iron. The process is largely in use for galvanisi
tubes. In one of several works where it is in opera
500 tons of tubes were galvanised in this way last
characteristic feature of electrolytic copper refining i
anode is formed of the same kind of metal as that d
and dissolves to keep up the supply of metal in the el
There is an equal and opposite action going on at th
and anode. But there is another class of electrolyt
tions of perhaps even greater interest to the electrical
and certainly of great economic importance—nam
class in which the ore, and not the already reduce
furnishes the metallic supply to the electrolyte. T
a very large subject, since there is included i
only the extraction of copper, nickel, zinc, gold, al
and sodium, but also the great question of the
lytic production of caustic soda and chlorine, a
substances hitherto produced by purely chemical o
There have been many attempts to utilise the fact th
matt or sulphide can be cast in the form of plates or
that such plates have a sufficient degree of conductivit
of their being used as anodes in an electrolytic bath
attempts have not always been successful, but th
interesting exception in the case of the copper-nick
worked by the Canadian Copper Company, who refin
and nickel electrolytically, and use the matte as anod
mattes contain about 40 per cent. each of copper and n
14 per cent. of sulphur, together with small quantities
gold, and platinum. The power used in the productio
of nickel is nearly one electrical horse-power hour.

Gold Extraction.

Before the introduction of the cyanide process for
ment of gold ore, various electrolytic methods, chiefly b
the solvent action of electrolytic chlorine, had been pro
worked; but the purely chemical cyanide process has
not wholly superseded these electrolytic methods for th
treatment of gold ore. Messrs. Siemens and Halske,
have patented and successfully introduced a method fo
the cyanide liquors from the tailings, or waste sludges,
in cyanide gold extraction, and containing a very small
gold. An extremely dilute solution of cyanide is em
dissolve the gold. This is afterwards subjected to el
with iron anodes and thin lead cathodes, with a curren
of one or two tenths of an ampere per square fo
results in an almost complete recovery of the gold in an
form upon the lead cathode. When the required a
gold has been deposited, the cathodes are removed
gold separated by cupellation. This process appe
exactly suited to the clean quartzite ore of the T
Over 1,000,000 tons a year of tailings, such as were
discarded as useless, are now profitably treated by thi

Zinc Extraction.

The extraction of zinc from its ores by electrol
problem on the solution of which much ingenuity and
able amount of money have been expended. It is a
problem, inasmuch as the method in common use of red
native sulphide or the carbonate of zinc to the state of
calcination, mixing this with non-bituminous coal, and
in clay retorts at an extremely high temperature, is
barbaric in its primitiveness and its wastefulness. The
of coal consumed in the smelting of zinc is more than
the weight of the metal produced. The cost for
involved in the production of a single ton of zinc,
coal, labour, pottery, and stores, is generally not less
and, as about 16 per cent. of the metal contained in
unextracted, the loss of this at the present value of
makes an addition of 56s. to the cost of production, a
of about £7. 16s. for smelting one ton of zinc. These fi
of course, variable with the market value of zinc ore,
the locality of the smelting works, and are based on th
value of zinc ore and the present cost of material and
England. Here would seem to be a great opportunit

duction of an improved method, and it is well worth con- ing again and again, notwithstanding past failures—and have been many—whether this is not a case in which lioration may be obtained by electrolytic methods.

step has been recently taken towards this object by means process (the invention of Dr. Hoepfner) at present being ted by Messrs. Brunner and Mond. In this process zinc ride is electrolysed; the products are chlorine and zinc. zinc is purer than ordinary commercial zinc, and will no t be welcomed by the users of zinc in primary batteries. pecimen ingot is lying on the table. For the electrolytic ment of that hitherto intractable class of ore such as the en Hill mine produces (the mixed sulphides of lead and , two processes deserve mention—one, the Ashcroft process, se very extensive preparations have been made for carrying t on a large scale; and the other, that of Cowper-Coles. process is in actual operation on a small scale, and we have some of the results. An interesting feature of these its (there is an example on the table) is that they have made on aluminium cathodes and stripped off, the film of preventing adhesion. These bold attempts in new ions deserve success.

ALUMINIUM EXTRACTION.

of the largest, the most important, and in many respects ost interesting of the electro-chemical industries is that of oduction of aluminium. In 1855 the price of aluminium ot far from the price of silver, when silver was twice its t value; now, bulk for bulk, it is the price of copper. It onger bought by the ounce, but by the pound or ton. The easure of change has been brought about by the employ- of electrolytic extraction. The purely chemical method had highly elaborated before the electrolytic process was ht into competition with it, but the lowest price of the cal product was three or four times the present price of etal. It is an instance of an electrolytic method displacing oughly elaborated and established chemical method, and enormous increase in demand that has followed a reduc- f price. The production at the present time is, I estimate, ss than 2,000 tons a year. At least 10,000 h.p. is absorbed s industry alone, and power to double that amount is to be applied to it. There is every probability that new rill be found for the metal, and that the manufacture will e a much larger one than it is at present. Prof. Richards, known as the author of the most complete work on nium, says, in a letter I recently received from him: end of the century sees another metal added to the list mmon metals, a metal whose ore is as plentiful as that of whose cost of production is steadily decreasing, and whose are just as steadily increasing. It is bound to stand next n in its production and in its usefulness to mankind."

hough English enterprise was prompt to adopt and improve riginal chemical process, the production of aluminium had y departed from us until the British Aluminium Company mmenced the manufacture in the electrolytic form across Border, attracted there by the advantage of cheap water r. (Mr. Swan here called attention to a carbon anode and mber of most interesting aluminium products illustrating manufacture, kindly supplied for the occasion by the British minium Company, through the managing director, Mr. ri, to whom he tenders his thanks.)

e process by which aluminium is extracted, in America, on Continent, and in Scotland to day, is in principle exactly lar to that by which Davy extracted potassium from potash ears ago. The electrolyte is kept in a state of fusion by the trically generated heat. There are nominally two processes se, but the difference is extremely small—chiefly a slight rence in the composition of the electrolyte. That known as l's process has as its distinctive feature an electrolytic bath posed of potassium fluoride in which alumina prepared from xite is continuously dissolved; while in Héroult's process solvent of the alumina consists of cryolite, the double ride of aluminium and sodium. The electrolytic furnace sists of a carbon-lined iron box connected with the negative e of a dynamo; this contains the electrolytic bath. Massive ds of carbon are connected with the other terminal of the amo, and form the positive pole. These are immersed in bath of fused material, and nearly reach the bottom. The bon used in the manufacture of the anodes and for lining furnace is required to be of great purity and hardness. e current density employed is very large—about 700 amperes square foot of cathode surface, about 8,000 amperes per l. A difference of potential of five volts is maintained ween the electrodes. In practice, 14 electrical horse-power urs are expended in the production of 1lb. of aluminium. a mean pressure of five volts is assumed, the theoretical ld should be nearly ½lb. more; there is, therefore, some ndary and wasteful action as well as true electrolytic action g on, and room for further economy.

SODIUM EXTRACTION.

he experiment by which Davy set free the few minute globules of metallic potassium in the little pool of fused potash has to-day its fruition in the electrolytic process of Castner for the extraction of sodium. In the Castner sodium process an electrolyte of fused caustic soda in employed, with an anode of iron and a cathode of copper. The sodium is reduced at a comparatively low temperature, and while in a fused state is run off into moulds. By this process there is produced in one works 260 tons of sodium a year. Sodium is also extracted electrolytically in Germany, and, I believe, in America also. The electrolytic process of sodium extraction is so much more economical than the chemical process as to have almost completely displaced it.

ELECTROLYTIC ALKALI PRODUCTION.

I now come to perhaps the most important of all the applications of electro-chemistry at present engaging the attention of chemical and electrical engineers—namely, its application to the alkali manufacture. The manufacture of alkali has undergone a revolutionary change during the last 25 years; the Le Blanc process, which produces carbonate of soda and hydrochloric acid, having been largely superseded by the ammonia-soda process of Hemming and Solvay—a process identified in this country, in its most highly developed form, with the names of Brunner and Mond. The ammonia-soda process yields no hydrochloric acid, and therefore does not lend itself as easily to the production of chlorine for the purpose of making bleaching powder as does the process of Le Blanc. Devices to meet the want of hydrochloric acid in the ammonia-soda process have been many. Most of these have been based on ordinary chemical reactions, but some have been electrolytic. I have already mentioned one of these—the chloride of zinc process of Hoepfner. But there are schemes afoot for the production of alkali and chlorine by the electrolysis of alkaline chlorides which aim at the accomplishment of another revolution in this great industry. There are now several processes in commercial operation for the production of caustic alkali and chlorine from brine. (Specimens of the products of some of these are on the table.) In the process of Holland and Richardson, brine is electrolysed in a tank divided into anode and cathode compartments by impermeable partitions reaching nearly down to the bottom of the tank. The anode compartment is enclosed, and provided with a flue for conducting the chlorine to bleaching powder chambers. Carbon anodes and iron cathodes are used. During electrolysis the caustic alkali formed at the cathode dissolves, sinks down to the bottom of the tank, and is drawn off. This alkaline solution is subsequently evaporated and fused. A somewhat similar process has been introduced by Messrs. Hargreaves and Bird for the manufacture of bleaching powder and alkaline carbonates. In the process of Hulin—in which brine is electrolysed for the production of soda and chlorine—the anode and cathode are both of carbon, but the carbon cathode is in the form of a thin porous partition. The peculiarity of the process is the percolation through the cathode partition of the stratum of the electrolyte in contact with it. This portion of the electrolyte is most strongly charged with alkali, and is forced slowly through the diaphragm by slight pressure on the surface of the bath, caused by restraining the escape of chlorine.

In the processes described, considerable loss and many disadvantages arise from imperfect separation of the products of the electrolytic action at the anode and cathode. There have been a number of inventions with a view to avoid this defect. The apparatus of Castner and Kellner is one that grapples with the difficulty in a most ingenious and effective manner, and it is especially entitled to notice because it is already in extensive commercial use. Ten thousand tons of caustic soda and over 20,000 tons of bleaching powder will be produced by it this year.

The elementary apparatus consists of a shallow rectangular slate trough, divided into three compartments by two partitions. These cross the trough from side to side, but do not quite reach the bottom, which is grooved to form a shallow gutter under each partition. The partitions dip into the gutters sufficiently deeply to ensure complete isolation of the three compartments when the gutters are filled to the level of the bottom of the trough with mercury. During operation the mercury not only fills the gutters, but extends in a thin stratum over the bottom of the trough. The trough is so mounted that a slow and extremely slight oscillatory movement is given to it. This results, when one end is tilted up, in the stratum of mercury on the bottom running out of the upper end compartment into the middle compartment. The alternate rise and fall of the ends of the trough is so small that the movement is almost imperceptible, but it is sufficient to cause the mercury in the compartment at the raised end to run into the middle compartment, and that from the middle compartment into the lower end compartment—that is to say, there is an alternate flow of mercury from end to end, which alternately leaves the raised end compartments denuded of mercury, but the floor of the middle compartment and of one of the end compartments are always covered with mercury. The grooves into which the partitions dip always contain mercury, and completely prevent the mixing of

the electrolyte in the three compartments. The two end compartments contain brine and carbon anodes, and the centre compartment an iron cathode and water. The anode compartments are covered with glass, and provided with pipes for the conveyance away of chlorine to bleaching powder chambers. During the working of the process sodium is deposited upon the mercury, with which it instantly amalgamates; the tank is then tilted until the mercury in an anode compartment runs into the cathode compartment, where the sodium is oxidised and dissolved by the water. The current generated by the oxidation and solution of the sodium helps to reduce the power required for electrolysis; for it will be seen that the sheet of mercury lying on the floor of the trough and divided by the partition is always negative in the end compartments and positive in the middle compartment relatively to the opposed electrodes. The chlorine evolved at the anodes is, so far, entirely used for the manufacture of bleaching powder. The caustic soda produced by this process is of great purity.

Closely resembling the Castner-Kellner apparatus is that lately invented by Rhodin, in which the mercury-sealed anode compartments are capable of being rotated, and the construction is such that external heating may be applied, a higher current density employed, and such temperature conditions maintained as are necessary for obtaining the best result. Electrolytic chlorine is also extensively applied to the production of chlorate of potash. The manufacture of chlorate of potash by electrolysis is performed in a tank divided by a porous partition, with very thin iridio-platinum anodes and iron cathodes. The electrolyte in the anode compartment is usually a solution of chloride of potassium maintained at a temperature of 45deg. C. to 50deg. C. The solution from the cathode compartment containing caustic potash is continuously supplied to the anode compartment, where the potash absorbs the chlorine, with the production of hypochlorite, which is almost immediately decomposed, with the formation of chloride and chlorate of potassium. The chlorate is removed from the electrolyte in crystals. The yield of chlorate of potash is about 1lb. per five electrical horse-power hours—nearly 45 per cent. of the theoretical amount. In Switzerland and in Sweden, chlorate of potash is now largely produced electrolytically by water power. I am informed on very good authority that preparations are in progress for a large increase of production, and that there is no question as to the electrolytic method entirely superseding the purely chemical method.

Electro-thermal Processes

The electro-chemical processes I have so far described or referred to are all of them of the electrolytic kind. There are other electro-chemical processes which are not electrolytic, but which are important and deserve mention. I refer, in the first place, to a group of processes and effects which depend on the principle of dissociation and combination at extremely high temperatures, and which involve the employment of the electric furnace, first suggested and applied experimentally by Sir William Siemens. In this class is included the electro-thermal manufacture of phosphorus, also that most useful and interesting polishing and cutting material next in hardness to the diamond—carborundum, the invention of Mr. Acheson, to whom I am indebted for these most beautiful specimens lying on the table. Mr. Acheson has developed the size of the electric furnace to enormous proportions, and made it yield results of great industrial value. Amongst these I must mention incidentally—for it is not a chemical, but a physical action—the complete transformation of amorphous carbon into graphitic carbon. It is not new to produce this transformation on a small scale, but to completely convert large masses of carbon into graphite is both new and of great importance. It is well known that blocks of carbon as ordinarily manufactured, when used as anodes in an electrolytic cell, rapidly disintegrate; and until now this has been a serious difficulty in the construction of electrolytic apparatus like that of Castner-Kellner. This difficulty is completely met by the use of graphite anodes, into which ordinary amorphous carbon anodes are now being transformed by the electric furnace. Some idea of the scale of these electric furnace operations may be formed when it is realised that 1,000 e.h.p. for 36 hours is expended in one heating.

To the same class of electro-thermal products belong carbide of calcium and a great number of analogous products, first obtained by M. Moissan by means of the electric furnace, employed with the most admirable skill, guided by thorough scientific knowledge, and the exercise of that kind of imagination which apprehends and realises far-off possibilities. I am imformed by Mr. Worth, of the Acetylene Company—to whom I am indebted for the specimen of carbide of calcium on the table—that carbide of calcium is now being manufactured at the rate of probably 20,000 tons per annum. Considering the value of this substance as a means of easily generating the highly illuminating gas, acetylene, and other products, there appears to be great probability of this manufacture becoming much larger.

Ozone Manufacture.

I must not omit to mention a quite different order of
chemical effects in which alternating or intermittent cur
high tension are employed to induce the formation of
By means of ozone secondary chemical effects of great v
obtained; among these I may mention the manufac
vanillin and heliotropine, now established manufactures.
has also been applied to wax-bleaching, and to the thi
and bleaching of oils, and to a number of other importa
Here is a model of an ozone-generating apparatus kin
by Mr. Andreoli, to whom I am also indebted for the sp
showing the effect of ozone on wax and oil. There are
the table specimens of vanillin and heliotropine, per
present the most important of the ozone products. Fo
and for much information on the subject, I am much obl
Mr. Salamon.

Prospects of the Electro-Chemical Industry

Although I have but touched the fringe of this matter
not weary you with further examples of the value and
of the applications of electricity to chemical manufactu
have shown that already there is a large amount of v
electro-chemical work being done, and that there is a li
prospect of expansion. Looking at the immediate future
interesting questions present themselves which must
sidered, even though we may not be able to completely
them. Amongst these are the questions: To what exte
in what cases, are electro-chemical methods likely to s
old-established chemical methods? And it is not too
ask, Where, and by what means, will the new electrolytic
factures be ultimately carried on? Will the introduc
electro-chemical methods of manufacture uproot t
manufactures from their ancient habitat? Already the
ominous signs. The aluminium manufacture, the carbor
manufacture, the calcium carbide manufacture, are
located where there is cheap water power. But
are all new industries, and of the kind in which the
element of cost is large, and the value of the product
large. In these respects they differ widely from such ind
as the alkali and the bleaching powder manufactures, an
electrolytic copper refining. In these manufactures, car
in the electrolytic manner, the cost of power is compar
very small; and nearness to the market, cost of the carr
raw material and of product, are even more important
Consistently with this, we find that caustic soda and ble
powder are being electrolytically produced on a large
Lancashire by means of steam power. It remains to
how far, in the long run, the most economically produced
power, as the basis of electrolytic manufacture, can h
own against water power. It seems to me probable th
number of instances steam power can hold its own. T
no uniformity in the cost either of water power or of
power. In one place water power will be less costly,
another place steam power.

Speaking generally, electro-chemical manufactures d
cheap electricity; not all of them with equal imperati
demand the cheapest, but some of them absolutely dep
electric energy developed at its cheapest rate. It is p
not entirely superfluous to ask the question whether t
any ground of hope that electric energy may be econo
generated by other means than by the transformation
energy of motive power. It would be rash to say that it
possible, but it is certain that there is no better way at p
discernible. Any hope once entertained of the possibly
mical direct conversion of heat energy into electric ener
crushed by the result of the investigation Lord Rayleig
municated to the British Association meeting of 1885.

The projects for obtaining voltaic effects by means of
as the positive element in a cell have never approached
measurable distance of practicability, and the prospect o
ever coming within that range is all but hopeless. It i
hopeless so long as the general lines of voltaic cell constr
are followed, and so long as it is contemplated to empl
positive carbon in the expensive manufactured forms in
hitherto it has been proposed to use it in carbon-cons
cells. It seems to me that if ever the voltaic cell is b
into serious competition with the dynamo, its form and ch
must be such that there will be no occasion for renewal
of the electrodes or the electrolyte, but that it must in
respects approximate in the condition of its working to
battery. But when it is remembered how small a ste
water engine and dynamo will develop a hundred or a th
electrical horse-hower, and what a small amount of atte
such apparatus requires, and when this is compared an
trasted with the much greater amount of labour invol
the maintenance of any equivalent voltaic combinat
the ordinary type, it will at once be seen that to
sede the dynamo something radically different from
superior to even the most perfect voltaic combi
now known would be necessary. Any such develo
as this is at the present moment entirely

leanwhile, in contemplating the prospective changes ctrolytic processes of manufacture must bring about, to count upon the dynamo and motive power as y by means of which, in the immediate future, such are will be carried out. The conditions under which wer is used in electro-chemical manufacture are favourable to economy, where, as would generally be coal is cheap, the unit of power large, and the power ntinuously and uniformly. It seems to me that there enty of room for the steam-engine in connection ctro-chemistry, and that, though there are certain emical industries which can be most economically by means of cheap and not too distant water power, other industries—and these may grow to be very hich may with great advantage be carried on in the Country," or wherever coal is cheap and the market aw material are near at hand. In the time that has Britain has enjoyed in chemical manufactures a great e in the possession of an abundance of coal. We are some measure, to lose the benefit of this advantage the innovations of electro-chemistry. Whether we lose by the change largely depends on our readiness or ess to adapt ourselves to the new order of things. r happens, nothing can be more certain than this— electrical engineer who adds to the ordinary knowledge ofession a competent knowledge of the principles of hemical practice in manufacturing operations, is thereby broader and surer his path to success.

м.—Ratio of Cost of Power to Production in Electrolytic Manufactures.

—	E.H.P. hours consumed in the production of 1lb.	Cost of power to produce 1lb. with 1 e.h.p. at £5 and £10 a year.	
		At £5. Pence.	At £10. Pence.
um	14	1·75	3·5
....	1	0·13	0·26
....	·3·33	0·41	0·82
oda + 2¼lb. bleaching r	2·7	0·33	0·66
of potash	5	0·62	1·24
raction	1	0·13	0·26
,, ...	0·5	0·065	0·13
refining	0·25	0·032	0·064

ALEXANDER SIEMENS moved that the thanks of the tion were due to Mr. J. W. Swan for his excellent s, and that he be asked to allow it to be printed s *Proceedings* of the Institution. He said that it ed everyone to endeavour to cheapen the cost of ction in all new industries, and to remove any ction that might exist tending to restrict output.

A. A. CAMPBELL SWINTON seconded the motion, was carried unanimously.

J. W. SWAN thanked those present for the kind they had received his address. He trusted that they l devote their energies to the advancement of the ution.

ROYAL INSTITUTION.

e following is the syllabus of a course of five lectures Recent Researches in Magnetism and Diamagnetism," to elivered by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., e following days at 3 p.m. The subscription to this is £1. 1s.:

LECTURE I.—THURSDAY, MARCH 3, 1898.

Ferromagnetism.

erromagnetic group of bodies, iron, nickel, cobalt, mag- pyrrhotite, and the iron alloys—Their unique properties— ic flux and gaussage—A bird's-eye view of electromagnetic lature—The abuse of the term "force"—How magnetic measured—Meaning of the term circuital—Experiments rate the nature of magnetic retentivity, coercivity, and is—Their mechanical analogues—Magnetisation curves— e permeability—Process by which magnetic flux is estab- ferromagnetics—It begins at their surfaces and soaks —Experiments to show this fact—Time taken to magnetise sses of iron—The physical effects of magnetic flux in netics — Molecular disturbances produced by flux —Effect of flux in changing the dimensions of ferro- s—Bidwell's experiments—Effect of magnetisation on the physical constants of iron—Effect on the electric and thermal conductivities—The effects of mechanical stress and vibration on the magnetic qualities of ferromagnetics—The Villari effect—Relation of torsion and magnetisation—Effect of magnetisation on the electro-chemical properties of iron and on the passive state—The magneto-optic effects discovered by Kerr and Kundt.

LECTURE II.—THURSDAY, MARCH 10, 1898.

Paramagnetism.

Behaviour of iron, nickel, and cobalt when placed in a non-uniform magnetic field—Tendency to move from weak to strong portions of the field—Faraday's classification of bodies into para-magnetic and diamagnetic—Similarity and difference between ferromagnetic and paramagnetic bodies—Magnetic attractions and repulsions—The Archimedean principle applied in magnetism—Faraday's experiments on the effects of the permeability of the surrounding medium in determining the motion of a substance when it is placed in a magnetic field—Experiments with magnetic solutions—Measurement of magnetic susceptibility—Magnetic ascent of paramagnetic liquids in tubes placed in a magnetic field—The so-called non-magnetic steels—The paramagnetic qualities of oxygen (gaseous and liquid)—The measurement of the magnetic permeability of liquid oxygen—Absence of hysteresis in paramagnetic bodies—Mechanical model to illustrate the differences between ferromagnetic and paramagnetic bodies when subjected to magnetism.

LECTURE III.—THURSDAY, MARCH 17, 1898.

Diamagnetism.

The discovery of diamagnetic repulsion—Faraday's researches—Exhibition of the behaviour of bismuth in a non-uniform magnetic field—Diamagnetics tend to move in a non-uniform field from strong to weak places—Diamagnetic orientation of bismuth, antimony, phosphorus, and iron in a non-uniform field—Diamagnetisation of flames and certain gases—Faraday's experiments with heavy glass—Magneto-optical rotation of the plane of polarisation in diamagnetics—Increase of electrical resistance of bismuth when transversely magnetised—Effects of low temperature on the above resistance change—The Hall effects in bismuth and other metals—Spurious diamagnetic phenomena—Electromagnetic repulsions produced by alternating electromagnets—Ampère's observations on electromagnetic repulsion—Effect of the circumjacent medium on the apparent diamagnetic property—The diamagnetic polarity controversy—The measurement of diamagnetic susceptibility—Curie's observations—Lombardi's recent researches.

LECTURE IV.—THURSDAY, MARCH 24, 1898.

Thermomagnetism.

Experiments to show the effect of heat and cold upon magnets and magnetic permeability—The effect of increase of temperature upon the permeability of ferromagnetics—The magnetic critical temperature—The recalescence of iron—The three critical temperatures of iron—The effect of rise of temperature upon hysteresis and susceptibility—Magnetisation curves at different temperatures—Identity of the recalescence temperature with the magnetic critical temperature—The effect of very low temperatures on the magnetism of permanent magnets and on magnetic permeability of iron—Analogies between the magnetic effects due to strain and those due to temperature—The thermo-electric effects of magnetisation—Thermo-magnetic hysteresis—Peculiar properties of the nickel steels in this respect—The general effect of sufficient increase of temperature is to destroy ferromagnetic susceptibility and to reduce paramagnetic and diamagnetic susceptibility—Curie's law connecting susceptibility and absolute temperature.

LECTURE V.—THURSDAY, MARCH 31, 1898.

Magnetic Theories.

Ancient ideas—The beginnings of a scientific theory of magnetism—The celebrated letter of Peter Peregrinus—The contributions of Gilbert, Descartes, Æpinus, Coulomb, and Poisson—The magnetic fluid theory—The methods of the French mathematical physicists at the beginning of the century—Discoveries of Ampère and Arago—The Ampère-Weber theory of magnetism—Weber's theory of diamagnetism—Faraday's views on magnetism—Maxwell's theory of molecular vortices—The hypothesis of molecular magnets oriented by an external field—The basis for that theory—Ewing's model magnet—Explanation of hysteresis and the finite limit to magnetisation on the above theory—Maxwell's electromagnetic theory—The fundamental properties of the ether—Ether theories—Rowland's discovery of the magnetic field due to a rotating body carrying an electrostatic charge—Outlines of a dynamical theory of magnetism—Rotating electrons—Hypothetical structure of an iron molecule—Discussion of the probable molecular structure of a mass of iron—Bonded and free molecules—The explanation, on the above theory, of the effects of heat and strain—The magnetic difference between annealed and unannealed iron—The direction in which further advance in theory may be expected—Conclusion.

The Trans-Mississippi and International Exposition.—This exhibition will be opened at Omaha (Neb.) on June 1, 1898, until Nov. 1. The work of construction is advancing rapidly, and a spacious building is being set apart for machinery and electricity.

THE

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TO CORRESPONDENTS.

THE PRESIDENTIAL ADDRESS.

Elsewhere the full text of Mr. Swan's preside address will be found, but it may not be an unp able task to briefly direct attention to the prin points referred to in the address. The main under consideration is the rise and progress of electro-chemical industries. But before touc upon this important subject, brief reference is to the history of sixteen years ago. Many of readers of this address will well remember historic evening, even though it came an others which were making electrical history startling rapidity. It was then that many of members heard of and saw for themselves possibilities of incandescent lighting. Then suc was hoped for—now it has been achieved; Mr. Swan's name must ever live in the hi of the movement as that of one most intim concerned in making electrical energy useful ordinary lighting purposes. There are other to whose energy of eighteen or twenty years the world owes a debt of gratitude. Fe those who visited Paris in 1878 were prep for the immense development between that and 1881, when again electricians from the en the world gathered together at Paris, and it there the incandescent light attracted the atte and roused the interest of capitalists. There is man, however, whose work in developing the trical industry has never been properly ap ciated—Mr. R. E. Crompton. He threw hi heartily into the movement, and possessed t qualities necessary to impress others. He great energy, great influence, and was vul practical. Even Mr. Swan will admit own indebtedness to Mr. Crompton. But t reminiscences may be passed. A cloud came the industry after 1881—the cloud of com promoting and stock-jobbing. When that p away, the industry looked forward, and has since looked back. Perhaps we ought to ref the labours of Edison at this time. In our opi the credit of perfecting the incandescent lam due to Mr. Swan, but there is no doubt that Ed better than any other man, grasped the pos when the incandescent lamp was available. looked upon electric installations as a whole designed each part to be its proper link in the c and did more to hurry on general lighting tha the other engineers of the world put together.

After the references to lighting, Mr. turns to the main subject of his paper, and ra sketches the work of Davy, and of Davy's eminent assistant, Faraday, in the histor electro-chemistry. The magneto machines very early by Elkington's at Birmingham noticed, as are the improvements of Wilde others, but to Gramme in 1871 is deser given the credit of producing the first r practical direct-current machine. In the cussion of the many processes employed electro-chemistry we find much that is food thought. One or two sentences, however, stan very prominent, and should be printed in large upon some of the brains whose owners are

stantly saying, "What is the use?" Too many nowadays are ready to decry experimental research if it has not an immediately practical object at its end. Mr. Swan tells how he was enabled to overcome his difficulties by considering the results obtained by another experimentalist. He says: "In the *Philosophical Magazine*, 1881, vol. xii., p. 300, Tribe published an exceedingly interesting series of observations on the distribution of the lines of conduction in a liquid undergoing electrolysis; these showed me the causes of the wasteful growths round the edges of electrotypes. By applying remedies suggested by Tribe's results, I was able almost wholly to prevent this waste, to obtain nearly complete uniformity in the thickness of deposits, and entirely to prevent excrescent marginal growths." Such a result is not only a triumph for Mr. Swan, but also a triumph to be recorded in the annals of original research. The only other question which we shall touch is one to be found towards the conclusion of the address: "Will the introduction of electro-chemical methods of manufacture uproot the old manufacturers from their ancient habitat?" A similar question has been asked with regard to other industries, and the answer in all cases is about the same. Information is required as to the details of processes and the operations of raw materials that make up the bulk of the prime cost. When this information is known, the answer is known. Mr. Swan briefly points out that when the cost of the power element is large, then the cost of power dominates the position of the factory; in other cases the dominant factor is the raw material. Hence the factory will be placed where the cost of this is a minimum. We again say the whole address is of the most interesting character, at once worthy of the President and of the Institution.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

ON THE MANAGEMENT OF STEAM-BOILERS.

SIR,—The article by Mr. F. G. Ansell, F.C.S., in your paper for Dec. 10 contains some orthodox errors upon softening water by the lime process that I respectfully ask your permission to correct. The quotations that I give are Mr. Ansell's words:

"The lime-water is made by putting quicklime into water and stirring it, by which it is made to appear somewhat like milk, and the quantity is regulated according to the natural hardness of the water to be softened. This, of course, is determined by the analyst."

Here lime-water is confused with milk-of-lime, two totally different things. Lime-water has quicklime in solution only. It can always be relied upon as a definite quantity, and by the proper use of it the perfection of the process can be obtained with ease and absolute certainty. This is the only correct way in which quicklime can be used for softening water, and is therefore the right principle. But Mr. Ansell uses milk-of-lime. This is water having quicklime both in solution and suspension. Perfect softening is impossible for several reasons, and it is a wrong principle of using quicklime for softening. Its use is a serious mistake, and this leads to a very serious misapprehension with regard to incrustation.

"I have many times analysed the water before and after softening by this process, and find that the total amount of lime is reduced from 10 grains per gallon to 1·4, the carbonate of lime from 15 grains per gallon to nothing . . . This result I consider very satisfactory."

The meaning of this is not quite clear, but it appears to be that 10 grains of quicklime are added to each gallon of hard water, that this is more than is necessary, that all the carbonate of lime is precipitated, and the excess of quicklime remains in solution in the softened water. This has been found to be the case "many times," and must be taken as constant. This means that the boiler is supplied with weak lime-water instead of pure water; surely an extraordinary state of things. Such water would be disastrous for most purposes, and is not desirable for steam-boilers. Yet it has been "determined by the analyst," and Mr. Ansell considers it "very satisfactory." The actual fact is that, when using quicklime on a wrong principle, too much or too little is certain to be used. Mr. Ansell uses too much. This is "very unsatisfactory," and proves that neither the analyst or Mr. Ansell know how to carry out the lime process properly or what perfect softening means. It is not, therefore, surprising that he arrives at a totally wrong conclusion, which I will now explain.

"I find that the boilers can be kept quite clean if the stoker will blow off frequently enough to prevent the water in the boiler becoming too concentrated. Of course, if this is neglected, sulphate of lime naturally in the water will be deposited on the inside of the boiler, . . . but a slight difficulty may arise with regard to the frequency of blowing off in the case of waters containing sulphate of lime."

With reference to "frequency of blowing off," this is too vague to deal with. But when he goes on to say, "Of course, if this is neglected, any sulphate of lime naturally in the water will be deposited on the inside of the boiler," he arrives at a conclusion that is totally wrong, and is not supported by actual practice.

This is the orthodox course of errors. Reference to circulars and papers describing softening plant—even including one awarded a prize by the council of the Institution of Civil Engineers—reveal three points: (1) The plant described is such that perfection of softening by the lime process is impossible; (2) no analyses are given to prove perfect softening; (3) all these circulars state that sulphates form incrustation, and one—which probably describes the most imperfect plant of all—represents that the incrustation caused by sulphates will be worse than ever. But not one gives the analysis of incrustation or any reliable evidence to prove it.

On the other hand, I have designed installations of plant for softening small and large quantities of water by the lime process up to 100,000 gallons per hour continuously, and they have been examined and tested in operation by Dr. Percy Frankland and other eminent analytical chemists, who have personally taken samples, analysed them, and proved that the process was being perfectly carried out. The points to be noted are these: (1) The quicklime is always used on the right principle. Each part of the plant is under complete control. The quantity of quicklime used is "determined" by the workman in charge, and not by the analyst. (2) Sometimes a single analysis, and sometimes a series of many analyses, have been made by eminent chemists, and have always proved that the process is being carried out perfectly. (3) I have never once found Mr. Ansell's words come true—viz., that "any sulphate of lime naturally in the water will be deposited on the inside of the boiler." And it is not a question of blowing off. Here is a case from actual practice.

I supplied plant for softening the water for some boilers at the railway locomotive works, Brighton. The water contained between five and six grains per gallon of sulphate of lime, and blowing off was impossible because the superintendent would not allow blow-off cocks to be fitted to any boilers under his charge. Chalk marks and chisel marks have been made inside the boilers when they were opened one Bank Holiday; they have been constantly under steam until they were opened the next Bank Holiday—August till December, or 4½ months. Both chalk and chisel marks were then found to be perfectly plain; not a trace of incrustration had taken place, but some of the old incrustration had begun to come away.

I can give many other illustrations to prove that when the lime process is accurately carried out, *sulphate of lime does not deposit in boilers, and gives no trouble whatever.* And

I submit that this reduces the problem of incrustation in steam-boilers from its present aspect of great complexity to one of great simplicity.

The reasons that this has not been generally recognised are, I believe these: there is no patent for this process, and it is, in itself, simple and cheap. Owing to this, there is a general idea that there is so little in it that everybody knows all about it; it is treated with deplorable indifference, and the actual result is that nobody knows anything about its real value when carried to perfection. Thus it comes about that perfection of plant, working, and results are regarded as accidental; accidental, or imperfect plant, working, and results are believed to be perfection, and this leads to endless confusion and uncertainty.

I have no hesitation whatever in saying that no one in the world can bring forward a series of analyses proving that water containing carbonate and sulphate of lime has been accurately softened by the lime process, and notwithstanding this, incrustation has taken place; whereas I can produce positive practical proof to the contrary.—
Yours, etc., WALTER GEO. ATKINS, C.E.
27, Agamemnon-road, London, N.W.

TELEPHONES.

SIR,—In your remarks upon the telephones in Sweden, you mention that the Swedish industry has only 27,000 instruments. I believe you will find on enquiry that this is incorrect, as previous to 1895 there were already 32,600 instruments at work in that country, and the number probably now exceeds 40,000.

You will be glad to see the movement in Great Britain is gaining considerably every day to obtain exchange telephones at less than half the cost of the present exchange tariff, and with a perfect service. Sixteen towns to my knowledge are at work forming companies, and with the co-operation of their town councils, to work competitive exchanges, as in Sweden, where every village has competitive telephones and trunk lines. This is the means by which Sweden has acquired the finest development of telephones in the world.

The following table may not be uninteresting, and shows what monopoly has done in Great Britain:

	Tariff.	Exchange telephones per 1,000 of population.
Stockholm	50s.	77
Finland	58s.	84
Luxembourg	64s.	55
Douglas (Isle of Man)	£5	17
London	£20	under 1
British towns (average)	£8 to £10	under 1

Yours, etc., ANTI-MONOPOLY.

REVIEWS.

The Induction Coil in Practical Work, including Rontgen X-Rays. By LEWIS WRIGHT. Macmillan and Co.

The increase of electrical apparatus due to the discovery of Röntgen rays will be enormous. In military surgery the apparatus is a necessity, and no doubt Röntgen-ray apparatus will in the course of a few years be as familiar in every surgery as the modest box of pills. The apparatus required is described in this treatise with a sufficiency of theorism to make the work still more interesting. But in the first place, the great want was a book to practically describe the various pieces of apparatus used in obtaining photographs by means of the X-rays. Mr. Wright has provided that book, and a careful study of it will enable anyone to obtain sufficient knowledge of the subject to practically use the apparatus described. The author is as careful to warn the reader what to avoid as he is to give him the necessary details of how to go to work to use the apparatus successfully. Chapter VIII., on the Röntgen X-rays, will probably be the one to attract the student, for the preceding ones lead up to this, and though they contain a mass of information put in a very clear manner, it is not of the newest order of things. While, after all, the X-rays, familiar as they are to scientific men, are not yet really understanded of the multitude. The author refers to the labours of Crookes, Hittorf, Lenard, and of Röntgen, as leading up to the final discovery by the latter of the X-rays. Then brief references are made to the theories put forward concerning the rays, but by far the largest portion of the chapter is devoted to explaining the practical use of the apparatus. This explanation is really what is wanted, for theories may come and theories may go, while the value remains in the application. Mr. Wright is to be congratulated upon his excellent work.

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week:

FRIDAY, JAN. 21.

Institution of Junior Engineers.—At the Westminster Palace Hotel, at 8 p.m., lecture on "Laboratory Testing Machines," by Prof. A. C. Elliott, M.I.C E.

Physical Society of London.—At the rooms of the Chemical Society, Burlington House, at 5 p.m., Prof. O. Lodge, F.R.S., "On Electric Signalling without Conducting Wires." A Tesla oscillator will be exhibited by Prof. S. P. Thompson, F.R.S.

SATURDAY, JAN. 22.

Institution of Junior Engineers.—Visit at 3 p.m. to the engineering laboratories of the Central Technical College, South Kensington.

MONDAY, JAN. 24.

Northern Society.—At the Palatine Hotel, Manchester, at 8 p.m., "The Cost of Heating and Cooking by Electricity," by Mr. W. P. Adams.

Camera Club.—At 8.15 p.m., Major P. A. MacMahon, R.A., F.R.S., on "Mirage."

TUESDAY, JAN. 25.

Institution of Civil Engineers, Great George-street, Westminster. At 8 p.m., "Reservoirs with High Earthen Dams in Western India," by W. L. Strange, A.M.I.C.E.

Royal Institution, Albemarle-street.—At 3 p.m., Prof. E. Ray Lankester, M.A., LL.D., F.R.S, on "The Simplest Living Things."

WEDNESDAY, JAN. 26.

Society of Arts.—At 8 p.m., "Fireproof Construction of Domestic Buildings," by Thomas Potter.

THURSDAY, JAN. 27.

Institution of Electrical Engineers.—At the Institution of Civil Engineers, 8 p.m., "Notes on the Electro-Chemical Treatment of Ores containing the Precious Metals," by Major-General Webber, C.B. (retired R.E.), past-president.

Royal Institution, Albemarle-street.—At 3 p.m., Prof. Dewar, M.A., F.R.S., on "The Halogen Group of Elements."

FRIDAY, JAN. 28.

Institution of Civil Engineers, Great George-street.—At 8 p.m., students' meeting, "Condensing Apparatus," by H. Williams, Stud. Inst. C.E.

THE PACIFIC CABLE.

In view of the developments which are taking place in the Far East, says the *Times*, the project of the construction of an all-British Pacific cable connecting the British colonies of the North with those of the South Pacific acquires fresh importance. In Canada, where the need for a Pacific cable is most keenly felt, and where the scheme of construction of the cable received its practical shape, the agitation in favour of the completion of this link in the chain of British communications in the eastern hemisphere is, we learn, about to be renewed. Canada has lately done much to promote the interests of Imperial unity. If she can so far realise the possibilities presented by her geographical and political position as to bring about the successful establishment of this simple but effective instrument for the development of British influence in the Pacific, she will deserve no less the gratitude than the respect of the Empire.

The history of the endeavour to establish a British cable across the Pacific, intimately connected as it is with the name of Mr.—now Sir—Sandford Fleming, is too recent to require any detailed recapitulation. The construction of such a line of cable communication between the far western and the far eastern extremities of the British Empire was first conceived in connection with the creation of the Canadian system of telegraphic land communication in 1874. Some definite shape was given to the proposal by Mr. Sandford Fleming at the same Colonial Conference of

1887 in which Mr. Hofmeyr put forward his scheme for a beginning of Imperial fiscal union. At that time the material conditions of the scheme were unknown, and it was dismissed from practical consideration until the possible route of the cable should have been surveyed. General opinion with regard to it in this country was that it embodied only a remote possibility not at all likely to be realised in our day. Partial surveys which were made of the proposed route served, however, to dispel some of the current illusions as to the nature of the physical obstacles to be overcome, and French initiative in constructing the first sections of a cable for the service of the French settlements in the Pacific, of which the ultimate intention was that it should be carried under French control to Hawaii to meet an American section connecting Hawaii with the United States, helping to give actuality to the Canadian project. Within five years the practical aspects of the scheme had been so far investigated that the Canadian Government found itself in 1893 in a position to lay a definite proposal before the several Australasian Governments. In 1894 the matter was formally discussed at the Colonial Conference held in Ottawa, and in consequence of authority delegated to it by the representatives of the other colonies the Canadian Government subsequently called for tenders for the construction of the line. The response made to the call for tenders by several leading firms established the fact that the expense of the construction would amount to about £1,500,000. Very careful calculations which were made as to the subsequent probable loss or profit on the working of the line, showed that at a cost of transmission considerably lower than that of the existing Australian cable service the line might reasonably hope within a few years to be something more than self-supporting. The question became one of whether it would be more advantageous that the scheme should be carried out as a private enterprise under Government guarantee, or as an Imperial public work, to the cost of which the Governments concerned should proportionately contribute.

The matter being thus reduced within clearly-defined limits and prepared for business-like discussion, it was submitted to the deliberations of a committee of Imperial and Colonial delegates. The committee held its first sitting in London on June 5, 1896. It is understood to have made an exhaustive enquiry into every detail of the project, and its report was presented just a year ago, in the first days of January, 1897. The report, which from the anticipations founded upon it in Colonial quarters was generally believed to be favourable to the scheme, has never been made public. In the summer of last year the question again formed a subject of discussion in the conferences of premiers held at the Colonial Office, and again no formal information was given to the public as to the result of the discussion. An informal statement was, however, made, and though unauthorised has been since confirmed from Colonial sources in a way which leaves little doubt of its authenticity, that the position as to the construction of the cable was entirely changed by the proposal of the Eastern Extension Telegraph Company to lay an all-British line from Western Australia across the Indian Ocean to Mauritius, thence connecting with the Cape and St. Helena and Ascension. The proposal appears to have been submitted to the consideration of the Colonial premiers as a substitute for the Pacific cable. Here, then, so far as the history of the movement can be summarised in a few words, the situation rests. As between a Pacific cable, for which they will be asked to pay, and an all-British eastern extension line connecting Africa with Australia, for which they will only be asked to make indirect concessions, Governments with the fear of the Treasury before their eyes hesitate to commit themselves to the support of the Pacific cable scheme.

The conditions of the alternative laid before the premiers are not known in detail to the public. The position does not, therefore, offer matter for judgment on general grounds. But from the points of view of Canada and of the development of British interests and influence in the Pacific, it is evident that the proposal of the Eastern Extension Company is not an alternative; it is simply a negation of the hopes which have been raised. The Canadian public is watching with much interest the development of events in China and Japan, the advance of Russia towards the shores of the Northern Pacific, and the expansion of the United States upon the same plane of activity as expressed in the movement for the annexation of Hawaii. It happens that simultaneously with these movements a very remarkable development promises to take place on the Canadian shore of the same sea. The discoveries of gold in the Yukon district and of vast mineral wealth in British Columbia may have no less an effect than that produced by discoveries of a similar nature in California, Australia, and the Transvaal. A rich industrial population having wide commercial relations will in such an event settle in Western Canada, and the natural outlet for its energy will be by the ports of the Pacific. Vancouver and Victoria should become emporiums of eastern trade, and the mere alternation of the seasons as between the northern and the southern hemisphere should secure the creation of a large trade in foodstuffs between Australasia and British Columbia. Australasia, on the high road to recovery from the depression which followed the financial crisis of five years ago, is preparing to take advantage of the markets which circumstances are opening to its produce. English influences in Japan and China tend to improve the opportunities of the commercial situation. British interests in the Pacific are all of a similar nature. They all demand for their favourable development the same conditions—namely, an undisputed command of the waterways and a system of easy communications. It is not surprising that the Canadian public, more closely concerned than any other, should desire to urge upon the British communities of the Pacific the wisdom of the maxim, "Unite and rule."

There exists at present no system of rapid communication across the Pacific. Under modern conditions the business sufficient to sustain lines of ships cannot be built up without the facilities afforded by the telegraph. Were a cable laid under British auspices from British Columbia to Australia, there would be little difficulty in tapping it to establish a branch line to China and Japan. If, as is the general desire of this country, the opening of China should prove to be rather a commercial than a military or political operation, the existence at Chinese ports of converging lines of telegraphic communication with every centre of British industrial activity in the Pacific must almost of necessity have an effect in the establishment of peaceful British influence which takes the question beyond the limits of purely local concern. Not only Canada but the whole Empire is interested in assuring to British interests a fair field for that policy of "equal opportunity" which has so far constituted the most definite pronouncement of our views with regard to European rights in Eastern Asia. Every sign would seem to indicate that the coming twentieth century will be celebrated in the history of the world by the development of a new civilisation on the Pacific. To affirm the legitimate position of Great Britain in that civilisation must be the object of British policy, and for this purpose cheap and rapid means of communication between the local British centres is one of the first of necessary conditions. This aspect of the question is not dealt with by any proposals for cable construction that exclude the Pacific Ocean from their scope.

It is perhaps unfair to Canada to lay upon her the burden of initiative in a matter which involves a general Imperial interest; but the immediate benefit of the Pacific cable will be felt very specially by Canada, and as a dominion she has shown herself so well able to deal with questions of a wider than provincial range that we look with some confidence to her action. The estimated cost of the cable is not great, and it is difficult to comprehend that the construction can have been so long delayed.

THE NEW WALKER ALTERNATORS.*

For some time past the engineers of the Walker Company have been engaged in designing a line of alternating machines which embody a number of novel features.

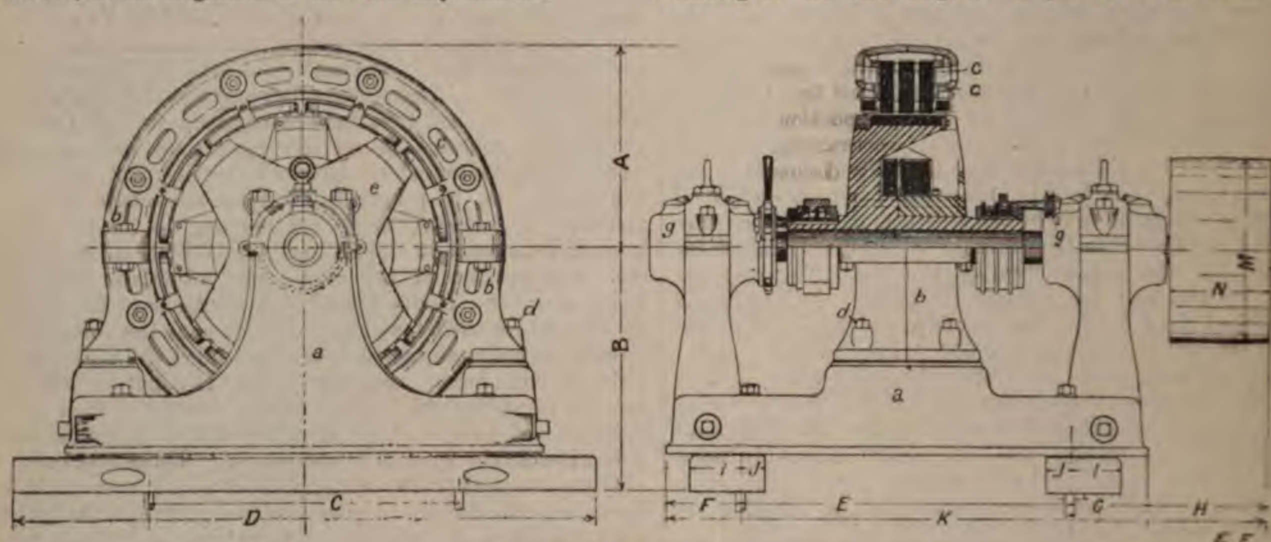
The inductor type of machine has been adopted, with a stationary armature, which can be wound and insulated for

* From the *Electrical Engineer* (New York).

any required pressure. This, in the case of power transmission, avoids the necessity, in most cases, for using a step-up transformer. The inductor, which is the only revolving part of the machine, is excited by a field coil, which, in the case of lighting machines, is compound wound, so that the pressure may rise in direct proportion to the increase in the load. The machines are separately excited by a small direct-current dynamo, which is furnished with each generator. The company have adopted 60 cycles per second as its standard for machines to be used for lighting, and for plants where both lighting and power are furnished. For long-distance power transmission, however, 30 cycles are used. The generators are wound for single, two, or three phase current, as the exigencies of the work may demand.

space around the hub, where the single field-magnet spool is carried, wound with the shaft as its axis. The ends of the inductor spokes are tipped with blocks of thin laminated steel to avoid heating them by the formation of eddy currents. Two extensions of the hub are provided—one outside of the inductor arms at either end. Upon one extension is carried a pair of collector rings, *h*, which carry the current from the exciter to the field-magnet coil, which rotates with the inductor.

When the alternator is to be over-compounded for incandescent lighting, the commutator, *i*, is placed on the other extension of the inductor hub, having in its periphery as many bars as there are spokes on the inductor. The alternate bars are connected together and then to the ends of the series winding of the field magnet. A portion of the armature



FIGS. 1 AND 2.—New Walker Inductor Alternator.

Figs. 1 and 2 illustrate the standard belted-type alternator, having a sub-base, *a*, upon which is mounted the stationary armature ring frame, *b*. This frame is divided into halves on a horizontal plane, so that the upper half can be removed to inspect and repair the armature bobbins or to remove the inductors.

The armature core, which is made with inwardly-projecting teeth, is constructed of the best quality of laminated steel, and is held firmly in the armature ring frame. The armature coils, which are rectangular in shape and machine wound, are arranged around its inner surface and thoroughly embedded in slots formed on the inner periphery. The armature core is ventilated by means of air-ducts passing radially through its mass, as in the revolving armature of the direct-current machine. The armature frame is hollow, with large openings to the atmosphere (as shown at *c*) permitting the air freely to circulate through the armature air-ducts and around the core iron and armature coils. These ducts, combined with the fanning effect of the rapidly-moving arms on the revolving

FIG. 3.—Armature Punching of New Walker Inductor Alternator.

inductor, form a most perfect system of ventilation. The entire armature with its frame can be moved parallel with the axis of the shaft by removing the bolts, *d*, which fasten it to the sub-base, thus uncovering the armature coils for inspection or repair, without the necessity of removing the upper half of the armature.

The inductor, *e*, is carried by the shaft, *f*, which is made to rotate in the bearings, *g*. This inductor consists of a hub made of steel, with radiating arms or spokes at either end, which spokes alternate in spacing, and have their outer ends bent into line over the centre of the hub, leaving an annular

current is thereby rectified, and as its quantity increases, the magnetisation of the inductor increases, producing the requisite over-compounding. Carbon brushes are used on both the collector rings and commutator in all cases.

In Fig. 3, *a* illustrates one of the armature laminations, showing the internal slotting for single phase. For two-phase winding, the unslotted portion would be punched out, making the teeth uniform in width throughout. One of the punchings used in building up the inductor arm tips is shown in Fig. 3. The armature coil, which is rectangular in shape, is wound on a form in a lathe, and then thoroughly saturated with armature varnish and baked. After baking, it is completely encased in a combination of mica and paper insulation, and, finally, taped with oiled linen. These coils will easily stand 10,000 volts constant pressure.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *two shillings and sixpence* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared, and should be written on one side of the paper only. Questions may be sent at any time.

QUESTIONS.

30. Discuss, from the consumer's standpoint, the Brighton system of charging for electrical energy when the reduced rate comes into force after one, two, or three hours' average use per day respectively. Also consider the case when a charge of 8d. per unit for the first hour and 2d. per unit after is introduced to replace a uniform charge of 6d. per unit.—P. T.

31. State the principal causes of the waste of fuel in boilers, and the best means to use in reducing such waste.—I. J. ARCHER.

ANSWERS.

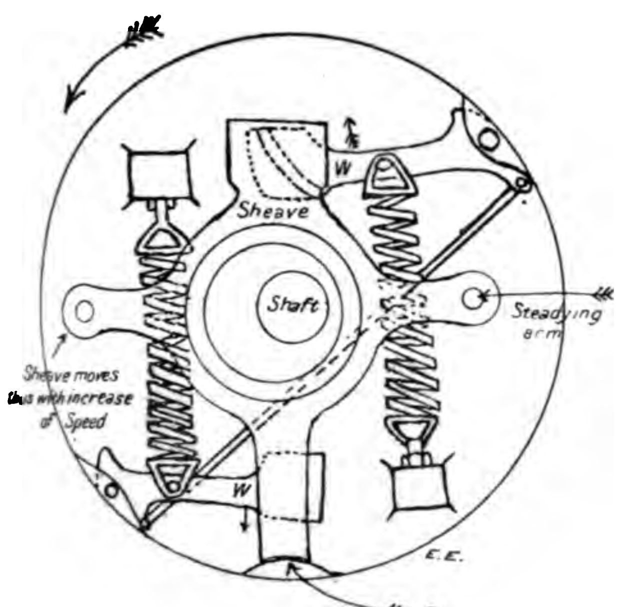
Question No. 25.—Describe, with sketches, the best system of governing for electric lighting engines.

Best Answer to No. 25 (*awarded* 10*s.*).—The systems of engine governing fall mainly under two heads: (1)

throttling; (2) by variable expansion. To say that one of these systems is better than its rival for all classes of electric lighting engines, is certainly considering them not on their merits for the cases with which they have to deal.

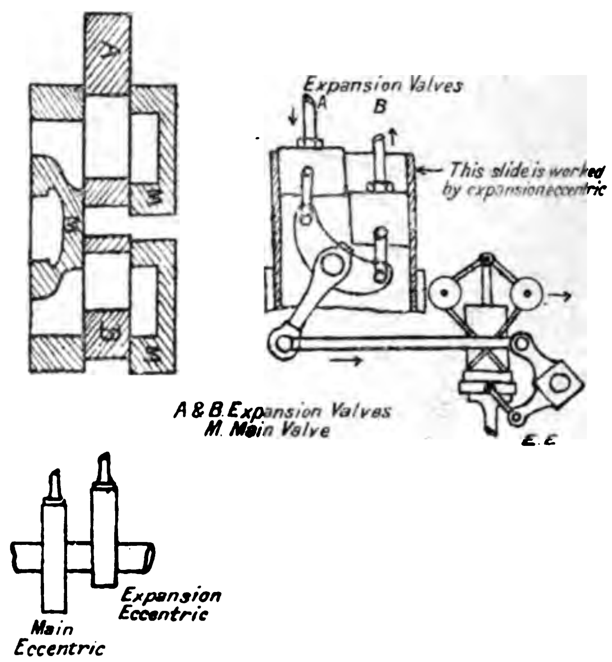
Discussing the case for throttling, the main fact to be noticed is that the throttle is placed between the stop-valve and the steam-chest, and therefore the effect is not felt so soon on the piston. This defect is much increased if the clearance spaces are large. One of the advantages of this system of governing is that we are enabled to run the governor at a speed very much higher than that of the engine shaft; and supposing the speed of the engine increases five revolutions, then the governor may possibly increase 15 or 20 revolutions, but before it has attained this speed the steam will be cut off and the speed checked. Looking at it from the economical side of the question, the throttle governor is the most efficient at light loads, since there is less initial condensation due to the lower temperature range; but even this is very much modified when compared with the high-speed engine fitted with shaft governor, for in them, although the temperature range is greater, yet the admissions of steam are at a greater speed, and the cylinder walls have not time to cool down.

Dealing with the variable-expansion methods, shaft governing is the one which has come into most prominent use. The principle of this is that of a weight revolving round the shaft and connected to the eccentric sheave by links, the centrifugal force of the weights altering the travel of the valve, and thereby varying the cut-off. In some governors of this class only the travel is altered, and in others the angle of advance. Hence in this system of governing the action of the governor is transmitted directly to the valve, producing an immediate effect upon the steam entering the cylinder. It therefore matters not what quantity of steam is in the steam-chest. Perhaps the greatest fault of this system of governing is the liability to "hunt." This comes about when it is made too sensitive—*i.e.*, when



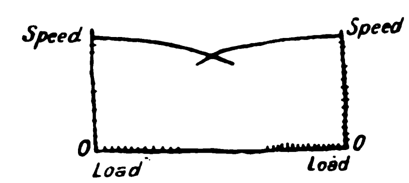
Shaft Governor.

the centrifugal force of the weights is exactly balanced at all loads by the tension of the springs, and the weights have therefore no stable position. Even the unequal turning moment of a single-cylinder engine is such as to cause "hunting," but this is minimised by the use of a heavy flywheel. A diagram of a shaft governor is given, in which only the travel of the valve is altered and the angle of advance remains constant. Under the "variable cut-off" system of governing may be mentioned that in which the steam admission is prolonged by means of expansion valves working on the back of the main valve, these expansion valves being driven from a second eccentric 25deg. or 30deg. behind the main eccentric. The expansion valves, which are moved differentially, are generally worked by a governor of the Porter type, in which the central weight is made heavy as compared to the balls. (See diagrammatic sketch below.)



Variable Cut-off Gear with Porter Governor.

To sum up, now, the different systems, we have in the throttle governor the most economy at light loads, it is simple in construction and not liable to get out of order, and is to be preferred for an engine driving a load which does not vary too rapidly. For engines driving dynamos by ropes or belts, and for running in parallel with other *direct-coupled plant*, the variable cut-off gear with Porter governor is perhaps the best, as the load is very much easier and more quickly adjusted than with any other system. But for large direct-driven plant with a rapidly varying load (as for traction) the shaft governor is the best; and when used for running in parallel with similar direct-coupled plant, it is absolutely necessary that the governors are not too sensitive, but should be designed for a slight decrease in speed between no load and full load. Graphically, the characteristic of the governors showing the relation between speed and load should be thus:



This last point is, I think, the secret of the successful parallel running of engines with shaft governors when directly coupled to alternators or dynamos.—A. D. MARKLAND.

Answer to No. 25 *(awarded 2s. 6d.)*.—The system of governing employed on a steam-engine depends on the speed of the engine, and the kind of work it is intended to do. For instance, a governor acting on Corliss trip gear, would be unsuitable for a fast-speed engine. Undoubtedly, for moderate speeds and fairly long strokes, the Corliss type is the best; but as the tendency now is towards fast-speed engines, I will describe a system suitable for one. Some discussion has lately been raised as to whether governing by variable expansion or by throttling the steam is the best. My opinion is that for sensitive governing variable expansion is the better, as it acts direct on the admission valves; whereas there is in throttling a certain amount of steam in the side pipes which has not been acted upon.

Crankshaft governors seem to be coming into general use. They have an advantage in that they are placed directly on the crankshaft of the engine, and so there is no intermediate gearing. They are very good governors for high-speed engines when controlling an ordinary Meyers cut-off valve (balanced) either by varying the travel

or angle of advance of eccentric. If the steam pressure is high, piston valves may be used with this governor.

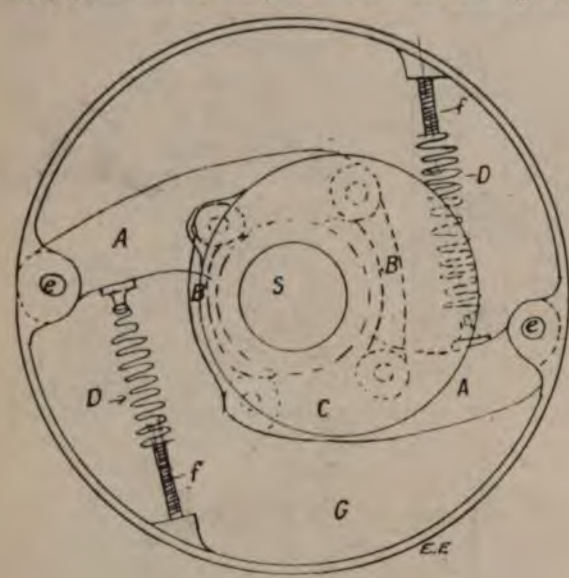


Fig. 1.

Fig. 1 is a sketch of a governor of this type, which varies the cut-off eccentric advance. A A are two weights, which are centred at *e e* and connected to the eccentric by two links, B B, so that when they fly out C is rotated on the shaft, S. The governor casing, G, is keyed on the shaft, and the eccentric is loose, and is therefore driven by the governor through the links, B B. The springs, D D, oppose the weights, and are regulated by screws, *f f*.

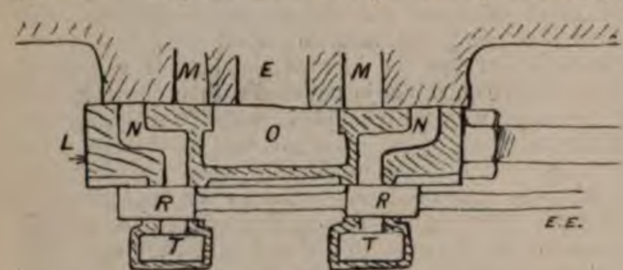
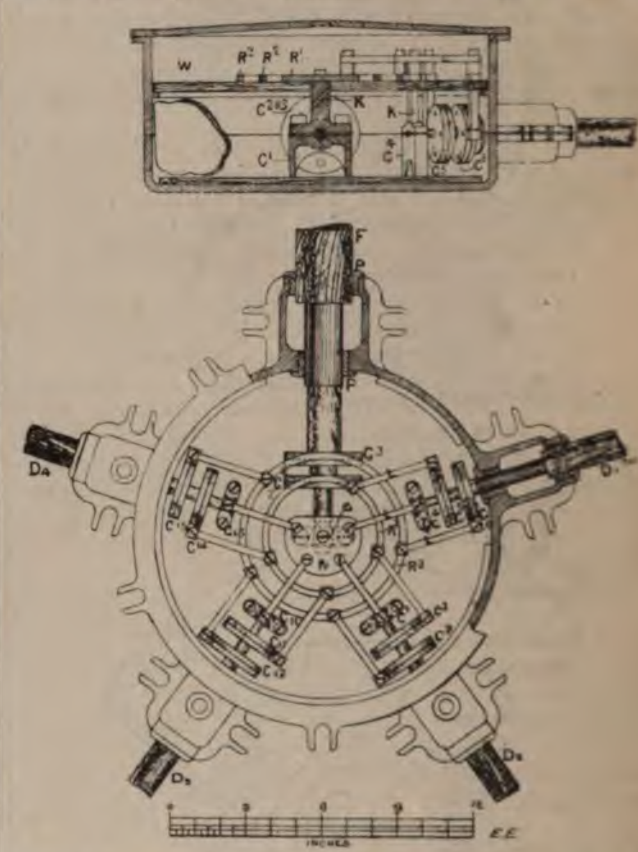


Fig 2.

Fig. 2 is the sketch of the valves driven by this governor. M M are the steam-ports to the cylinder; E is the exhaust port; L is the main valve, which is driven directly by a fixed eccentric, and has a fixed cut-off at about three-quarter stroke; N are the steam-ports through the valve; and O is the exhaust cavity. R R are the cut-off valves controlled by the governor. When the weights in the governor are down, these valves will cut off at about three-quarter stroke exactly the same as the main valve; but when the weights fly out to the top the eccentric cuts off the steam altogether, thus preventing racing of the engine. T T are two casings put on main valves to balance the cut-off valves. If Corliss valves were used, a fast-speed ball governor would be required to actuate the trips and regulate the admission of steam. A description and sketch of a Corliss trip motion would take up too much space, but the principle is this: the eccentric rod moves the valve until a catch or trip comes into position, and then this relieves it, and the valve springs back. The position of this catch is regulated by the governor.—H. HARGREAVES.

Question No. 26.—Given a system of distribution by triple concentric armoured cables supplied from a distant generator, what would you consider the best arrangement at a feeding point, say, where four distributors come on the end of the feeder, to combine in itself efficient sealing for the ends of the lead-covered cables, detachable and easily accessible links for disconnecting any conductor without interfering with the others, and insulation able to stand underground conditions? Give sketches.

Best Answer to No. 26 (*awarded* 10*s.*).—The accompanying drawings show a combination which will answer all the specified requirements—viz., efficient sealing for the ends of the lead-covered cables; detachable and easily accessible links, the lid of the box being merely removed in order to unscrew the links; and good insulation. The box has a horizontal joint at the centre line of the glands, and an iron lid to cover the top. The joints may be machine-faced and put together with white lead, or they may have a groove for a lead joint. The cables are stripped and cut back in the ordinary way, and passed through the glands of the box, the jute and armouring stopping just past the first gland, and the lead stopping just past the second gland, as shown. The three conductors of the feeder, F, are provided with clamps, C_1 C_2 C_3, which have projections, K, for connection to their respective concentric contacts, R_1 R_2 R_3. The three conductors of each of the distributors, D_1 D_2 D_3 D_4, are furnished with similar clamps, C_4 C_5 . . . C_{14} C_{15}, so that they may be connected by means of links to their respective contacts. All the clamps have projections, K, which pass through holes in the prepared wood or ebonite cover, W, and this rests upon the ledge round the inside of the box.

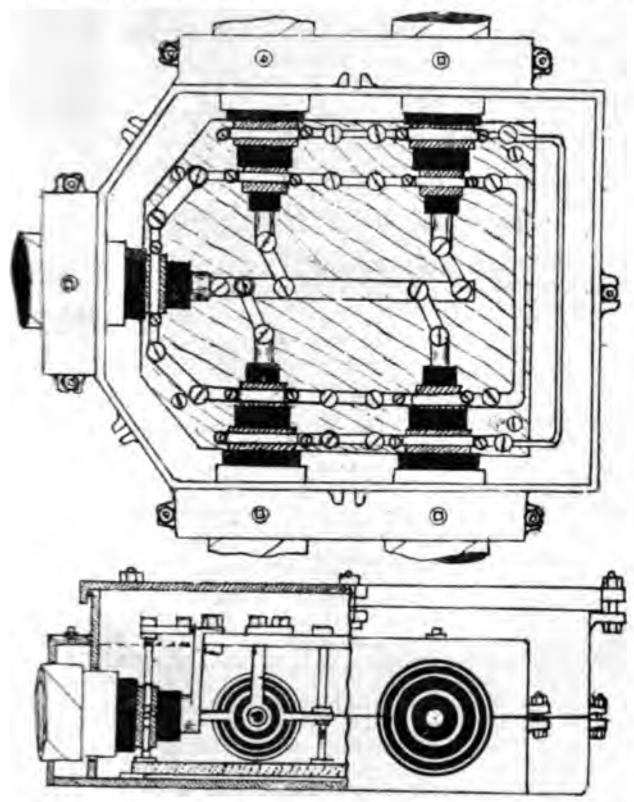


When all the clamps are in position, and the wooden plugs, P, forced into place around the cables in the glands, the pockets and the lower part of the box are filled with an insulating compound, such as bitumen, and the insulating cover put into place, with the projections, K, passing through it. The concentric contacts, R_1 R_2 and R_3, are then placed on the cover and connection to the lugs, K, of the distributors made by means of the links, L. The rings have bosses cast on them which stand up, so that when the links are in place they are prevented from short-circuiting the rings. The lip around the upper section of the box is then spread over with white lead and the lid bolted on. A hole is provided at the top of the lid, through which oil may be poured into the box if it be thought advisable. A screw plug closes this hole. If the clamps be spaced out carefully, all the links may be of the same length, and thus save considerable time and trouble in finding which link is right for any one connection.

There are several kinds of clamps for connecting on to the conductors of concentric cables. Some are in the form of a cone, round which the wires are splayed and then a cap screwed over to hold them tight. In another form the wires are splayed over a cone which has a groove round it, and then bound to the cone by a wire wrapped round and pressing them into the groove. The binding is then soldered over. The whole box should be placed in a brick-lined pit with a concrete bottom, and an ordinary street-box cover. In this way there are two coverings for protecting

the open connections from wet and damage. The insulating compound will effectually seal all the lower connections, and they need never be disturbed.—T. A. LOCKE.

Answer to No. 26 (*awarded* 2s. 6d).—The subjoined sketch shows such a box in plan and part sectional elevation. The outers of the tri-concentrics are assumed to be the neutral wires (though this is not always the case in practice), and these are simply interconnected by links, a separate box being provided to take off the occasional connection to the neutral 'bus bar at the works. The other two conductors of the triples are also connected by links with the two



conductors of the concentric feeder; the middles, like the outers, being clamped, and the inners having socket lugs sweated on. All the links are supported on terminal bolts let into a marble base, which rests on four projecting points of the box. The box is filled in over the cables (after first heating with a blow lamp) with an insulating and damp-resisting compound, such as diatrine, bitumen, etc., the links on top of the pillars alone being left uncovered, the space above being filled with a light oil to prevent shorts from condensation. The entering pockets must also be filled with compound through the plugged hole. As will be seen, the box divides at the cables for greater convenience in fixing, and there is an opening in the top half covered by a flanged plate. As regards the pillar supports, these would scarcely be necessary if the cables were stiff enough to keep from bending out of position, or if there was no chance of them being worked at a high-current density, or danger of the connections heating. In such suitable cases the connections could be made, the links put on, and everything adjusted to position, and held there while the compo cooled, and this would then hold the parts in position for all eternity, and save the cost of the lower pillars and marble base. There are boxes, however, where the current ebbs and flows, like the tide, according to the load, and whose wooden supports warp and perpetrate short-circuits with careless grace. Solid construction will always pay for itself.—J. H. C. B.

Answer to No. 26 (*awarded* 2s. 6d.).—The arrangement most suitable for the case in question would be a box similar in design to the one sketched below (Figs. 1 and 2), consisting of a round network box divided on the line, C D, so as to thoroughly admit of the cables being packed at their entrances with gasket or some similar material, and with an easily detachable lid at the top. The main features of the connections consist of three circular copper rings of successive diameters supported from the bottom of the box by ebonite pillars, each conductor composing the triple cable being connected by short links or fuses to these rings. Fig. 3 gives a larger view of the socket for sweating on to the cables. It is simply a copper casting thoroughly tinned for facilities of soldering. In the top of the vertical lug is a tapped hole for the set screw which clamps one of the links to it. After the various cables have been cut to their proper lengths and sweated on to these sockets, the whole is filled in with some suitable insulating compound (some form of bitumen) to just below the copper rings; this efficiently seals the ends of the cables,

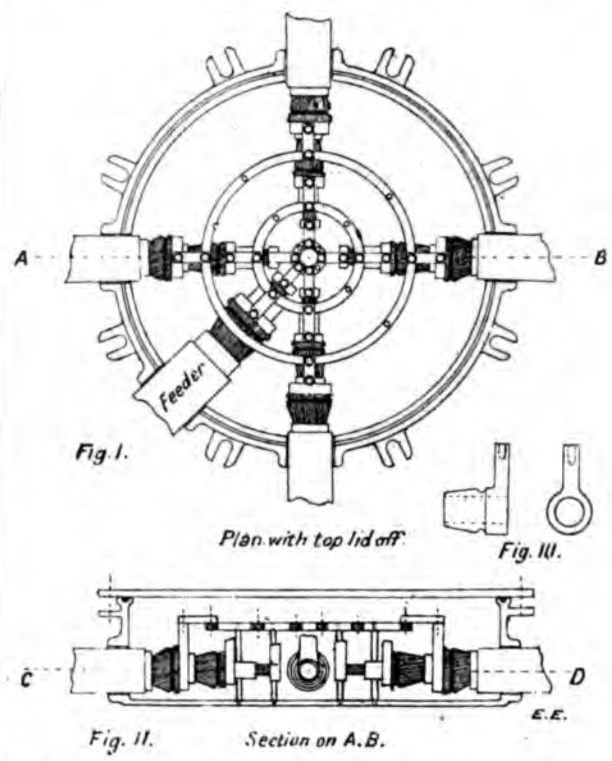


Fig. I. Plan with top lid off. Fig. III.

Fig. II. Section on A.B.

at the same time leaving the links, which are above the compound, quite accessible and easy of disconnection. The advantage of this circular design over a square box with three straight 'bus bars is that the connections are less complicated, and the number of spare parts is very much reduced, making the fittings cheaper and more readily laid in position. The joints of both the lid and the middle division of the box are made with gasket and securely fastened by means of bolts with gunmetal nuts. The whole box is laid in a brickwork pit of somewhat similar shape to itself, with a cast-iron cover filled in with cement to resemble the adjacent flagging.—H. BELL.

LEGAL INTELLIGENCE.

DISPUTED LIABILITY FOR ELECTRICAL GOODS.

In the Westminster County Court on Thursday, his Honour Judge Lumley Smith, Q.C., had before him the case of South v. Lowenfeldt, in which the plaintiff, Mr. Harry South, an electrical engineer, of Garrick-street, Covent Garden, sued the defendant to recover the sum of £18 in respect of goods supplied to him in connection with the Prince of Wales's Theatre.

The **Plaintiff** appeared and said he had supplied the defendant with goods for some years past, and hitherto there had been no dispute between them. Upon this account being applied for, however, the defendant repudiated his liability on the ground that he had not authorised the order.

The **Defendant's Manager** was called and said that at the time of the order and delivery of the goods the theatre had been sub-let to another tenant. Moreover, the plaintiff had been warned in writing not to supply any further goods excepting for cash. He had chosen to do so, however, and that was why the defendant repudiated payment.

The **Plaintiff** was recalled, and said the goods in question were now being used in the theatre for the benefit of the defendant.

His **Honour** said he was satisfied beyond doubt that the defendant gave the plaintiff notice not to supply goods without the money, and if, in face of that, he chose to do so, he must take the risk of losing the money. Judgment, therefore, would be for the defendant, with costs.

extension of the electric light station. Send names to the borough surveyor, Mr. G. H. Pickles, A.M I.C.E., Town Hall, Burnley, by 25th inst.

Novorossisk (Russia).—Tenders are invited for the construction, etc., cf an electric tramway. The deposit required is 5,000 roubles. Specifications, etc. (in French), are to b϶ obtained from, and tenders addressed to, the Municipal Authorities, Novorossisk (Russia), by March 1 (13). The time has been extended from November 15.

Newport (Mon.).—The Corporation of Newport invite tenders for an electric lighting plant for temporary lighting at Wentwood Waterworks. The plant will be required to light about 130 16-c.p. lamps and six 500-volt arc lamps. Further particulars may be had upon application to the borough engineer, Mr. R. H. Haynes, Town Hall, Newport, to whom tenders, endorsed "Wentwood Lighting," should be sent by 10 a.m. on 25th inst.

Brighton.—Tenders are invited by the Town Council for the supply and delivery of dynamos, motors, switchboards, and the necessary wiring at the Municipal School of Science and Technology. Specifications may be obtained on application at the office of Mr. Francis J. Tillstone, town clerk, Town Hall, Brighton. Sealed tenders, addressed to the Town Clerk, and endorsed "Tender for Dynamos," must be left at his office before 10 a.m. on 31st inst.

Rochdale.—The Corporation invite tenders for the following: (Contract No. 1) steam dynamos, balancer and boosters, etc. Specifications, conditions of contract, and form of tender may be obtained at the offices of the engineers, Messrs. Lacey, Clirehugh, and Sillar, 10, Delahay-street, Westminster, on payment of £5. 5s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed and endorsed "Electricity Works," must be delivered at the office of Mr. Jas. Leach, town clerk, Town Hall, Rochdale, by Feb. 19.

Burnley.—The Corporation invite tenders for the supply and erection at their electric lighting station of two combined steam-engines and dynamos. Specification and form of tender may be obtained on application to Mr. W. R. Wright, borough electrical engineer, on payment of £1. 1s., which will be returned on the receipt of a bona fide tender. Sealed tenders, endorsed "Tenders for Steam Dynamos," and addressed to the Chairman of the Electric Lighting Sub-Committee, Town Hall, Burnley, must be delivered by 26th inst.

Wolverhampton.—The Public Works Committee invite designs and tenders for motor-vans for street scavenging and the conveyance of road materials. Outline specification and form of tender can be obtained on application to Mr. J. W. Bradley, C.E., borough engineer and surveyor, Town Hall Wolverhampton, Firms tendering do so at their own cost in every respect. Drawings and a full description of the motive power, capacity, and other particulars, addressed to the Chairman of the Public Works Committee, to be delivered by February 7.

Worthing.—The Electric Light Committee of the Town Council invite particulars and conditions under which any person, firm, or company is willing to instal and maintain the electric light in the borough for a term of years, with power to the Corporation to acquire the undertaking upon agreed terms and at stated periods. The provisional order of the Board of Trade, which is in the usual form, may be inspected, and a plan of the town, showing the compulsory area and other particulars, obtained, on application at the Town Clerk's Office, Liverpool-road, Worthing.

Blackburn.—The Corporation are prepared to receive tenders for the supply of a 500-kw. continuous-current steam dynamo and a 100-kw. steam alternator. Specifications, conditions of contract, and form of tender may be obtained at the offices of the engineers, Messrs. Lacy, Clirehugh, and Sillar, 10, Delahay-street, Westminster, on payment of £3. 3s., which sum will be returned on receipt of a bona fide tender. Tenders (sealed and endorsed "Electricity Works") must be delivered at the office of Mr. Robert E. Fox, town clerk, Town Hall, Blackburn, on or before 22nd inst.

Guipuzcoa (Spain).—The Secretary of State for Foreign Affairs has received a despatch from her Majesty's Consul at Bilbao, reporting that the Provisional Board appointed in connection with the electric tramway which it is proposed to lay from Zumarraga to Zumaya, in the province of Guipuzcoa, invite plans and tender, to be received by February 28, for the construction and equipment of the line. Further particulars of the conditions of the tenders for the above-named tramline and branch, which together measure 30 miles, may be inspected at the Commercial Department of the Foreign Office between 11 and 6.

Leith (Scotland).—The Magistrates and Council invite tenders for erection of electric light station at Great Junction-street. Drawings and specifications may be seen at the office of Mr. Simpson, town architect, Town Hall, and copies of bills of quantities obtained on payment of £2. 2s. each for mason and carpenter's work, and £1. 1s. each for other works—viz., iron, plumber, slater, glazier, plasterer, and tile-layer—returnable if a bona fide tender is furnished. Tenders, in the prescribed form, endorsed "Electric Light Station," addressed to Mr. T. B. Laing, town clerk, Leith, to be delivered by 22nd inst.

Leicester.—The Sanitary Committee invite designs and tenders for motor vehicles for the collection of house refuse. The motive power, capacity, and all other particulars are to be described in a full specification, accompanied by drawings, and delivered at the office of Mr. E. George Mawbey, C.E., borough engineer and surveyor, Town Hall, Leicester, addressed to the Chairman of the Sanitary Committee, by January 31. The loaded wagons would have to ascend an incline of 1 in 20, turn in a limited space, back and tip over a beam about 14in. high by 12in. in width, and when empty descend a road having a gradient of 1 in 15. The Committee do not bind themselves to accept any proposal, and firms tendering must do so at their own cost, no fees being allowed for the preparation of drawings, etc.

Ashton-under-Lyne.—Tenders are invited by the Baths Committee for the installation of the necessary wires, fittings, etc., for the electric lighting of the Corporation baths. The current will be supplied from the town mains. Copies of specifications, general conditions, and form of tender can be obtained on application to Mr. J. Neal, borough comptroller, Town Hall, Ashton-under-Lyne, on payment of a deposit of £1, which will be returned on receipt of a bona fide tender and specification. Any information relating to the work may be obtained from the consulting engineers, Messrs. Lacey, Clirehugh, and Sillar, 78, King-street, Manchester. Tenders to be delivered to the Borough Comptroller, endorsed "Tender for Electric Light Installation at Baths," by 12 noon on Feb. 2.

Wimbledon.—The Urban District Council invite tenders for the supply, delivery, and erection of the following works in connection with their electric lighting scheme: (Section A) water-tube boilers, pumps, etc.; (B) condensing plant, steam-pipes, etc.; (C) overhead crane; (D) high-speed steam-engines and alternators; (E) switchboard; (F) underground mains, conduits, etc. Copies of the specifications, with form of tender and general conditions, can be obtained at the offices of Mr. A. H. Preece, A.M.I.C.E., 39, Victoria-street, Westminster. Applications for any or all of above must be accompanied by a cheque for £5. 5s., which will be refunded on the receipt of a bona fide tender. Tenders, sealed, and endorsed "Tender for Section —, Electric Lighting," must be delivered at the office of the Urban District Council, Wimbledon, by 6 p.m. on Feb. 2.

Bradford. — The Tramways Committee of the Corporation invite tenders for the equipment of about nine miles of street tramways to be worked by electric traction: (Contract No. 1) for steel poles, bracket arms, etc.; (No. 2) for trolley wire, insulators, and overhead equipment; (No. 3) for cars, including trucks, motors, and trolley-pole complete. Conditions, specifications, and bill of quantities may be obtained at the offices of the City Surveyor and the City Electrical Engineer, Town Hall, Bradford, on payment of £5, which sum will be returned on receipt of a bona fide tender. An undertaking must be given by each contractor that he will pay to the workmen employed by him not less than the minimum standard rate of wages. Sealed tenders, endorsed "Tender—Electrical Equipment," to be sent to Mr. George McGuire, town clerk, Bradford, by Feb. 1.

Shoreditch, E.C.—The Shoreditch Vestry invite tenders for the erection of an underground transformer sub-station in Worship-street, Shoreditch, E.C., together with stairways, street refuge, and fittings complete. Specifications, quantities, and forms of tender can be obtained, and the drawings can be seen at the offices of the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of a fee of £3. 3s., which sum will be returned on receipt of a bona tender. The contractor whose tender is accepted shall enter into a formal agreement, under seal with sufficient sureties, for the fulfilment of contract. Trade union rates of wages and hours to be observed. Sealed tenders, endorsed "Electricity Supply, Tender for Sub-Station," to be sent to Mr. H. Mansfield Robinson, vestry clerk, Town Hall, Old-street, E.C., at or before noon on 31st inst.

West Hartlepool.—The Corporation invite tenders for the following work in connection with their electric lighting station: (Contract No. 1) boilers (Lancashire) and mechanical stokers; (Contract No. 2) engines, dynamos, pumps, etc., steam, exhaust, feed, and drain pipes; (Contract No. 3) storage battery; (Contract No. 4) switchboard for lighting and traction work; (Contract No. 5) arc lamps and their erection. In Contract No. 2, it is a condition that the dynamo makers must have already constructed dynamos of at least 100 units capacity. Copies of any of the specifications, with forms of tender and general conditions, can be obtained from Mr. Higson Simpson, town clerk, on payment of £1. 1s. for each section, to be returned on receipt by the Corporation of a bona fide tender. Specifications and drawings can be seen at (but not obtained from) Prof. Alex. B. W. Kennedy's office, 17, Victoria-street, Westminster. Tenders, on the prescribed form, enclosed separately in sealed envelopes, and marked "Electric Lighting, Tender for Contract No. —," must be delivered at the office of the Town Clerk not later than 24th inst.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic

foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one-fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to July 1, 1898.

Stockport.—Tenders are invited by the Corporation for the supply and delivery of the following articles, together with the fixing thereof, at the electrical generating station in Millgate, Stockport, or elsewhere within the borough as may be directed—namely: (B) two mild-steel "Lancashire" double-flued boilers, each 28ft. long, 8ft. internal diameter, and for a working steam pressure of 200lb. per square inch, together with their brick settings, smoke flues, dampers, and all other matters necessary to leave the boilers in complete working order. (C) Three sets of steam dynamos, together with their foundations, beds, trenches, and other matters connected with the working of above machines. Each steam dynamo to consist of a steam-engine of the inverted vertical type of 90 h.p. indicated, with 180lb. steam pressure, at 450 revolutions per minute; the engine being fixed on the same base-plate and coupled direct to a shunt-wound dynamo having an output of 56 kw. of electrical energy. Also a feed-water heater of 150 h.p. nominal, as well as a 6-ton overhead traveller, likewise two feed pumps, each of 2,000 gallons per hour, together with all the steam, exhaust, water pipes, and other connections in and around the generating station. (D) An electric storage battery of 136 cells, and having a total capacity of 750 ampere-hours, together with the stands, switchboard, contact switches, connections, acid, charging of the battery, and all matters necessary for the efficient working of the battery. (E) Electrical instruments and other apparatus upon the general switchboard and elsewhere, together with all electrical connections between the various machines, and other apparatus or things; the wiring and other arrangements and fittings for the lighting by electricity of the generating station. (F) Underground armoured cables, street boxes, and other appliances, to be laid in and under certain streets of the borough, in the neighbourhood of the generating station in Millgate. The Corporation reserve to themselves the right to do the trenchings, and the making good of the streets, and in other places. The works to be carried out in accordance with the plans and specifications prepared by Mr. James N. Shoolbred, C.E., 47, Victoria-street, London, S.W., electrical engineer to the Corporation, at whose office, as also at the Millgate Gasworks, Stockport, the plans and specifications may be inspected during ordinary office hours on and after 17th inst. Copies of specifications and general conditions can also be had there, on payment of £1 per copy of the specifications of each of the various sections lettered alphabetically, or of £5 per copy of the entire set of the specification, which amounts will be returned on the receipt of a bona fide tender. A separate tender must be sent in for each of the various sections. Tenders, enclosed in an envelope, sealed, and endorsed on the outside "Electricity Works," must be sent, addressed to the Chairman, Electric Lighting Committee, Gas Offices, Millgate, Stockport, by 12 noon on 27th inst. Contractors will have to undertake to pay the standard rates of wages and observe the standard number of hours.

RESULTS OF TENDERS.

Westminster.—The Vestry have accepted estimates and designs of Messrs. Verity, of 137, Regent-street, for lighting the vestry hall by electricity for £61. 13s. 2d.

Liverpool.—The Corporation have accepted the tender of Messrs. Willans and Robinson for the supply of two sets of electric lighting plant, at £1,727 per set.

Southampton.—The Town Council have received the following tenders for the wiring and fitting of the electricity supply station: H. M. Ashton, £387. 18s. 6d; A. Ford-Lloyd and Co., £395; Sanby and Co., £415; F. Shalders, £476. The acceptance of the first-named, subject to the engineer approving the fittings, etc., was recommended.

Canterbury.—The Electric Lighting Committee have accepted the following tenders for the supply and erection of electrical plant:

R. Taylor and Sons, boiler-house plant	£1,512	0	0
India Rubber, Gutta Percha and Telegraph Works Company, Limited, engine-house plant	3,773	13	0
J. Spencer and Co., overhead travelling crane	235	0	0
Crompton and Co., Limited, switchboard and instruments	999	0	0
Chloride Electrical Storage Syndicate, accumulators	1,165	0	0
Fowler-Waring, mains	5,336	0	0
Crompton and Co., Limited, public lighting	1,400	0	0
S. Z. de Ferranti, meters	262	10	0

Edison and Swan United Electric Light Company, Limited.—The annual entertainment given by this company to their employés will be held in the Queen's Hall and Winter Gardens, at the People's Palace, to-night. We are invited, and are informed that dancing will commence at 5 o'clock, and that the committee have engaged Mr. W. H. Berry's concert party and the animated photographs; exhibitions will also be given during the evening of Edison's latest invention—the graphophone.

BUSINESS NOTES.

Ealing.—There are now 13,412 8-c.p. lamps connected in this district.

Elland.—The District Council are considering the advisability of providing the town with the electric light.

Llanelly.—The Town Council have decided to reduce the charge for electricity for motive power from 3d. to 2½d. per unit.

Yarmouth.—Additional lamps of 16 c.p. are to be placed between the lamps already standing outside the covered market at the Fish Wharf.

Sedgley.—The Council have decided not to oppose the application of the Midland Electric Corporation for Power Distribution to the Board of Trade.

Globe Telegraph and Trust Company.—The directors of the Globe Telegraph and Trust Company, Limited, announce an interim dividend of 1s. 9d. per share on the ordinary shares.

Greenock.—It appears that the company which intended to apply to the Board of Trade for a provisional order to supply Greenock with electricity has, in the meantime, withdrawn the scheme.

Partnerships.—We are informed that Messrs. Hill, Gifkins, and Co., of 68, Victoria-street, S.W., have joined interests with Messrs. Beanland, Perkin, and Co. as sole selling agents of the Ajax enclosed arc lamp.

Coseley.—The District Council have resolved to give consent to the application of the Midland Electric Corporation for Power Distribution to the Board of Trade for a provisional order to supply the district with electricity.

Electric Construction Company.—The transfer books for the ordinary shares are to be closed from 18th to 31st inst. inclusive, for the payment of the second half of the dividend of 6 per cent. per annum declared on July 22 last.

Westminster Electric Supply Corporation, Limited.—The directors recommend a dividend of 8 per cent. for the past half-year, making with the interim dividend already paid 12 per cent. for the year 1897, payable on March 1.

St. James's and Pall Mall Electric Light Company, Limited.—The directors recommend a dividend for half-year ended Dec. 31 of 11s. per share on the ordinary shares, making with the interim dividend 14½ per cent. for the year 1897.

Bermondsey.—The County of London and Brush Electric Lighting Company's application to the Board of Trade for power to change the supply of electricity from continuous to alternating currents has been referred to a special committee.

Automatic Safety Motor Switch.—Messrs. John Turner and Sons, of Denton, near Manchester, are introducing a new motor switch, which is finding great favour amongst the users of motors who are dependent on central stations for their supply of power.

Hythe.—The Corporation have decided, with reference to the proposed Folkestone tramways, to postpone the question until they know what the sister town of Folkestone is going to do, and also until they had learnt the wishes of their constituents in the town.

Carlisle.—An application from the New Mutual Telephone Syndicate, Limited, requesting the support of the Corporation in an effort to obtain a license to supply an independent telephone service in the city had been considered and refused by the Finance Committee.

Boston.—The Town Council have adopted a report of a committee which stated that the question of lighting the town by electricity had been considered and favourably entertained, and a desire expressed that further information should be obtained on the subject.

Ipswich.—The Guardians have formally rescinded a resolution which was passed in 1896 and which affirmed the inadvisability o lighting the workhouse by electricity. The resolution in favour of an electric lighting installation passed at the last meeting has been confirmed.

Sutton-in-Ashfield.—At the last monthly meeting of the Urban District Council, Mr. J. C. Sampson in the chair, the clerk was requested to obtain a copy of the Bill to be brought before Parliament by the Electrical Power Distribution Company (Warsop), and report thereon.

Hammersmith.—The Vestry have entered into an agreement for renting a strip of land providing a back entrance into the electric lighting works from the Metropolitan District Railway Company, and for the laying of an electric cable under the same at a nominal rental.

Loughborough.—The Mountsorrel Granite Company's works were illuminated on Tuesday night with the electric light, the company having laid down an electric light installation at considerable cost. The lamps are erected on 22 poles, and the lights are steady and brilliant.

Eastern Extension, Australasia, and China Telegraph Company.—The interest on the 4 per cent. mortgage debenture stock for the half-year ending 31st inst. will be paid by warrant on Feb. 1. The stock register will be closed from 27th to 31st inst., both days inclusive.

Beckenham.—At a meeting of the Electric Lighting Committee, the surveyor's report was submitted and partly considered by the committee. Before going further into the question the committee decided to visit the electric lighting and dust destruction works at Oldham and Manchester, and instructed the clerk and surveyor to endeavour to arrange for this visit on the 27th inst.

Jersey.—The St. Heliers Parish Assembly have adopted a petition to the States of the island in favour of a Bill empowering the municipality of the town to borrow a sum of £30,000 for the purpose of an installation of electric light, which is to be under the management of the Parochial Committee.

Personal.—Mr. William George Walker, of 47, Victoria street, Westminster, has been appointed consulting engineer to the Taylor Hydraulic Air Compressing Company, Limited, of Montreal, Canada, and British Columbia. The company will shortly commence operations in this country with offices in London.

Southend-on-Sea.—The Council have agreed to appoint an electrical engineer, at a salary of £200, rising by annual increments of £25 to £300, to prepare plans, sections, drawing, and specifications, and to supervise the carrying out of electric lighting in accordance with the scheme recommended by Prof. Kennedy.

Chester.—A feeder is to be laid at a cost of £2 050. The Lighting Committee's expenses during the year ended Dec. 31 are stated as about £2,400, the receipts as £4,985. The sub-committee have recommended to the General Committee that the price of electricity during the current year should be 5d. instead of 6d. per unit.

Walsall.—The total number of consumers supplied on Dec. 31 last was 98. The town clerk has been instructed to advertise for tenders for constructing, delivering and fixing one 250-b h.p. engine and one high-tension dynamo at the generating station in accordance with the specification prepared by the electrical engineer.

Bristol.—It has been decided to lay a main in Mortimer-road, Clifton, and another from the top of Stoke's-croft along the Cheltenham-road to Gloucester-road, at the point where Somerville-road joins. Designs of the engineer for the new street lamps have been considered, and one with a shaft of less diameter than the existing posts adopted.

Amblecote.—With reference to the scheme of the British Electric Traction Company and the electric lighting provisional order for Kingswinford, it is contemplated to put a generating station in Kingswinford parish to work the Kinver electric tram line. In that case it would be possible for Kingswinford to enter into an arrangement for the supply of electric light.

Soldering Paste.—Messrs. Beanland, Perkin, and Co. inform us that they are now putting on the market a new soldering flux called "Burnley's Royinal Soldering Paste." It contains no acid, and is said to be much more convenient to use than resin. The circular concludes by the characteristic quotation that it is "Used in every first-class shop in America. Should be in yours also."

Ward Electrical Car Company.—The first meeting of creditors of this company will be held at 33, Carey-street, Lincoln's-inn, London, W.C., on the 26th inst., at 11 a.m., and the first meeting of contributories will be held at the same place on the same day at 11.30 a m. The Board of Trade has appointed Mr. Samuel Wheeler to be the official receiver of the company.

Oldham.—The Electric Lighting Committee has resolved to reduce the price of the electric light from 4½d. to 4d. per unit, with a further reduction to large consumers, the new rates to apply alike to all consumers both for lighting and motor purposes. A proposal that energy be supplied for motor purposes at 2d. per unit has been negatived, but it may ultimately be carried into effect.

Direct West India Cable Company.—The cable from Bermuda to Turk's Island is now completed. Messages to the latter colony can now be accepted in Great Britain and Ireland at the rate of 3s. a word. The cable steamer is at the present moment laying the Company's cable from Turk's Island to Jamaica, and it is expected to be completed well within the contract date—namely, 31st inst.

Eastern Telegraph Company.—The fifty-first half-yearly ordinary general meeting was held yesterday at Winchester House at 1 p.m. An extraordinary general meeting was held immediately on the conclusion of the ordinary meeting, for the purpose of considering the Bill now being submitted to Parliament for the conversion of the existing preference shares of the company, and for other purposes.

Kirkcaldy.—Prof. Kennedy on the 18th reported to the Tramways and Town Council Committees on the proposed combined scheme of electric lighting and traction. He recommended the combined scheme, which had no engineering difficulties and was being carried out in other towns, and he approved of the overhead electric system of traction. After the meeting the party drove over the proposed route.

Leicester.—The provision of the electric light to the museum buildings will it is estimated cost £451. 10s., and furniture and fittings a further £548. 10s., making a total estimated expenditure of £3,000. This the special committee have recommended should be provided out of the district fund during the next three years after the rate of £1,000 per annum. The committee's recommendations have been adopted.

Dover.—The electric light company's men are carrying their wires for domestic supply of current up the south side of Park-avenue, there being several residents in the mansions on that estate who are desirous of having the electric illumination in their houses.—With regard to the proposed telephone service, the Council have decided to wait and watch the result of the Huddersfield application.

Llandudno.—From the report of the Electric Lighting, etc., Committee it appears that the chairman of the committee and one of the solicitors of the Council have had an interview with the Council with regard to the attitude adopted by Lord Mostyn in declining his consent to a proposal to take the proposed electric tramway over his land, and declining also to see the deputation appointed by the Council to wait upon him.

Wellington Ignition Tubes.—The Motor Development Corporation, Limited, of the Tower Works, St. George's-square, Regent's Park, N.W., inform us that they have secured the rights and obtained the services of Mr. F. F. Wellington and staff of the Indestructible Ignition Tube Syndicate, Limited (now in liquidation). They beg to inform the customers of that syndicate that they are prepared to supply them as heretofore.

Westminster.—The Vestry have agreed to the St. James's and Pall Mall Electric Light Company proceeding with the laying of mains and constructing street boxes in accordance with the several notices, subject to the precise position of the main and box in each case being arranged with the Vestry's surveyor, the work carried out under his supervision, and to the covers of the street boxes being constructed of some non-slippery material.

Huddersfield.—The borough electrical engineer, Mr. A. B. Mountain, has reported that the number of consumers in the present month was 598, an increase of 30 over December last. The lamps connected at the present time were 41,702 and in December 39,977, an increase of 1,725. The Empire Theatre, Huddersfield, will be lighted by electricity. The committee have accepted tenders for the extension of the electric lighting station.

City of London Electric Lighting Company.—We are informed that all outstanding forms of application (with the banker's receipt for the payment upon application which is attached thereto) and all certificates for fifths of a share of the issue of 10,000 ordinary shares, November, 1897 (Nos. 90,001 to 100,000), must be lodged with the Company on or before 31st inst., otherwise the same will be liable to cancellation or forfeiture at the discretion of the Board.

W. H. Willcox and Co., Limited.—We are informed that the business carried on by W. H. Willcox and Co., engineers' stores, oil refiners, etc., has been converted into a limited liability company for family reasons, and that the management will be as formerly. The Company state that in consequence of increased business they have taken additional offices in 23, Southwark-street, retaining the former premises, 34 and 36 in the same street, as a warehouse.

Wrexham.—The Town Council some time since made an application to the Local Government Board for sanction to purchase some premises for £8,000 for the purpose of converting them into an electric light station, gymnasium, baths, Corporation depôt, etc. The Local Government Board do not approve of the purchase, but state that if the Corporation still desire to buy the property, the Public Works Loan Commissioners will be recommended to lend the money necessary to make the purchase.

Rowley.—The draft of the provisional order to be applied for by the Midland Electric Corporation was considered by the District Council at its last meeting, and the Chairman said no doubt the introduction of electricity into the district would be a great assistance to manufacturers. The solicitor, Mr. T. Cooksey, advised the Council not to take any action in the matter until several alterations in the order were made. This suggestion was adopted.

City and Waterloo Railway.—The City and Waterloo Railway, which will give the London and South-Western Railway direct access from the Waterloo terminus to the heart of the City, will shortly be opened for traffic. The line itself was completed some time ago, but delay which could not be avoided has occurred both by reason of the dispute in the engineering trade and also in connection with the enormous amount of underground work which has had to be undertaken by the Central London Railway Company at the new station opposite the Mansion House.

Taunton.—The Electric Lighting Committee have reported that applications had been made to the committee for terms for the supply of electricity for power and heating, and the committee hoped shortly to be able to arrange supplies for those purposes. The existing contract for the supply of coal having nearly run out, the committee had advertised for tenders for the supply of 1,500 tons, and they asked for power to accept a tender. The installations during the past month had been equal to 99 16-c.p. lamps. The report has been adopted by the Town Council.

Bridgwater.—At the last meeting of the Council the Engineer reported having examined the draft provisional order for conferring power upon the Corporation to provide electric light. There were certain watercourses under the streets of the town which were in the jurisdiction of the Commissioners, and he recommended that clauses should be inserted protecting the interests of the Commissioners with respect to these, and also to the river. The clerk was instructed to communicate with the town clerk of Bridgwater, and also to attend the Board of Trade enquiry on behalf of the Commissioners.

Fulham.—At the last meeting of the Vestry the following motion was proposed, but not carried; "That in view of the large expenditure involved it is expedient to ascertain as far as possible the opinions and desires of the ratepayers upon the important questions as to whether or no the Vestry shall proceed to the erection of electric lighting plant, dust destructor, and sanction the erection of swimming-baths and wash houses, and to take suitable steps in conjunction with the overseers and the collectors of the general rate or otherwise to obtain a poll of the ratepayers of the parish."

Bootle.—The Town Council have decided that in accordance with the resolutions of the Council on Dec. 12, 1894, and Feb. 13, 1895, passed on the recommendation of the Health Committee,

the purchase of the strip of land near Pine-grove, belonging to the Leeds and Liverpool Canal Company, and containing as to the portion opposite the central electric lighting station site, 142 square yards, and as to the portion opposite the Corporation wharf, 319 square yards, be concluded on the terms agreed with the company—namely, the payment of £150 and the erection of a retaining wall opposite the first-named portion.

Liverpool.—A conference was held on the 13th inst. of the members of the Lighting Committee and the Tramway Committee with regard to the utilisation of electricity as the motive power on the tramways, the lighting of the tramcars on the experimental line, and the extension of the electric mains throughout the city. A report was presented by Mr. Holme, the electrical engineer, showing how the electric system could be applied to the tramway service, and the advantage that would probably result therefrom. After some discussion it was decided to refer the matter to Dr. Hopkinson, the consulting electrical engineer.

Gravesend.—At the last meeting of the Town Council the Town Clerk reported that the parliamentary agents of Messrs. Crompton and Co., Limited, had printed and advertised the provisional order, which had been settled in the form assented to by him on behalf of the Corporation. He further reported that they had paid Mr. Bond, the Corporation electrical adviser, and had undertaken to pay the charges for perusal of the drafts of the provisional order and other documents, but that the terms of the draft of the assignment of the order to the company, and of their preliminary agreements with the Corporation, had not yet been settled.

Buxton.—At the last meeting of the District and Parish Councils a letter was read from Messrs. Bennett and Co., solicitors, *re* the electric light installation, stating that their clients desire to work with the Council, and that they would not proceed further with the application to the Board of Trade this year, on the understanding that the Council would communicate with them when they received Prof. Kennedy's report. The New Mutual Telephone Company wrote pointing out the necessity for a cheap and efficient telephone service, and the Council thought the project in question was a good one, inasmuch as the price would be £6. 10s., instead of £10 a year.

Cardiff.—A second resolution, referring to the tramways proposals, was carried unanimously at the adjourned town's meeting last week. In this power was asked for the Corporation to form and carry on certain tramways from the Docks to Grangetown by Clarence-road and Corporation-road, in the neighbourhood of Corbett-road, Portmanmoor-road, Clifton-street, and other streets in Roath, and also up Penylan Hill way; and further to adapt the existing tramways for traffic, the whole to be worked by mechanical traction, including electricity; and to make certain rates and charges therefor, as well as to make provision for the carriage and convenience of workmen.

Melbourne.—The electric light has just recently been introduced into this town by Mr. William Helmsley, of Ashby, at his Kendrick Mills. The dynamo, as at present used, is capable of producing eight amperes of current at 110 volts pressure, equal to 30 lights of 8 c.p. each. This was put in as an experiment in one room, with a view to further development if found satisfactory. The testimony of the workmen is that it is a better artificial light than any they have worked with before The motive power is supplied by the engine that drives the mill machinery. There is surplus power to light the whole of the works, and from 150 to 200 lights to spare. The installation has been carried out by Mr. Jeques, of Melbourne.

Brechin.—No objections have been lodged to the proposed scheme for the installation of the electric light in Brechin, so that there is now practically nothing to stand in the way of operations being commenced on an early date. The provisional order was obtained by the Town Council in November last, consequent upon an offer by Messrs. Edmundsons, Limited, London, to form a local company to carry out the project. The company are to pay all the expenses of obtaining the order, and also the transfer. The Council are to receive current for street-lighting purposes at a reduced rate, in addition to other minor considerations. At any time after 10 years the Council have the option of purchasing the undertaking at the price of the capital expended, with the addition of a certain percentage.

Great Northern and City Railway.—The Great Northern and City Railway Company (authorised in 1892 to construct an electric underground railway from the Canonbury branch of the Great Northern Railway to the City) are applying for powers to extend their line to Finsbury Park Station (Great Northern), and also to effect a diversion for a short distance of the Canonbury branch of that company near Drayton Park. Considerable areas of additional lands are also sought to be acquired at Drayton Park, including lands for a generating station. For these purposes Parliament is asked to sanction the creation of £400,000 additional share and loan capital, and power is sought to cancel the existing agreement with the Great Northern Railway Company and to enter into and carry into effect a new agreement.

Wolverhampton.—The following recommendation of the committee upon the application of the Midland Electric Corporation for Power Distribution (referred to in our last issue), was, after a lengthy debate, carried by 25 to 8 by the Town Council: "That the application of the Midland Electric Corporation for Power Distribution, Limited, to the Board of Trade for a provisional order empowering them to supply electricity within the borough of Wolverhampton be received, and that in pursuance of the recommendations therein contained this Council doth hereby give its consent to the promotion of the said order so far as the same relates to this borough; and that if any steps should be taken by the applicants with the view of asking the Board of Trade to dispense with such consent, steps be taken to resist it."

Croydon.—A report of the Lighting Committee has been adopted by the County Council, according to which Prof. Kennedy is to act as consulting engineer to the Corporation from March 25 next. Prof. Kennedy is to make half-yearly reports on the state of the plant and mains after special inspection, and he will be at the service of the Corporation to make reports on any matters in which they might require help or advice connected with electricity, whether in the matter of lighting or traction. Preparation of plans and specifications and the superintendence of extension work in the station from time to time are to be placed in the hands of the professor, he being paid on such work a commission at the rate of 4 per cent. Mr. Minshall, the present engineer-in-charge, has been appointed borough electrical engineer, as from March 25 next. At the next meeting a return will be presented of the present members of the staff, with particulars of their experience, duties, and remuneration.

Cardiff.—A meeting of the Lighting and Electrical Committee of the Cardiff Corporation was held on Tuesday, when the electrical engineer, Mr. Appelbee, reported that the total number of 8-c.p. electric lamps supplied on Dec. 31 last was 15 431, compared with 14,136 in the corresponding period of 1896, being an increase of 1,298. The lamps connected and applications received during December were 208, and the total number of lamps awaiting connection at the end of the month was 1,296. The total number of Board of Trade units generated during December last was 63,782, compared with 59,365 in the corresponding period of 1896, being an increase of 4,418. The calculated revenue for last month was £78 from arc lamps, and £786 from private supply, making a total of £864. The revenue in December, 1896, was £819. 19s. 1d. The sale of current for the year 1896 was 308,430 units, compared with 342,461 units in 1897, and increase in the latter year of 34,031. The results of the year would show a surplus making it worth while for the committee to consider the question of reducing the rates for the supply of current. The rates now charged were 6d. for the first two hours and 3½d. afterwards. He suggested that the rates should be 7d. for the first hour and 3½d. afterwards. The committee, however, took no action in the matter.

Waterford and Limerick Railway.—An exchange says: "The luxuriously-furnished saloon carriage in which the Duke and Duchess of York travelled over the Waterford, Limerick, and Western Railway Company's line during their visit to Ireland, has just been equipped with electric light. It was intended from the first that this additional comfort should be provided in this carriage, which reflects so much credit on the skill and taste of the locomotive department at Limerick, but the work was hastened in view of the Lord-Lieutenant's visit to Glenstal on the 25th inst., this being the carriage which will be placed at his Excellency's disposal. The dynamo is worked from underneath the carriage, and three clusters of electric lamps are placed along the roof. One, two, or three lights can be switched on or off by simply turning a tap which is at the end of the carriage. The saloon has been run to Killaloo for the purpose of testing the efficiency of the new illuminant. Two representatives of the firm of Messrs. Stone, electrical engineers, London, who fitted up the light, were in charge of the machinery, and were accompanied by Mr. Robertson, superintendent of the locomotive department, and Mr. Brown, foreman. The result was satisfactory in the highest degree, and when the light was turned on at the ordinary pressure the carriage presented a brilliant appearance."

Southampton.—At the last meeting of the Town Council the Electric Lighting Committee reported that, according to a report from the engineer, the output for November last was 24,240 units, being an increase of 8,970 units, or 58 per cent. over that of November, 1896. Owing to the general increase of output, it had now become necessary to run the works continuously throughout the 24 hours. To do this the staff would have to be increased sufficiently to enable three eight hours' shifts to be worked. At present the only addition necessary was a third assistant engineer to take charge of the third watch. He had managed to dispense with this up to the present, but as the amount of current consumed at night and early morning had increased, it had become more and more difficult to arrange to keep the pressure right at those times. The load on Dec. 23 was the heaviest on record, and required the whole of the plant to deal with it. In order to cope with the pressure of work, the committee recommended that an additional assistant be engaged, at a salary of 30s. per week; and that, in consideration of the extra work the engineers had performed since March last, they further recommended that bonuses of £10 and £5 be paid to several of the assistants, and it was resolved that the wages of the assistant linesman be increased. The town clerk was instructed to advertise for tenders for the supply of 50 to 200 tons of steam coal, in accordance with specifications to be prepared by the engineer. Tenders were submitted, to which we refer elsewhere. The report was adopted.

Swansea.—At the annual banquet of the Horticultural Society, the Mayor said he believed that during the remaining months of his tenure of office something would be done by the Town Council to advance Swansea a little further. The triple scheme was lost last year, not because there was not a sufficient majority at the Council in favour of it, but because some of the leading ratepayers outside were afraid of it. He took it they were not going to be satisfied with paying a high price for a low quality of gas, especially when they were situate in the middle of a coalfield, a great part of which was capable of being utilised for the purpose of producing gas. The monopoly of the gas company was

growing, but there were two ways of overcoming it—either to purchase the concern or establish electric lighting. Whatever was done, they must send men of calibre and of experience to the Town Council to manage the public business properly. His worship predicted that they were going to get electric light, and repeated that it could be supplied for 2d. per unit, provided a customer, such as the tramway company, could be obtained to take the day load. And that would be better than gas even at 2s per 1,000 and of 20 c.p., instead of 3s. per 1,000 and 15 c.p., as at present. He believed the town almost as a whole would unanimously adopt the triple scheme—that the opposition would be simply stamped out—and, towards the conclusion, mentioned that the tramways company would not sell unless under a lease, as they believed in their concern, whilst the Corporation, in trying to come to some arrangement that would meet the approval of all, did not intend landing the town into any terrific expense.

Crieff.—Mr. Frederick Yorke, electrical engineer, Glasgow, has submitted a proposal (referred to in our last issue) to the Town Council for the public and private lighting of the town, by which, he says, the town will not be put to any expense in connection with the scheme, which will be carried out by a private company, the water power being given by Sir P. Keith Murray free. It is proposed to provide at the Turret Falls duplicate turbines and dynamos, working in combination with electric storage at Crieff, dealing with 5,000 lamps (exclusive of the power for public lighting); the current for generating station at the Turret Falls to be conveyed by means of overhead wires to the outside of the town and underground through the town; to provide in Crieff electric storage capacity capable of dealing with 3,000 lamps connected, etc. Mr. Yorke also offers to supply and erect 12 arc lamps of approved design of 1 000 c p. each, placed in the most prominent parts of the town, and 160 incandescent lamps of 16 c.p each; also 20 16-c.p. all-night lamps. He further offers to supply and fix on the existing gas standards approved tops and globes to make them suitable for electric lighting, at the rate of £160 per annum for the whole of the current supplied for public lighting. For the purpose of giving security to the shareholders the town will be asked to give a contract for public lighting at the above rate for 21 years, with a break in favour of the town at the end of 10 years. Private lighting will be undertaken at 6d. per Board of Trade unit, which is equivalent to gas at 3s. per 1,000 cubic feet. The rent of meters to be 1s. 6d. per quarter. The further consideration of the proposal has been postponed till another meeting.

Whickham.—The special committee appointed to enquire into the necessity of providing light for the Marley Hill district, and also the best method of illumination, have submitted to the Urban District Council the following report: "We are now able to fully report on the lighting of Marley Hill and Byer Moor, and, after careful consideration of the whole question, are unanimously in favour of electricity. We have been considerably assisted in getting out the necessary details by a visit at night (whilst the lights were burning) to Sacriston, Witton Gilbert, Daisy Hill, Plawsworth, Nettlesworth, Kibblesworth, and Langley Park, which places have an installation somewhat similar to that which we respectfully submit for your consideration. We therefore recommend that lamps be fixed as follows: Marley Hill, 12; High Row, 6; School Houses, 2; Marley Hill Hole 4; and Byer Moor, 8, making a total of 32 lamps, each lamp to be equal to 16 c.p. We have received an estimate and specification from the Corlett Electrical Engineering Company, Limited, Newcastle, who will fit up the installation, which includes 60 poles, 24ft. long, and all the necessary fittings for the same. The price for the complete installation to be £165 net. For the supply of the current, we consider that an agreement could be made with the Marley Hill Coal Company, the switchboard to be placed in their engine-room, and to receive the amount of current necessary to light up the 32 lamps, to burn 1,100 hours per annum, at a cost of £1. 14s. 6d. per lamp; this to include both the lighting and keeping in repair of the whole of the lamps, and to be subject to a six months' notice on either side. We therefore have first £165, and a yearly charge of £55. 4s., which we consider very reasonable, and one of the best opportunities the Council have had." It has been decided that tenders be asked for each district.

Appointments Vacant.—The West Ham Town Council require a chief assistant in the borough electrical engineer's department. Applicants must have had a mechanical and electrical training, and had experience in the working of a high-tension (alternating) station. The gentleman appointed will be required to devote his whole time to the duties of the office, and reside within the borough. The salary will be £130 per annum, rising by two annual increments of £10 to £150. Applications must state age and experience, accompanied by not more than three copies of testimonials of recent date, and be endorsed "Appointment of Chief Assistant, Electrical Engineer's Department," and reach Mr. Fred. E. Hilleary, town clerk, Town Hall, West Ham, by 4 p.m on 26th inst. Canvassing is prohibited.—The Plymouth Corporation require a competent cable jointer. Applicants must be experienced in the laying and jointing of lead-covered paper-insulated mains, including the making of plumber's lead joints, and the fixing of transformers and house meters. A knowledge of vulcanised rubber jointing would be a recommendation. Hours, 50 per week, or as required in cases of emergency. Wages, 45s. per week inclusive. Permanent employment to a suitable man. None but strictly sober, competent, and trustworthy men need apply. Applications, in writing only, stating age and experience, with references, to be made to the borough electrical engineer, East-street, Plymouth, by 25th inst.—The Corporation of Barrow-in-Furness invite applications for a resident electrical engineer, who will be required to devote the whole of his time to the superintendence of the works of the installation and take charge of them after completion. The salary is £200, with the privilege of taking a pupil. Applications must be sent in by Feb. 8.—The Southend-on-Sea Corporation invite applications for the appointment of electrical engineer, at a salary of £200, rising by annual increments of £25 to £300 per annum. Further particulars appear elsewhere in this issue.

Lewisham.—A special meeting of the District Board was held last week "to consider the proposed application to the Board of Trade for a provisional order authorising the Board, as the local authority for the district, to supply electricity for any public or private purposes within the district." The Chairman said that on Nov. 24 the Board decided to give notice of intention to apply for such a provisional order, and public notice was given in the usual manner, and a memorial presented to the Board of Trade on Dec. 21. This meeting was held to comply with all the provisions of the law. The following resolution was moved: "That the application now being made to the Board of Trade for a provisional order under the Electric Lighting Acts of 1882 and 1888, authorising this Board to supply electricity in the Lewisham district for all public and private purposes, as defined by the Acts, be made, approved, and confirmed, and all necessary steps be taken to carry into effect the Board's resolution in the matter, and in support of their application to the Board of Trade for their consent to the application accordingly." The resolution was a formal one, which had to be passed before Jan. 15 in order that it might be considered by the Board of Trade on the 20th. There are two companies now supplying the electric light in the parish of Lewisham, and two other companies have applied, but the Board thought it advisable to supply the electricity themselves, especially as in the dust destructor which had lately been purchased there was a large amount of extra heat which could be utilised for the purpose of producing electricity. The Chairman said that what they were doing then had to be done to satisfy the Act of Parliament. The details would afterwards have to be considered. As regards the project, they were in a more favourable position than some others, as, whatever they might say about their dust destructor, they had more heat there than was wanted to burn their dust, so that the production of electric light might result in making that destructor a very good bargain. The motion was carried *nem. con.*, as was also an alternative resolution to apply for a license to supply electricity.

Bath.—*Keene's Bath Journal* gives the following extract of the report of Mr. Metzger to the Electric Light Committee: "Some trouble has been experienced in the works, due to the heavy loads on the machinery. When one considers under what harrassing conditions the station is now running, it is not surprising. It must be remembered that the station last winter was considerably overloaded. The lamp connections were then 11,700, and we had only 10 000-light plant. On the strength of the promises that the new plant would be in working order by Oct. 1 last, fresh lamp connections have been made during this year, and these now amount to 13,000. It follows, therefore, that our whole plant is considerably overloaded; and in the event of one engine or dynamo breaking down, some circuits cannot possibly be supplied with current. In addition to this, our coal bunkers have been pulled down to erect the new boilers on the site they previously occupied, and the coal has to be stacked in the yard adjoining the engine-room. The coal dust smothers the machinery, even when all the windows are closed, thereby bringing up the temperature in the engine-room to over 100deg. Hot bearings are, unfortunately, in consequence of the coal dust and cement, a frequent occurrence, which were very rare before. We are even in a worse condition with the boilers. Last year we had four 100-h.p. boilers, but one has since been removed, as per contract. We have, therefore, 300-h.p. boiler power, and the demand of steam to supply both street arcs and house lights amounts to 680 h.p. I am obliged, therefore, to force the boilers to their utmost limit, and to such an extent that the flames can be seen issuing from the top of the 90ft. chimney shaft; but, of course, it is not possible to keep full steam during the heavy load. The stokers have to work under most trying conditions. I trust, therefore, that, in taking all these points into consideration, you will exonerate myself and my staff from the somewhat defective lighting of late. I am doing my best to keep things going, and often wonder that we are supplying to the present extent. We are working against overwhelming odds, and I have been compelled to request various customers to economise the light as much as possible, and we have even had to dispense with the light in the works. It will indeed be a relief when we are once again in smooth waters." At a meeting of the committee on Jan. 5, Mr. Metzger reported that he could supply current for arc lighting in six weeks from that time.

Islington.—At a meeting to be held to-day the Vestry will receive a report from the Electric Lighting Committee stating that in consequence of the exceptionally heavy demand for electricity in the Upper-street and its vicinity it is found absolutely necessary to at once supplement the present mains in that district with additional feeders; that it appears from a report of the electrical engineer that when the cables are laid from the works along Holloway-road to supply the Highbury New Park district (which is a very large one) and the Canonbury and Essex-road districts, the conduits in Holloway-road from Eden-grove to Highbury Station will be fully occupied; that the laying of additional conduits under the footpaths of Holloway-road would be a most difficult and costly matter on account of the large number of gas, water, and telegraph pipes already in existence there, while it appears that it is inadvisable to lay these conduits in the carriageway in consequence of the risk of breakage to the requisite surface boxes owing to the traffic; that it has therefore

been deemed advisable to open up a fresh cable route and line of conduits from the works through Wellington-road to St. James's-road, and thence along one side of Liverpool-road to Upper-street, which will permit the whole of this district, including Upper-street, to be supplied from two directions, and enable the standard pressure required by the Board of Trade to be maintained there; that, in view of the fact that the demand in Upper-street is increasing, it is essential that this work should be carried out before the ensuing winter; and that the committee is of opinion that such work should take precedence of all other work hitherto authorised. The committee will submit the engineer's estimate of cost, and recommend that the work in question be carried out as soon as the sanction of the London County Council be obtained to the borrowing of the money. The committee is also of opinion that as a line of trams runs along Liverpool-road it will be advantageous to extend the arc lighting through this thoroughfare, and to proceed with the erection of the lamps and the laying of the necessary mains at the same time as the other work is being carried out; that it has been ascertained that the estimated cost of this work, including about 40 arc lamps with columns, cable, and all accessories and labour complete, is £2,500, and they recommend that this additional work be executed accordingly. The engineer's estimate for the necessary cast-iron conduits, surface boxes, taking up and relaying footway and all accessories, including cable, labour, etc., for the purpose of improving the distribution in Upper-street, and to meet the growing demand for electrical energy, is £3,164.

Aberdeen.—At the last meeting of the Watching and Lighting Committee of the Town Council the sub-committee reported on the lighting arrangements of certain parts of the city, suggesting additional lamps in various places, and recommending that the existing gas lamps in front of the municipal buildings and round Castle-street be lighted by electricity. The report was unanimously agreed to. The latter part of the recommendation will be carried out by the introduction of incandescent electric burners into the lamps indicated; and it is obvious that if the experiment proves a success there will be no further necessity for the erection of the tall standards from which the electric globes are suspended.—The question of the extension of the electric mains to the west end of the city, according to the *Aberdeen Journal*, is at present engaging the attention of the Gas and Electric Lighting Committee of the Town Council, and a report on the subject by the gas engineer, Mr. Smith, and the electrical engineer, Mr. Blackman, has been communicated to Prof. Kennedy for his opinion. It is urged by the reporters that the west-end scheme, if adopted, should be gone on with while the harbour mains and the mains to Bridge-street are being laid, as operations would then be in progress over a very considerable portion of the route to Queen's Cross. It would be quite possible, they say, to commence supplying electricity in the west end from Cotton-street on the same system as is in use at present, but when the demand grew to anything like large proportions, it would be uneconomical to do so. The reporters then discuss two alternative methods—a new electricity works, or a high-tension supply. The objections to a new works are the large first cost (at least £20,000) and the extra yearly expenditure in wages. Further, with two electricity works, one in the east supplying business premises chiefly, and one in the west end supplying a residential neighbourhood only, the works would, at the same time in the evening, be one of them heavily and the other lightly loaded, and would never have the time of their heaviest load simultaneously. It is therefore of the very greatest importance, in order to obtain economy and reap the benefit of these different classes of consumers, that the two classes of load be supplied from the same works. For the cost of electrical energy depends very greatly upon the load factor at which the plant can be worked, or, in other words, the more hours per day the plant can be loaded the greater will be the earning capacity of the capital employed. The surest way, then, of obtaining this desirable end is for an electricity works to have on the mains supplied by it customers varying as much as possible in the time of their demands. With a high-tension supply on either the continuous or alternating current systems, it would be economical and practicable to supply the whole area of Aberdeen from Cotton-street for lighting and power purposes, and also for the tramcars, but the high-tension continuous-current system would work the better in combination with the existing low-tension system. Mr. Smith and Mr. Blackman therefore recommend that the supply of the west end and other outlying portions of the town be carried out by high-tension continuous-current feeders, and that mains to supply 24,000 lamps should be laid to Queen's Cross at an estimated cost of £7,900.

Australia.—The following is an abstract of Mr. Hesketh's report on the electric lighting tenders of Ipswich, Queensland, considered by the Town Council on Nov. 23 last: "In considering what recommendations to make to your Council on these tenders I have borne in mind (1) that any tender now recommended must be subject to the final contract being satisfactory; (2) that it is preferable to recommend a reliable tender at a fair price rather than adopt one which may eventually prove to be the least advantageous to the Council. I therefore submit for consideration three alternative tenders in each section from which your final decision may be made. This final decision, I take it, will not be made until after you have obtained power to borrow the necessary money, and authority to go on with the work. Section E, it will be noted, includes cables for 27,000 yards, but it is improbable that the whole of this would be laid down at once. Remarks: Section A—The boiler I would prefer to have accepted would be the Babcock and Wilcox water-tube, but as the price seems too high, I think the compound Cornish made by Messrs. Evans, Anderson, and Phelan should be accepted. Section B—If the Cornish boilers are obtained, the steam-pipes should be ordered from them to save trouble. Section C—Messrs. Siemens Bros.' combination I consider the best. Section D—It is advisable to place the order for the switchboard with the successful tenderers for Section C if the price is not prohibitive; I therefore recommend Messrs. Siemens's tender for acceptance. Section E—I have, personally, great faith in the Brisbane Electric Supply Company's cable, manufactured by the British Insulated Wire Company, and from personal experience can testify to its excellence; I have no reason, however, to doubt the excellence of the cable manufactured by the other two tenderers, and their prices are considerably lower. Section F—The transformers quoted are all good, and in the final selection it will be on details that the decision must rest." The following were the tenders received:

Section A.	
Crompton and Co.	£1,020
Siemens Bros. and Co., Limited	1,075
Babcock and Wilcox, Limited	1,650
Section B.	
Crompton and Co.	856
Siemens Bros. and Co., Limited	971
Babcock and Wilcox, Limited	1,050
Section C.	
Siemens Bros. and Co., Limited	3,159
Brush Electrical Engineering Company, Limited	3,200
Babcock and Wilcox, Limited	3,550
Section D.	
Babcock and Wilcox, Limited	375
Electric Construction Company	417
Siemens Bros. and Co., Limited	518
Section E.	
Siemens Bros. and Co., Limited	6,894
Noyes Bros., agents for the Callender Company	7,316
Brisbane Electric Supply Company	10,068
Section F.	
Siemens Bros. and Co., Limited	725
Crompton and Co.	760
Nalder	785

The expense seems to frighten the authority, for up to the time of writing we have not heard that any tender has been accepted.

PROVISIONAL PATENTS, 1898.

JANUARY 10.

632. **Improvements connected with electric lamps and switches.** William Miller Walters, 4, Clayton-square, Liverpool.

665. **Improvements in electric switches.** Jesse Lorenzo Hinds and Huntingdon Beard Crouse, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

678. **Method of diminishing the affinity of electrolytically-produced chlorine.** Christian Albert Jensen, 77, Chancery-lane, London. (Alf Linding-Larsen, Norway.)

698. **Improvements in or relating to the electric illumination of railway trains.** Bronislaw de Szwantowski, 8, Quality-court, Chancery-lane, London.

JANUARY 11.

729. **Electric rotary cutters.** Fulton Gardner and Delby Joseph Smith, 154, St. Vincent-street, Glasgow. (Complete specification.)

735. **Improvements in switches for use in electric light installations.** Harry Taffs and James Hill, 5, John Dalton-street, Manchester.

756. **An improved electrical apparatus for railway signalling during fogs.** Robert William Gay, 104, Colmore-row, Birmingham.

783. **Improvements in portable electric alarms and bell-sets.** John Davidson, 35, Therapia-road, Honor Oak, London.

809. **Improvements in automatic calling devices for telephone exchanges.** William Phillips Thompson, 6, Lord-street, Liverpool. (The Strowger Automatic Telephone Exchange, United States.) (Complete specification.)

812. **Improvements in or relating to dynamo-electric machinery.** P. R. Jackson and Co., Limited, and Joseph Slater Lewis, 322, High Holborn, London.

814. **Improvements in the means for controlling the lighting and extinguishing of electrically illuminated signs and other advertising and show tablets.** John Thomas Gent, 11, Burlington-chambers, New-street, Birmingham.

817. **Improvements in electric railway conduit systems.** Ralph Fowler Thompson and Edward Jeremiah Sullivan, 6, Lord-street, Liverpool. (Complete specification.)

831. **A system of conducting electricity for propelling heating, lighting, and telephoning from railway vehicles.** Hosea Waite Libbey, 45, Southampton-buildings, Chancery-lane, London.

834. **Improvements in single-phase induction motors.** Llewellyn Birchall Atkinson, 1, Queen Victoria-street, London.

848. **An improved galvanic battery.** Johannes von der Poppenburg, 4, Corporation-street, Manchester.

835. Improvements in single-phase and multiphase alternate-current motors. Llewellyn Birchall Atkinson, 1, Queen Victoria street, London.

JANUARY 12.

932. Improvements in the manufacture or production of electrodes for secondary batteries. Charles Pollak, 47, Lincoln's-inn-fields, London.

933. Improvements in electrolytical condensers and electric current-directing devices. Charles Pollak, 47, Lincoln's-inn-fields, London.

935. Improvements in or connected with pole-pieces of dynamo-electric machines. Charles William Dawson, Norfolk House, Norfolk-street, Strand, London.

JANUARY 13.

953. An improved telephone line switch. Gilbert Lay, 27, Chancery-lane, London.

1002. Improvements in electricity-measuring instruments. Arthur Annesley Voysey and Reginald Page Wilson, 191, Fleet-street, London.

1011. Improvements in electric incandescent lamp sockets or holders. Reuben James Bott, 235, Phillip-lane, West Green, Tottenham, London.

1017. Improved method of and apparatus for signalling or advertising by electricity. Alexandre Ginisty, 9, Warwick-court, Gray's inn, London. (Complete specification.)

1021. Improvements in the manufacture of filaments for incandescence electric lamps. Charles Henry Stearn, 47, Lincoln's-inn-fields, London.

JANUARY 14.

1046. An improved method and electromagnetic cut-out for automatically disconnecting charged conductors in the event of breakage or short-circuit applicable to overhead systems of electric traction and the like. Robert Cornelius Quin, Ambleside, Palatine-road, Blackpool.

1073. Improvements relating to graphic or writing telegraphy. Richard Hurley, 10, St. George's-crescent, Liverpool.

1114. Improvements in telephone exchanges. John Owden O'Brien, of the firm of W. P. Thompson and Co., 6, Bank-street, Manchester. (Georg Ritter, Germany.)

1127. Improvements in electrical safety devices. Henry Max Salmony, 226, High Holborn, London.

1140. Improvements in electromagnets for electric traction. Henry Harington Leigh, 22, Southampton-buildings, Chancery-lane, London. (The Gesellschaft zur Verwerthung elektrischer und magnetischer Stromkraft (System Schiemann and Kleinschmidt) Ad. Wilde and Co., Germany.)

JANUARY 15.

1145. Improvements in electric cables. Gerald Carlyle Allingham and William Fennell, 27, Bower-road, Victoria Park, London.

1184. Improvements in safety devices for electrical circuits. Thomas Harden, 85, Foxbourne-road, Balham.

1194. **Improvements in secondary batteries.** Gustav Philippart, 6, Lord-street, Liverpool. (Complete specification.)

1213. Improved apparatus for the electro-decomposition of water. Sir Charles Stewart Forbes, Bart., 21, Finsbury-pavement, London.

1216. Method and means or apparatus for facilitating the erection of overhead telephone, telegraph, and like wires or conductors. Joseph Hallett, 46, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED.

1896.

24019. Electric batteries. Rochatte. (Date applied for under International Convention, April 21, 1896.)

29087. Electrical low-water alarm or indicator for steam-boilers. Hughes.

29576. Electric furnaces. Hughes.

29868. Electrical appliances for the handles of cycles, pedals of sewing machines, harmoniums, and the like. Bhise.

29933. Controlling apparatus for electrically-propelled vehicles. Brougham and Bersey.

30061. Electrical connecting cords. McEvoy.

1897.

1800. Electric clock movements to record the time by electricity. Stockall.

2301. Time meters for telephonic conversations. Keim.

4916. Electrical accumulators. Heyl.

5565. Construction of a synchronous motor for single or polyphase alternating electrical currents in combination with an auxiliary synchronous motor. Abel. (La Société Anonyme pour la transmission de la force par l'electricité.)

22236. Porous diaphragms for electrolytic apparatus. Darling and Harrison.

TRAFFIC RECEIPTS.

South Staffordshire Tramways.—The traffic returns for the week ending January 14 were £609. 15s. 10d., as compared with £569. 6s. 2d. in the corresponding week of the previous year.

Dover Tramways.—The traffic receipts for the week ending January 15 were £108. 3s. 4d. The total receipts for the year 1898 are £225. 15s. 2d. The mileage open at present is 2½ miles.

Birmingham Tramways.—The traffic receipts for the week ending January 15 were £3,458. 10s. 6d., as compared with £3,023. 18s. 8d. in the corresponding week in 1897, being an increase of £434. 11s. 10d.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended January 16 amounted to £1,361, as compared with £1,278 in the corresponding week of the previous year, being an increase of £83.

City and South London Railway.—The returns for the week ended January 16 were £1,085, compared with £1,085 for the corresponding period of last year, being exactly identical. The total receipts for the half-year amount to £3,259, compared with £3,273 for the corresponding period last year, being a decrease of £14.

Bristol Tramways.—The traffic returns for the week ending January 14 were £2,365. 3s. 2d., compared with £1,913. 14s. 2d. for the corresponding period of last year, being an increase of £451. 9s. 0d. The aggregate receipts for this year are £1,151. 1s. 3d., as compared with £1,138. 11s. 4d. in the corresponding period of 1897.

S.D. Tramways, Dublin.—The traffic receipts for the week ending December 17 were £366. 6s. 10d., as compared with £414. 10s. 0d. in the corresponding week in the previous year, being a decrease of £48. 3s. 2d. The number of passengers carried was 63,574 in 1897 and 63,798 in 1896. The aggregate returns up to date are £15,035. 8s. 3d., as compared with £15,853. 18s. 1d. last year, being a decrease of £818. 9s. 10d. The mileage open is the same as last year—viz., eight miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	11½
Brush Company, Ordinary	3	2-2½
—— Non. Cum., 6 per cent. Pref.	2	2½-2¾
—— 4½ per cent. Debenture Stock	100	109-112
—— 4½ per cent. 2nd Debenture Stock	100	102-105
Callender's Cable Company, Debentures	100	107-112
—— Ordinary	5	7½-8½
Central London Railway, Ordinary	10	9¾-10¼
——	6	5½-6
—— Pref. Half-Shares	1	1¼-1¾
—— " "	5	4-4½
Charing Cross and Strand	5	12½-13½
—— 4½ per cent. Cum. Pref.	5	6¼-6¾
Chelsea Electricity Company	5	10½-11
—— 4½ per cent. Debentures	100	112-114
City of London, Ordinary	10	27½-28½
—— Prov. Cert.	10	27-28
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	129-134
City and South London Railway, Consolidated Ordinary	100	67-69
—— 4 per cent. Debenture Stock	100	138-140
—— 5 per cent. Pref. Shares	10	15½-16
—— " " " '96	10	13½-14½
County of London and Brush Provincial Co., Ordinary	10	13½-14½
—— 6 per cent. Cum. Pref.	10	15½-16
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
—— 5 per cent. Debentures	—	86-91
Edison and Swan United Ordinary	3	2½-3
—— 5 per cent. Debentures	5	4½-5½
Electric Construction, Limited	2	1½-2¼
—— 7 per cent. Cumulative Pref.	2	3¼-3¾
Elmore's Copper Depositing	1	½-¾
Elmore's Wire Company	2	½-1
W. T. Henley's Telegraph Works, Ordinary	10	21-22
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-113
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	11-11½
India Rubber and Gutta Percha Works	10	23½-24½
—— 4½ per cent. Debentures	100	105-110
Kensington and Knightsbridge Ordinary	5	14½-15½
—— 6 per cent. Pref.	5	8½-9½
London Electric Supply, Ordinary	5	2¾-3¼
Metropolitan Electric Supply, Limited, Ord. No. 101-50,000	10	18-19
—— " " " 50,001-82,500	10	18-19
—— 4½ per cent. First Mortgage Debenture Stock	100	117-121
National Telephone, Ordinary	5	6¼-6¾
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	14-16
—— 5 per cent. Non. Cum. Third Pref., No. 1-119,234	5	6-6½
—— " " " 119,235-250,000	4	6-6½
—— 3½ per cent. Deb. Stock, Red.	100	105-107
Notting Hill Company	10	17½-18½
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-8¾
—— £4½ shares	4½	7-7½
Oriental Telephone and Electric Company	1	½-¾
Royal Electrical Company of Montreal	—	145-147
—— 4½ per cent. First Shares Mortgage Debentures	100	105-107
South London Electric Supply, Ordinary	2	2¼-2¾
St. James's and Pall Mall, Limited, Ordinary	5	17½-18½
—— 7 per cent. Pref.	5	10-11
—— 4 per cent. Deb. Stock, Red.	100	101-104
Telegraph Construction and Maintenance	12	38-39
—— 5 per cent. Bonds	100	103-105
Waterloo and City Railway, Ordinary	5	12½-13
Westminster Electric Supply, Ordinary	5	16-17
Yorkshire House-to-House	5	5-5½

NOTES.

trical Laundry.—All the machinery in the r Castle laundry is electrically driven.

onal.—Mr. Thomas H. Blakesley informs us that resigned his seat at the council board of the Physical . He is therefore no longer honorary secretary of iety.

Webb Testimonial.—The presentation dinner and Mrs. Webb has been postponed to Monday, , owing to the rooms of the Hotel Métrôpole being l on the 14th. Early application for tickets should e to Mr. H. Edmunds.

Central London Railway.—We understand locomotives for this line are to be of 800 h.p., l weigh 45 tons. A speed of 15 miles per hour train of five cars is said to be guaranteed. We however, that much higher speed will be used at

tution of Electrical Engineers.—The meeting ed on the card for Feb. 10 has been altered to to oblige the Institution of Mechanical Engineers. tter institution holds a two days' meeting on the d 11th in the Civil Engineers' rooms at Great street.

ling Cables in the United States.—The n raised by the action of a French company, landed a cable at Cape Cod without the express ion either of Congress or the President, has been ed by the Acting Attorney-General to the effect that esident has full power to control the landing of a submarine cable.

Royal Institution.—Mrs. Louisa C. Tyndall, dow of the late Prof. Tyndall, has just remitted to yal Institution the sum of £1,000, "as an expression attachment to the institution, with which he was so onnected, and of his sympathy with its objects." um is to be disposed of by the Board of Managers e promotion of science.

Marconi Telegraphy.—Signor Marconi still his name well before the daily Press, and we note he is conducting a series of trials between Totland near the Needles, and Bournemouth. He claims to have unicated with his assistants on the other side of the t, some 35 miles distant, by means of his new telec system. Signor Marconi is sanguine that in a short time the invention will be in practical working . We wish he would favour representatives of the ical Press with information at times, and give them a s of observing how far he has succeeded in avoiding rbances to other electric conductors.

e Mining Association and Institute of Corn-l.—Mr. F. H. Headley read a paper on the 19th inst. the above association on "Electricity, the Trans-r of Power." He explained by the aid of numerous n slides the practice of electrical transmission of r for mining purposes. He referred to the inefficiency he pumping plants now in use, and explained that as s for pumping purposes in Cornish mines electrical inery could be laid down for driving electric drills. latter could be placed in convenient spots under-d, and thus drills could be employed where under resent system of compressed air it was impossible to them.

Telephone Company's Defence.—Speaking at nual meeting of the Halifax Chamber of Commerce, mes Fergusson, M.P., director of the National Telephone Company, said there were numerous complaints respecting the company's service. Many people expected impossibilities, but a new science which was being gradually developed must for a long time leave a good deal to be desired. The great difficulty was that, unlike the Post Office, the company had no power to place wires underground. But the authorities of nearly every town in England had now given the necessary consent, and all would soon be enjoying a vastly improved service on the twin-wire underground system.

Coming Storms.—Litigation has absorbed too much of the profits arising from electrical engineering, and we regret to note that the present year is not likely to be free from expensive patent right disputes. The meter patents will be responsible for at least two big battles which will take away from their ordinary business much of the energy of the firms involved. Another fight is likely to arise over the enclosed arc lamp patents. The broad principle of burning an arc in an enclosed space is free, but the details of how to do this are patented, and infringements of these patents threaten to result in law proceedings. This we regret, as a small royalty to the inventor, if his priority is certain, is far better than spending many times the amount on lawyers.

High E.M.F.—Prof. John Trowbridge has been experimenting with high E.M.F. of which the exact values are known. He constructed 10,000 small secondary cells with lead plates placed in test tubes ¾in. diameter by 5½in. long. From this battery some 20,000 volts can be obtained, and by charging in succession a series of condensers, a potential of 1,200,000 volts was obtained. Prof. Trowbridge communicates the results of this experiment at this high voltage to the *Scientific American*, from which we gather his conclusions as follows: "The length of the electric spark between two points separated by more than 1in. varies directly with the E.M.F. Also, that a spark 48in. to 50in. in length requires an E.M.F. of 1,200,000 volts."

Advancement in Transformers.—The *Western Electrician* gives details showing how much transformers have been improved of late years. The first case given is that of a company operating in a town of 56,000 population in Massachusetts. Here 57 small transformers built in previous years were supplanted by 18 of a late type. The total light capacity of the superseded apparatus was 1,499 lights; of the newly-installed transformers 1,624. The total core loss of the old transformers was 5,866 watts; of the new, only 1,348. So much for the electrical facts. The saving is calculated at 39,578 units per annum. It is estimated that this saving will repay the actual capital outlay for the new transformers in 21 months. Other cases are given where even more striking differences are shown.

Manganese Compounds in Lead Accumulators. The following abstract of an article by Georg von Knorre appears in the *Journal* of the Chemical Society: "A freshly-charged positive accumulator plate placed in dilute sulphuric acid containing a little manganese sulphate quickly oxidises the latter to permanganic acid. The same result is obtained with lead peroxide, although more slowly. The formation of permanganic acid is also observed when manganese peroxide is deposited in any way on the accumulator plate. A negative accumulator plate quickly decolorises dilute sulphuric acid coloured red with permanganate. Pure spongy lead has the same effect. It follows, therefore, that manganese compounds in lead accumulators merely serve to carry oxygen from the positive to the negative plates, thereby discharging the cells."

New Fire Rules.—The 1898 edition of the electrical installation rules of the London and Liverpool and Globe Insurance Company has just been issued. The value of this periodical reissue is shown in the present edition by the inclusion of several added rules this year. For instance, the growth of the adoption of "free wiring" in various districts has necessitated rules specially dealing with the lead-covered twin wires used in this class of work, and the extension of the use of electricity for tramway work has led to the prohibition of the use of trolley wires or of dynamos feeding trolley wires as a direct source of current for lighting or power upon insured premises other than the power stations, sheds, etc., of the tramway people. Further slight additions deal with precautions desirable in specific risks, such as corn, oil, and textile mills. The rules are well thought out, and are reasonable in their requirements.

Depolarisation of Mercury and Platinum Electrodes.—The following abstract of an article by Karl R. Klein appears in the *Journal* of the Chemical Society: "The size of the polarised electrode, as long as this remains small in comparison with the other electrode, has no influence on the depolarisation. The rate of depolarisation decreases as the time occupied by the preceding depolarisation increases; moreover, the rate of depolarisation increases with the temperature. The presence in the electrolyte of a salt, the metallic radicle of which is the same as the metal of the electrodes, and the acid radicle that of the electrolyte, increases the rate of depolarisation of the cathode. The rate of depolarisation of platinum electrodes is generally smaller than that of mercury electrodes in the same electrolytes. Anodic polarisation disappears at a slower rate than that of the cathode."

Destructor or Destructive Fuel.—The Vestry of St. Luke has had a serious scare. The chairman of the Wharf Committee reported at their recent meeting that amongst the loads of refuse brought in for the dust destructor was a box containing 60 revolver cartridges and 27 Snider rifle cartridges. This might have been sent in by accident or design; but it was very evident that had not the cartridges been discovered the newly-erected dust destructor would have blown up, and probably a number of lives lost. Independently of the wharf workers' lives, there were others to be considered, and he thought that the Vestry should take some steps to ascertain who was responsible for sending this box in. We are assured by an eminent expert that cartridges do not explode with sufficient violence to do harm when burned in the open, and that no damage would have been done had the box in question been cremated.

Multiple-Rate Metering.—The method of charging different rates for the electrical energy used at different times has been adopted in many towns in this country. If our memory serves us, the St. Pancras station adopted a reduced price for current supplied by day as long ago as 1892. Mr. Eustace Oxley has recently taken the matter up in the States, and communicates his methods to the *Electrical Review* of New York. This consists of a throw-over switch actuated by a pair of electromagnets. These are so connected to the mains of a three-wire or two-wire system to earth that the throwing over of an earth contact at the central station is supposed to actuate the switch-gear, which either charges or shunts the meter. The system involves an earth contact in each house, and the consequent earthing of one main by night and one by day. This, in our opinion, damns the system, and certainly prevents it ever being used in this country.

Transformers in the Streets.—The London County Council are endeavouring to prevent the placing of trans-former boxes in the streets. Their formal objecti made to some plans of the County of London and Provincial Electric Lighting Company last Novembe company has appealed to the Board of Trade agai disapproval, and the County Council therefore in the Board of Trade that "the Council, having no that the decision would be appealed against, and view to the matter being again considered by the ment, disapproved of the construction of these box further that the Council is still of the opinion, pre expressed to the Board, that such large portions public streets should not be appropriated for the p of a private undertaking; but that having, by withh consent to the construction of the boxes referr sufficiently indicated this, the Council proposes to action on the appeal of the company, but to lea Board of Trade, as the department ultimately resp to come to such decision as it may see fit with reg the appeal."

Insulators for High-Voltage Lines.—The lators required for the insulation of overhead wires ing voltages up to 20,000 volts have to fulfil conditions. The chief fault to be guarded again sparking through from the wire to the pin. Case occurred, however, in California, as detailed *Journal of Electricity*, where the iron pins have through just where they enter the insulator. T found to occur during storms, and as a rule the b confined to a very short length just under the tip inner petticoat. Also where the inner petticoat h siderable depth, the pin shows no signs of burn distance of from ¼in. to ½in. below the contact line and insulator. It is considered probable that actually pass from the edge of the petticoat to th and that the succession of such sparks severs th We rather fancy that after the spark has once pa will persist in forming an arc, which will burn off t Pins burnt in this way have not been observed o working with 5,000 volts potential, but are compar frequent on 10,000-volt lines.

Bonding.—Mr. W. E. Harrington recently read a before the Franklin Institute on the above question. difficulty of selecting the best bond for electric trac obviously increased by the personal errors of th executing the work. Also any single tests are deprecated, in our opinion, as the worst rather th best results determines the value of the bond in qu The author quotes tests of this character, but give facts as well to support his general conclusions, whi as follows: (1) the Edison-Brown plastic cork bond the best results; (2) the standard bond, under fishp excellent, but is difficult to place; (3) the Bryan bond best round fishplate type of bond, both electricall mechanically, provided, however, that the bond is thor amalgamated with the Edison-Brown alloys; (4) the and Columbia types of bonds would not be so objecti if they were stranded, and the strands protected electrolysis; (5) the Crown type of bond is re materially efficient by the use of the Edison-Brown while the Columbia type is only benefited slightly—i instances the Columbia is the better bond; (6) ir bonds are highly inefficient.

The Alteration of Length in Magnetised W Mr. Byron R. Brackett communicates to the *P Review* the results of a series of experiments on the " of tension and quality of the metal upon the chan length produced in iron wires by magnetisation." description is well illustrated by a description apparatus used, and by the curves connecting the

ities measured with different samples of iron. The r concludes: (1) That any increase in the magnetic tion tends to lengthen the iron wire. As shown by irves connecting the elongation and the intensity of etisation (I), the relation between I and the elonga- s nearly the inverse of the relation between H and I in the ordinary induction curve until well beyond aximum value of μ, when it curves in an opposite ion on account of the field effect. (2) The magnetising ends to shorten the wire, and the shortening due to ause has no determined limit. Up to a field of two e hundred the shortening seems to be directly pro- nal to the field strength, and then it seems to begin proach asymptotically some limiting value. (3) The city changes with the induction, the modulus being ne cases ½ per cent. greater at the highest magnetisa- than when the magnetisation began. The law con- g the change is as yet unknown.

ilcarts.—The Post Office authorities are often ed of backwardness in trying new inventions, and of behind the times. This accusation cannot be sub- iated as far as the use of motorcars for the con- ce of mails is concerned. The Electrical Cab pany have this week had an opportunity afforded them owing what they can do in this respect. They are iding an electrically-driven mailcart to convey mails the General Post Office to Paddington Station, the journey has to be made four times a day. e trips are being accomplished well within the tted time, and to the satisfaction of all concerned. more extended trial with a steam vehicle has just n concluded by Messrs. Julius Harvey and Co., who re now completed their first six weeks' contract under Postmaster-General for conveying her Majesty's mails steam motor-van from London to Redhill. This trial has so far been most satisfactory, and, in fact, the authorities made another contract for a further period with the me firm. The trial began on Dec. 16, and the van is ed to leave Mount-pleasant post office at 10.30 p.m. and arrive at Redhill at 1.42 a.m., returning to Mount-leasant post office at 4.45, but it has been able to get in an average from 15 to 30 minutes before time, both on e outward and return journeys, and on Dec. 30, on a cord run, Mount-pleasant was reached at 3.45 as against 45 a.m., an hour before time.

istakes.—Our New York contemporary, the *Elec- ical Review*, makes merry over the sensational mistakes n technical matters made by daily papers. We often ake merry over similar errors on this side of the water, nd if we were to take notice of one half of them it would be necessary to employ the technical staff of all the technical papers going to set matters right. The particular points which our contemporary discusses is that one of the daily papers says one ampere will destroy two tons of iron per year, which, to say the least of it, is rather a tall order. He points out that "Under the most favourable laboratory conditions iron can be dissolved at the rate of 1·04 grm. per ampere per hour, or about 16 grains avoirdupois. With 8,760 hours, that makes 140,160 grains per year, almost exactly 20lb.! Two hundred and fifty amperes, then, could dissolve 5,000lb. per year, but only under the most perfectly planned conditions, and in ferrous sulphate solution as the electrolyte, and constant care and attention. There must be an acid present; water or moisture will not do; and in dissolving, the iron must be changed into a salt, either a sulphate or a chloride of iron." We need not refer to the matter any further than to say that our contemporary completely dismisses the idea that the Brooklyn Bridge is likely to suffer from the leakage from the trolley wires. We must confess, however, that our American cousins are a little prone to frighten their readers with tall statements.

Accumulator Charging.—The practice of raising the voltage of shunt machines required to charge accumulators necessitates that the dynamo shall have large field magnets, and also that it shall run with a comparatively weak field when on ordinary lighting work. This is objectionable, and tends to raise the cost of the dynamos in question. Also at maximum current output the maximum field strength is not employed, so that the sparking limit may be approached. The practice of using a continuous-current rotative transformer for providing the extra voltage required for charging has found favour, and we have noticed that Prof. Kennedy has adopted it in all his recent stations. An alternative method is described by Mr. P. Simon in *L'Electricien*. This consists of placing a small auxiliary dynamo on the top of the main dynamo direct coupled to a quick-running engine. This small machine is belt-driven off a pulley on the shaft. The dynamo is arranged on the constant-current principle, and so designed that at the predetermined current the brushes will run sparklessly on any diameter of the commutators. The machine illustrated was designed to generate any voltage up to 30 volts, and passes a current of 60 amperes. The lead of the brushes is then altered to give whatever voltage may be required as the accumulators charge. Carbon brushes are used. The method is not so flexible as the transformer supplied from the 'bus bars, but may save some of the energy due to the double conversion.

Electrical Goods Locomotives.—The use of these for shunting purposes around terminal stations is finding great favour in the United States. The usual series-parallel controllers are frequently used on these for starting purposes. The following notes from the *Electrical World* show, however, that the practice of starting with all the motors in series may give trouble. The chief consideration in the construction of such electric locomotives is to obtain as great a draw-bar pull as possible with the weight on the drivers. Speed is of little consideration. Such machines as built so far have been mounted on two four-wheel trucks, with a motor geared to each of the four pairs of wheels. In starting, these four motors are thrown in series, and this particular combination has a very deleterious effect on the action. It is well known that the horizontal effort is much greater when the wheels stick than when they slip. If, therefore, any one pair of wheels for any local reason slips with the series combination, its horizontal effort will immediately fall off, and consequently the torque necessary to drive it. It will then speed up to such a point that the back E.M.F. of the motor will cut down the current to a value giving a torque just sufficient to overcome the reduced braking effect of the rail on the wheel rim. Being in series with all the other motors, their torque will be reduced to the same extent. In other words, any local slippery spot sufficient to start the slipping of one pair of wheels will reduce the horizontal effort of all four as much as though they were all slipping.

The Engineering Dispute.—The leaders of the men should now see the difficulties arising from rapid changes of front. The votes returned to the headquarters of the Amalgamated Society of Engineers show that in certain quarters there is a great majority against the acceptance of the employers' terms. This was likely to be the case, because precisely similar terms were put to the vote in December last, and, by the advice of the leaders, refused by an overwhelming majority. The men were assured that the terms in question meant the abolition of trade unionism, and that they supported the iniquitous idea

that all workmen were not equally capable. All the arguments against the terms were urged in spite of the fact that the men's representatives had assisted to draw them up, and had practically agreed to them. Now when these representatives turn round, and bless where they formerly cursed, they find that their followers follow no longer. The Scottish engineers are the chief offenders, but several English centres returned majorities against the proposed terms. Thus the totals available up to going to press show that 2,805 votes have been recorded in favour of accepting the terms offered, and 2,097 against. This in spite of the lecturing of their leaders, among whom Mr. Barnes has been most active in eating his own words before the local societies. We trust that the majority will be found in the right direction when all the votes have been received on Friday. In any case the men should learn by their heavy financial losses, and select new representatives to manage their affairs in future.

Wireless Telegraphy.—A summary of Prof. Oliver Lodge's most lucid lecture on "Electric Signalling without Connecting Wires," will be found in another column of this issue. The few opening remarks made by the lecturer were, however, of special interest as summing up his views of the present value of the above art. He said that the daily Press appeared to know more about this than anyone working in the matter. His idea was that the value of a telegram depended on the message reaching only the individual to whom it was addressed. Doubtless there was some news, such as political speeches, which were required to be published broadcast, and for such purposes wireless telegraphy would be applicable. Prof. Lodge then proceeded to describe the lines on which he had worked in his endeavour to tune the individual sending and receiving apparatus so as to get distinctive messages. In the course of the lecture it was incidentally mentioned that the experiments carried out at Liverpool had caused great disturbance on the telephone system, and had had to be stopped in consequence. That this will be so is clear from the fact that all telephone transmitters resemble more or less closely some form of coherer. Thus the Blake transmitter, with the single platinum point resting against a carbon block, is very similar to the single-point coherer described by Prof. Lodge. When, therefore, the effect of the Hertzian waves is to cause a large change of resistance in such a piece of apparatus, the cause of the interference with the telephones connected to overhead wires is apparent. In fact, the similarity of the behaviour of the coherer and the telephone transmitter is most marked, and the phenomena observed in each case have yet to be explained scientifically. N.B.—The report of the Physical Society containing the above summary has been held over by request.

Electric Railways for London.—The relief of the congested suburban lines already in existence round London is the problem in the solution of which great help is expected from electricity. The daily journey to the City becomes with the present means of communication more tedious each year, and the rush at certain times exceeds altogether the capacity of the lines now in existence. The high price of land round these lines, as well as the engineering difficulties, makes the task of widening them a doubtful financial undertaking. So the deep-level electric lines, constructed with the Greathead shields through the London clay, as in the case of the South London line, now being extended to Finsbury, has to be looked to for success in overcoming these defects. Such a construction solves the problem of making an underground line without disturbing the buildings above and without expending large sums for the purchase of the lands passed under. We are glad to see in the *Lancet* this week a detailed approval of this class of electric lines from the health point of view. The faults due to grading and the noises heard in the South London line are not likely to be found in the new railways now being constructed. We are sorry therefore to see opposition arising from those whom the projected lines would benefit. Thus the ratepayers of Camberwell have sent in a petition to their Vestry against the proposed New Cross and Waterloo line. The signatures to the petition deny that any public necessity exists requiring the proposed railway, and they contend that at the present time there is ample accommodation to meet the requirements of the travelling public by tramways, omnibuses, and other vehicles at very cheap fares along the roads and streets under which the railways are proposed to be made. They claim to believe that if the construction of the proposed railway is allowed, the removal of the sub-soil for the works will materially interfere with, weaken and otherwise injure the foundations of various of their premises, besides depreciating the value of the properties in the whole by interfering with underground cellars and storage places. Such twaddle is always being advanced; but we are glad to see that the Vestry in question appears to recognise the feeble nature of the objections raised. Tramways and omnibuses, with average speeds of five to six miles an hour, are unable to cope with a demand for rapid transit however ample their accommodation may be.

Light and Power in Brooklyn.—The development and prospects of the Edison Electric Illuminating Company of Brooklyn, is the subject-matter of a most complete article contributed by Mr. J. Wetzler to our New York namesake. The progress of the incandescent lighting since 1890, when some 6,000 16-c.p. lamps were supplied, is not extraordinary, and will not compare with many of our London companies, but in arc lamps and motors the numbers are surprising. Thus on Jan. 1, 1898, there were the equivalent to 103,591 16-c.p. incandescent lamps connected, 4,032 low-tension arc lamps, 1,939 high-tension arc lamps, and motors with an aggregate of 3,702 h.p. Again the large area to be supplied was first served by a number of stations scattered over the district, but, as is now being done in London, the power is now being put down in one central station outside the town, and transmitted at high tension and with multiphase currents into the various sub-stations. At the present the system of supply is, however, a mixed one, and all of the following systems and apparatus are in actual use—viz. (A) vertical engines directly connected to low-tension direct-current multipolar generators, three-wire system, with corresponding boiler equipment; (B) static and rotary converters and induction regulators to transform 6,000 volts, three-phase, 25 cycles, alternating, into low-tension direct-current three-wire system; (C) synchronous motor arc generator to transform 6,000 volts, three-phase, 25 cycles, alternating, into from 2,000 to 6,500-volt direct current for series arc circuits; (D) static transformers, synchronous and induction motor, to transform 6,000 volts, three-phase, 25 cycles, alternating, into 2,400 volts, two-phase, 60 cycles, alternating; (E) storage battery for low-tension three-wire system; (F) static transformers, two-phase, 2,400 volts, 60 cyles, to 115 volts alternating. Of the A type some 3,600 kw. are installed, while 2,800 kw. of the B type has already been fixed. The new station, called the Union, which is eventually to supply the whole of the town, is situated at Bay Bridge. The units used in this station are to have a capacity of 2,000 kw., but up to now only one set is at work. A space is provided for five of these sets in the present building. The alternators have already been referred to in our columns. They are three-phase machines, and generat

'olts. From the above it will be seen that the station of the London Electric Corporation may be l to have set a lead in the right direction by the of large units on a site where cheap fuel is

tive Motorcar.—The following account of an to a motorcar appeared in the *Telegraph*, and is f the occasion and of reproduction: "A case in curred in Fleet-street shortly after midnight on r, ending in an accident which was fortunately led by the serious consequences which at the first seemed inevitable. An attractive-looking motor, e gentleman inside, came whizzing along from the urts towards Ludgate-circus, when suddenly it pricious, swerving now to the right and now to the nding, pitching, rolling, swaying, and buzzing, till ning stars might well seem to the citizen within to ing together in the firmament and the bricks of ses instinct with life. The motion was so jerky, r, and uncontrollable, that the spectators feared re might be metamorphosed into an improvised ent to make holes in the roof and the sides, which precisely the destiny of a modern man of culture. were several hansoms passing at the time, and a was more than once imminent, but the Jehus, g into the spirit of this Pyrrhic dance, deftly led horses through the labyrinthine mazes till their s seemed 'trifles light as air,' and safely vanished pace. The motor, whose interior appeared to be 'out of order, still wandered east and wandered while wayfarers watched anxiously from various ls of retreat. The citizen inside, 'uneasy and d from home,' as the poet puts it, might well give f up to thoughts of the life to come. For him it have been a novel and a harrowing experience. and Old Night seemed to be leagued together the ill-starred fare. He had no idea of what was g. If he speculated at all, electrocution might well seemed to him the very mildest of the soul-shattering ities in store for him. There was death before him, behind him, death on either side of him, and death l even in the nethermost depths beneath the seat. ally, however, this meandering journey, which was ly not a primrose path of dalliance, came to a sudden expected end. The vehicle collided with the edge of ement, and amid a firework of blue sparks, such as ent to accompany exorcism in the Middle Ages, the r was shot on to the road, while his fare suddenly hd through the window. Both were happily unhurt. otor alone suffered severely, and remained all night able wreck on the spot, guarded by a policeman, ed that it was alike incapable of moving on itself f being taken away by a horse. It is earnestly to be l that accidents with motorcars will not become , else the days of those new-fangled conveyances mbered. No doubt 'Variety's the very spice of life gives it all its flavour,' but Londoners can hardly be be enamoured of spice of that degree of pungency." the above flowery description it is disappointing to the plain facts showing the extent of the poetic license writer of the above. It seems that an electrical cab he offender, and that the hind wheels merely skidded, as happens daily to horse-pulled vehicles. Both the and occupants alighted in the usual way. Further, to the construction of these vehicles, it is electrically ly impossible for any sparks whatever to have d. Also the carriage was never more out of control horse-pulled vehicle would have been under the cumstances. The damage to the vehicle was confined to the straining of a hind wheel, which was quickly put right, and the cab proceeded on its way. No further damage whatever was done, and the cab was working as usual the next day. We believe that the fact that the hind wheels of the cabs in question had to drive was not duly considered in the first vehicles turned out, and that trouble has occurred in consequence, as in the above case. This is, however, now being rectified.

The Copper Voltameter.—An abstract of a paper by F. Foerster on this subject is given in the Chemical Society's *Journal* as follows: The author discusses the errors of the copper voltameter and the methods of avoiding them, in the light of his previous experiments on the electrolysis of copper sulphate solutions. The use of a concentrated solution of copper sulphate is necessary in order to prevent the deposition of the copper in a powdery form; it has the disadvantage that it increases the concentration which may be reached by the cuprous ions, but the solution never becomes saturated with the latter owing to their oxidation by the air. For this reason, the quantity of copper deposited when the solution is exposed to air is too small, especially with smaller current densities. This action of the atmospheric oxygen explains the fact that a copper plate partially immersed in an acidified solution of copper sulphate is most strongly acted on at the surface of the liquid. The addition of sulphuric acid to the copper sulphate solution diminishes the concentration of the cuprous ions to some extent; it is of more importance, however, in preventing the separation of cuprous oxide which takes place in neutral solutions owing to the hydrolysis of cuprous sulphate. The deposition of cuprous oxide not only increases the weight of the deposit on the cathode, but produces inequalities in its conductivity which give rise to the formation of cuprous ions where the current density is smallest. Since the presence of the acid diminishes the solubility of copper sulphate, a saturated solution of the latter cannot be used, as this would lead to deposition of the salt on the anode, entailing a large increase in resistance. A suitable solution is one containing 125 grm. of $CuSO_4 + 5H_2O$, and 50 grm. of H_2SO_4 per litre. In presence of air, the strongly acid solution dissolves no more copper than one containing little acid. Thus a normal solution of copper sulphate, which was also normal with respect to sulphuric acid, dissolved 17 milligrm. of copper, whilst a solution containing $\frac{1}{1000}$ of an equivalent of sulphuric acid dissolved, under the same circumstances, 15 milligrm. In order to measure very small currents, a closed voltameter is used with a solution containing $\frac{1}{10}$ grm. or $\frac{1}{20}$ grm. equivalent of copper sulphate, and 1 grm. equivalent of sulphuric acid, a slow current of purified hydrogen being passed through the solution during the experiment. The quantity of cuprous ions which can be formed under these circumstances is very small, and their conversion into cupric ions, at the anodes, is prevented almost completely by enveloping the latter in parchment paper. By comparison with a silver voltameter, it was found that the error in the quantity of copper deposited did not exceed a fraction of a milligramme, even with a current density of 0·025 ampere per square decimetre. The maximum current density with which an adherent deposit of copper can be obtained is higher the greater the concentration of the copper sulphate and the more thoroughly it is stirred so as to avoid local dilution near the cathode. With a solution of copper sulphate and sulphuric acid, both of normal strength, two amperes per square decimetre may be safely employed. The author finally discusses the possibility of using the loss of weight of the anode as a measure of the current, and concludes that no advantage would be obtained by so doing.

THE GLASGOW DISTRICT SUBWAY.

(Continued from page 72.)

The Electrical Generating Plant.

As previously mentioned, the electrical generating plant is placed on the west side of the power station.

ENGINES.

The engines are four in number, and were built by Messrs. G. E. Belliss and Co., of Ledsam-street Works, Birmingham, and are of this firm's well-known quick-revolution double-acting vertical enclosed type. The engines are compound non-condensing, with high-pressure cylinder 9in. diameter and low-pressure cylinder 15in. diameter, with a 9in. stroke. Each engine when running at 450 revolutions per minute gives out 120 b.h.p. Although having the appearance of an enclosed engine, it is simply an ordinary double-acting engine with a casing surrounding the working parts to keep out dirt and grit, and to permit of a liberal use of oil without waste.

The forced system of lubrication is one of the noticeable features of the engine, whereby oil is pumped to every bearing, keeping it there under pressure and permitting it to do its work deliberately and therefore effectively. The oil is supplied by means of a neatly-contrived pump, and this is without valves or packing, working off the eccentric and drawing the oil from a well on the framing, and discharging it at a pressure of from 10lb. to 20lb. through suitable channels into the working parts. The double action of the engine permits the film of oil at this pressure to enter thoroughly between the working journals and brasses, keeping them apart and preventing any wear or liability of knocking taking place with any load.

Through a compound engine the steam distribution is effected by one central valve on Messrs. Belliss's well-known practice, worked by a single eccentric; while balanced cranks and a heavy flywheel further contribute to that necessary smooth running when the engines are used for electric lighting work. There is a hinged door at the back of the engine to allow of free access for inspection and adjustment, and the entire front of the casing can be removed in a few minutes, if necessary to overhaul the working parts. From the fact that the cranks are never immersed in oil there is not the splash as in other closed-in engines, so that, as before mentioned, it being simply an ordinary engine fitted with back and front doors, the simplicity is such that there is nothing for an attendant to master save the ordinary principles of steam-engine running.

View of Generating Plant—Glasgow District Subway.

The engines are remarkable for their quiet a running, inasmuch as the constant film of oil betw shafts, pins, and bearings entirely prevents knockin the lubrication being on the improved principle referred to, the brasses can, it is claimed, be let t much closer than in an ordinary open engine, an absence of wear will so remain. We might add similar set of plant to these under notice gave as of a six hours' test an efficiency of 88·39 with a consumption of 19·89lb. per electrical horse-power.

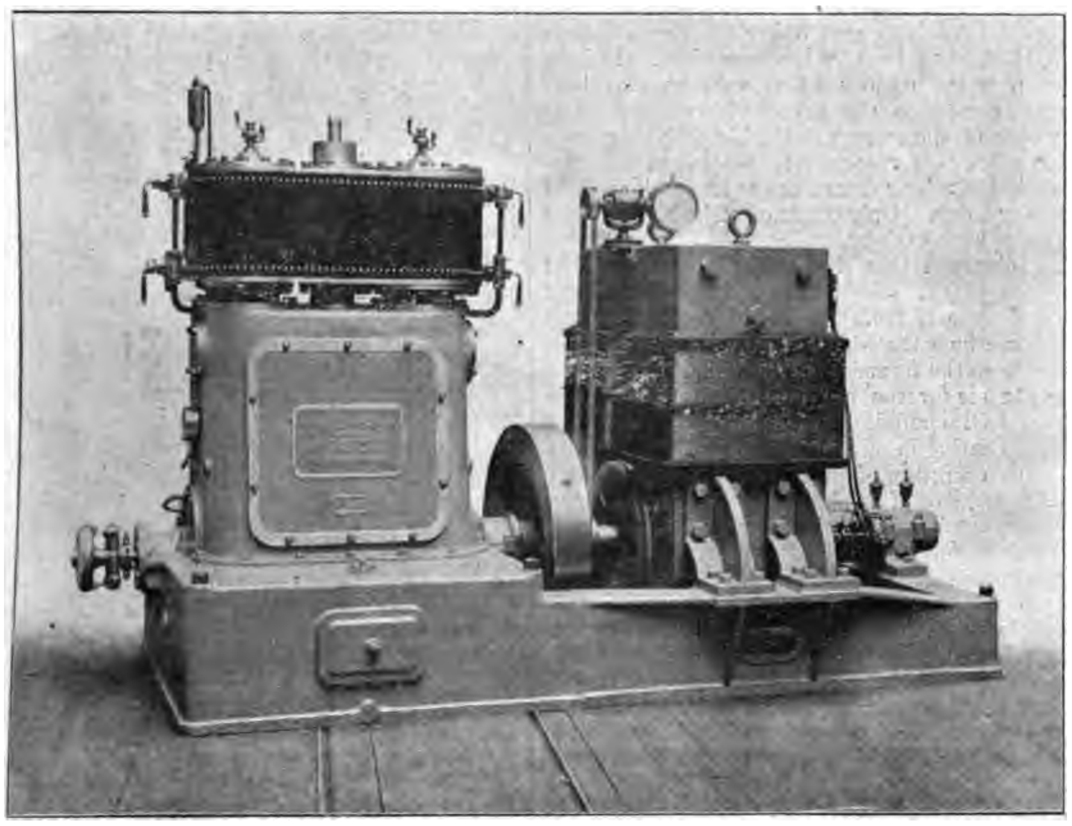
Special attention has been paid by Messrs. Bellis governing of these engines, this being an all-im consideration for an engine used for dynamo d The engines under notice are fitted with the thrott type of governor, the arrangement being so simpl need little explanation. The governor valve is equilibrium type. The centrifugal force of the g balls is mainly met by springs directly applied to but a part is also carried by the adjusting spring by of which the revolutions can be varied whilst the e running through a considerable range. By experi was shown that a range of 15 per cent. could be while at the same time maintaining governing Tachometers are fitted on each of the engines to the attendant to tell at a glance what speed t running at.

The steam separators, which are mounted on th combination bed-plates as the engines, are fitte Holden and Brooke's Sirius steam-traps, which app give very satisfactory results. This trap is one o based on the principle of the unequal expansion metals, and is made up in a compact semi-circular ca no external working parts, and makes a very neat jo fitted on a bed-plate of a combined plant. The stea are all carried overhead to the engine, and the e pipes below the floor-level. The steam-pipes are so ar that any engine can be shut off at the point where its pipe branches from the main pipe. This main stea is also fitted with further sluice valves to allow section of it being cut out. A light iron gangway i along these valves to admit of their convenient ma tion.

THE DYNAMOS.

Each engine has a dynamo direct coupled on to its shaft. They are of the inverted horseshoe type, wound, each capable of developing 79 kw. Th dynamos nearest the switchboard are arranged for r on the outside wires of the three-wire system, a wound for an output of 145 amperes at an E.M

ts, while the other two machines, intended for in series across the three-wire system, have an of 290 amperes at 270 volts.
dynamos are shunt machines of the well-known wn type manufactured by the India Rubber, Gutta and Telegraph Works Company, Limited. The and yoke are made of cast steel, the windings ound on wooden formers. In the case of the high- machines, the shunt windings for each limb are on two formers and connected together in series. done with the object of lessening the risk of -circuit on the shunt winding, by preventing the ity of adjacent windings carrying a large difference ntial. The armatures are of the Gramme ring und with laminated copper strip. The commutator awn copper, and is of ample size to easily carry the , and insulated with mica; after 12 months' g they none of them show the least signs of wear. ght mention that one of the high-tension machines pare armature, which can be connected up so as to the machine into a low-tension one; at present ing used in this way, as it is found with the present



View of Belliss-Silvertown Combination—Glasgow District Subway.

m of load to be more satisfactory. The weight of ature is about 35cwt., and it is built up of No. 26 each keyed to four-armed spiders shod with cast insulated with mica, and windings have also mica under bands. The outer bearing is split, and is with two sight-feed lubricators.

wish to note a slight error that occurred in our of the above line which appeared last week—viz., tion of the power station, which is shown between road and Kinning Park Station, whereas it should shown between Shield-road and West-street .—Ed. *E. E.*]

NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

[*Copyright.*]

LXVI.

Referring to Section XL, the specification of Sir Frankland's earlier patent (No. 4,303, 1882) is worth studying. The inventor sums up in few words the position of the storage battery at the period of his invention. He points out that the Sellon and Volckmar plates, having perforations filled with spongy lead, are more permanent than those of Faure; but that plates of a given size are less active because a considerable area of their surfaces is uncovered by spongy lead, oxide of lead, or other lead compound. But the important fact that a considerable proportion of the charging current may in this case traverse the electrolyte without traversing the active material (IV.) was not referred to. The reader may also note that the total inapplicability of carbon as a support for the peroxide active material (XXXIX.) was not at that period known to the distinguished chemist from whose specification the following extracts are made:

"My invention consists in hardening oxide of lead upon the metallic or other plates of electric storage batteries, whether perforated or not, and either on the whole surface of the plate or in perforations only, so as to cause it to attach itself firmly to the plate without the use of felt or other similar retaining fabric. The hardened oxide of lead may, if desired, be used without a metallic or other supporting plate.

"In carrying my invention into effect, I employ by preference minium or red lead as the raw coating material; but any other oxide of lead except the peroxide will answer the purpose nearly as well; and I harden this minium or oxide of lead, before the plate is used either as a positive or negative plate in the storage battery, by applying to it or mixing with it sulphuric acid, phosphoric acid, hydrochloric acid or other acid which forms an insoluble or sparingly soluble salt of lead, the acid used being either diluted with or dissolved in a suitable quantity of water. I employ by preference sulphuric acid."

Prof. Frankland then describes five modes of carrying the invention into effect. The first consists in making the oxide of lead into a paste with water and spreading it over the surface of the plate to the required thickness. The coating, when dry, is loose and friable; and, to prevent it from falling away from the plate, it is moistened with a mixture of one part (by measure) of concentrated sulphuric acid to nine parts of water. The coating is dried and remoistened as before; two applications of the acid being generally sufficient to render the coating hard, and to attach it firmly to the plate. In the second method, the oxide is made into a thin paste with a mixture

of one volume of strong sulphuric acid and two volumes of water; the paste is then applied to the support with a trowel or spatula. The latter, by the way, must not be of iron or steel; but may be made of silver, vulcanite, or celluloid. The third mode of using the hardening mixture of oxide and diluted sulphuric acid is to cast it "upon, in, or around any suitable metallic, graphite, carbon, or gauze plate." The casting is afterwards saturated with sulphuric acid diluted with six times its volume of water. A fourth mode is to dip the support into the mixture of oxide and acid. The fifth method is to cast the mixture without any conductive support, and, after drying the castings and saturating them at least once with dilute sulphuric acid, to reduce them to spongy lead, or to convert them into peroxide of lead, by attaching them to lead electrodes, which are used as cathodes in the former case or as anodes in the latter, in an electrolyte of dilute sulphuric acid.

The claims in this specification refer to the various processes, and call for no particular remark except in the case of the fifth claim, for "the use of the hardening mixture for casting into plates, cylinders, or blocks without any metallic or other basis or nucleus," a claim which goes beyond the provisional specification.

LXVII.

A paper by Dr. Frankland, read before the Royal Society in February, 1883, should not be left unnoticed. In it he completely refutes the notions which were at that time prevalent with regard to the action of occluded gases in the phenomena of the storage cell. Electrolytic spongy lead and peroxide were respectively heated in separate pieces of combustion tubing drawn out at one end, so as to form gas delivery tubes. Only traces of occluded hydrogen and oxygen gases were evolved.

The author observed that during the "formation" of storage elements of the pasted kind a large quantity of sulphuric acid disappears from the liquid contents of the cell—indeed, sometimes the whole of it. This removal of acid must be due to the formation of lead sulphate in the plates, but the salt is for the most part indiscoverable by the eye, owing to its admixture with chocolate-coloured lead peroxide. Bearing in mind that the plates referred to were pasted with a mixture of an oxide of lead with but a fraction of its equivalent of sulphuric acid, that the latter, as we have seen, combines but slowly with the oxide, and that a percentage of sulphate of lead is always present even in fully-charged peroxide plates, we shall have no difficulty in accepting the following statements: "Unless the coated plates have been previously immersed for some days in dilute sulphuric acid, this disappearance of acid during their 'formation' continues for 10 or 12 days. At length, however, as the charging goes on, the strength of the acid ceases to diminish and soon aftewards begins to augment. The increase continues until the maximum charge has been reached and abundance of oxygen and hydrogen gases begin to be discharged from the plates—that is to say, until the current is occupied exclusively, or nearly so, in the electrolysis of hexabasic sulphuric acid, expressed by Burgoin in the following equation:

$$\underset{\text{Sulphuric acid.}}{SO_6H_6{}^*} = \overbrace{\underbrace{SO_3}_{\text{Sulphuric anhydride.}} + 3O}^{\text{Eliminated on + plate.}} + \overbrace{3H_2}^{\text{Eliminated on − plate.}}$$

Of course, the sulphuric anhydride immediately combines with water and regenerates hexabasic sulphuric acid:

$$SO_3 + 3OH_2 = SO_6H_6.$$

On discharging the cell the specific gravity of the acid continually decreases until the discharge is finished, when it is found to have sunk to about the same point from which it began to increase during the charging. Hence it is evident that during the discharge the lead sulphate, which was continuously decomposed in charging, was continuously re-formed in discharging."

It is interesting to note that at the above-mentioned early date the present Sir Edward Frankland pointed out that whereas no method had previously been kn the charge of a storage cell could be ascertai discharging the cell, his experiments indicated means of ascertaining the amount of stored en any interference with the charge itself. The sp and consequently the strength, of the dilute s in a formed cell, in its uncharged and also charged condition, being known, it is only take the specific gravity of the acid at any ti to ascertain the proportion of its full charg cell contains at that moment.

LXVIII.

It is to Dr. Frankland that we owe the fac the ordinary red lead of commerce—Pb_3O_4 (XLI.)—is subjected for a lengthened period of sulphuric acid, the compound $S_2Pb_3O_{10}$ = (Frankland's red-lead salt) is produced.* The d of sulphuric acid from the liquid contents of the experiments above referred to, in which th pasted with red lead, is clearly due to the form salt. In the process of charging, one mol sulphate of lead component of the salt is in t decomposed at the anode, whilst PbO_2 become cathode. Thus:

$$2(PbO_2 2PbSO_4) + H_2O$$
$$= 2PbO_2,PbSO_4 + PbO2PbSO_4 + H_2S$$

the electrolyte becoming enriched with one sulphuric acid, whilst at the cathode peroxide monoxide, and, at the anode, the wholly inert has become converted into a compound molecule of PbO_2 over and above that cont peroxide element when the couple is dischar 1·85 volt.

In the next stage of the charging proc theoretically, $3PbO_2$ produced at the anode (bu some undecomposed sulphate remains in adm the peroxide); whilst only one atom of Pb i the cathode, and another molecule of sulphuric added to the electrolyte. Thus:

$$2PbO_2,PbSO_4 + PbO + H_2O$$
$$= 3PbO_2 + Pb + 2PbSO_4 + H_2SO_4.$$

These equations exhibit the economic "pasting" the cathode element with red lea lead monoxide—the anode element being now f whilst the cathode is only one-third charged. observed, however, by reference to our form that the proportion of active material at element is in excess of what is *theoretically* requ

It is, at our present stage, scarcely necess out that, in a properly worked accumulator, material is never run down to the condition of red-lead salt, but only to that in which it cont sulphate of lead present in the latter.

LXIX.

Frankland has also shown† that when mono is acted upon by sulphuric acid, even for a period of time, the salt that is formed is n sulphate, but one having the compositi $= (SO_3)_3(PbO)_5 = 2PbO,3PbSO_4$. This, then, which is formed when lead plates or grids a with a mixture of litharge and sulphuric acid, partly hardened or "set," is treated with excess acid. In regard to this compound, any chemi not a specialist in the direction of lead accumu well be excused for the incautious statement not exist in presence of sulphuric acid.

In ordinary accumulators of the pasted typ usually employed for the peroxide plates, for the spongy-lead plates. This plan is more than that of using red lead for both electrod not appreciably more economical than using both plates if the weight of active *lead* (III.) same on each. Thus, using ordinary red l peroxide element and litharge for the spongy-l we have in the case of the former element

* Otherwise bi-hydrated sulphuric acid: $H_2SO_4 2H_2O$.

* "Contributions to the Chemistry of Storage Roy. Soc., vol. xlvi., 1889, p. 304.

† *Loc. cit.*

$=3PbO_2$, an equation involving the decomposition of only two dyad equivalents, but in the case of the latter element $3PbO+3H_2=3Pb+3H_2O$, an equation involving three equivalents. Whereas, with litharge on both plates, we have $3PbO+3O=3PbO_2$ and $3PbO+3H_2=3Pb+3H_2O$, three equivalents of water being decomposed as in the former case. But, on the other hand, if the weight of active lead in the peroxide and the spongy-lead elements respectively is required to be in the proportion of 3 : 2, then there is economy in using red lead instead of litharge for the former element, as both elements can be fully charged by the expenditure of two dyad equivalents of electricity. It should be stated, however, that the peroxide obtained from litharge is considered by some to be superior to that obtained from red lead.

LXX.

In ordinary accumulators of the pasted type, it may be said that Frankland's red-lead salt, or his buff-lead salt, or both, virtually constitute the original active material of the plates. Besides these, there are four compounds at least which have been more or less extensively used for conversion into active material in secondary batteries. Three of these have been patented at various periods by myself, and are known as lithanode compounds.

The first was patented in 1885, No. 4,671. The idea was to effect very gradually a partial conversion of PbO into $PbSO_4$. With this object in view, litharge was made into a paste with a solution of ammonic sulphate $[(NH_4)_2SO_4]$, or it was mixed with this salt in fine powder and subsequently moistened. Ammonia (NH_3) was evolved from the moulded compound, during the "seasoning" of the plates, for many days, or even weeks; the reaction thus slowly taking place being expressed by the equation $PbO + (NH_4)_2SO_4 = PbSO_4 + 2NH_3 + H_2O$. Practically, however, the proportion of $PbSO_4$ to residual PbO was sometimes no higher than 1 in 37. The plates when seasoned were painted with peroxide of lead in fine powder, and, being thus rendered conductive, were charged as anodes between two equidistant cathode plates preferably in a solution of sulphate of magnesia. If the cathodes were not equidistant, the plate in charging would bend or warp so as to present a convex surface to the nearer cathode; but after the first complete charge the plates no longer warped or varied in dimension. They varied in porosity according to the proportion of ammonic sulphate used in their manufacture, and according also to the degree of pressure employed in moulding. It was found necessary to expel the whole of the ammonia from the plates, by heat if the period of seasoning was insufficient, prior to painting with peroxide, otherwise the latter was liable to become decomposed, with production of a nitrite, according to the equation—

$$3PbO_2+2NH_3=NH_4NO_2+H_2O+3PbO.$$

The plates, when fully peroxidised, were very homogeneous and compact, and of higher conductivity than any ordinary form of peroxide of lead. I have never found the material, when properly manufactured, to "shed" or disintegrate at the surface in the form of a fine powder, as in the case of other peroxide plates; but I have been informed that in certain cases this shedding has occurred. It was intended to use this material, not for pasting lead plates or grids—for which purpose, however, it is well adapted—but for the manufacture of plates without metallic support, so as to avoid all destructive local action. Contact with the peroxide was established by means of a disc or strip of thin platinum, maintained in position by ebonite screws and nuts. Spongy-lead plates were made from the same lithanode material, charged as a cathode instead of as an anode.

WINDINGS OF POLYPHASE ARMATURES.*

BY J. P. STONE.

With the introduction of polyphase apparatus, a number of different windings have necessarily been developed, though all of them have the same general features. Since they are slightly different, it may be thought that they are of essentially different character. It is the object of this paper to illustrate how these windings are made, and to show that it is rather unessential what type of connections are used as far as behaviour and output of machines is concerned.

The single-phase winding in its simplest form consists of a number of coils connected up so as to give alternate polarity all round the surface of the armature. Assume that an alternator has 10 poles, we could thus have a winding consisting of 10 coils, as illustrated in Fig. 1, each

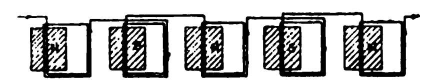


FIG. 1.—Single-Phase Winding.

coil connected in reverse direction in regard to the preceding; or we could have a winding as illustrated in Fig. 2, consisting of five coils, which coils are connected so as to give the same polarity, but separated from each other by the pitch of the poles—that is, by the distance between two adjacent poles. Necessarily, if all coils are connected so as to give the same polarity, the space between the coils will have the opposite polarity to that given by current passing through the coil. A two-phase generator could be made from a single-phase generator by adding a set of new coils placed midways between the first coils and wound in

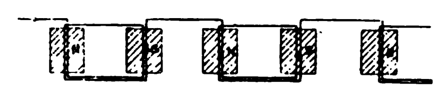


FIG. 2.—Single-Phase Winding.

identically the same way as the first winding. Since the distance in phase between two adjacent poles is 108deg., it is evident that the beginnings of the two independent windings will be 90deg. apart; thus, if the two windings have the same number of turns, the generator will have two independent sources of power of same magnitude, one displaced 90deg. from the other—that is, we have a two-phase generator with independent windings. Such a machine would then, of course, have four collector rings, two for each of the windings. By connecting two adjacent collector rings together, a two-phase relation still remains and we have a two-phase machine with interlinked winding.

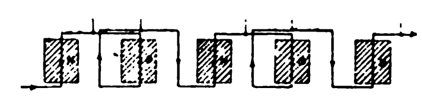


FIG. 3.—Two-Phase Winding.

The same results can also be obtained from a distributed single-phase winding by proper connections, provided that the number of coils between each pair of poles is divisible by 2. Such a winding is illustrated in Fig 3, and is, as can be seen, essentially a direct-current winding in which four taps are taken out to four collector rings (bipolar machine). Thus no new features in winding are introduced in making a two-phase generator.

A three-phase generator is made on essentially the same plan. It consists primarily of three independent single-phase windings, such as are described in Figs. 1 or 2, each starting 120deg. in phase from the preceding; that is, since

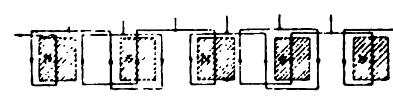


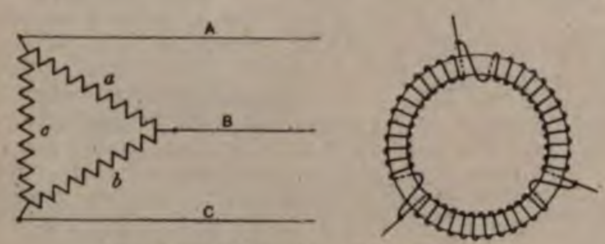
FIG. 4.—Three-Phase Winding.

the distance between two pairs of poles is 360deg., if the first winding starts midway under one pole, the second winding, wound identical with the first, should start at one-third of the distance between two poles and the third at two-thirds the distance between the poles. Thus we see how a three-phase generator can be wound. If these circuits are not joined, six collector rings are necessary, two for each phase. Since, however, each winding has a point of equal potential with either of the other two, that point can be connected on all three. That is, one end of each of their windings is brought to a common junction,

* From the *American Electrician.*

from which they branch out starwise, and the remaining ends are connected to the three line wires. The three lines thus serve in turn as outgoing and return circuits, the maximum current shifting from one to the other in succession. We thus obtain a Y-connected machine which necessitates three collector rings only.

Similar to what was stated regarding the two-phase winding, the three-phase winding can be obtained from the distributed single-phase winding by tapping the winding at suitable points—that is, points differing in phase by 120deg. Such a winding is illustrated in Fig. 6, and is called the delta winding. This is also shown diagrammatically in Fig. 5. Here the coils form a closed mesh, the six terminals being united two and two, the lines being connected to the windings at three points of junction, forming a triangle. In order to make such connections, however, it

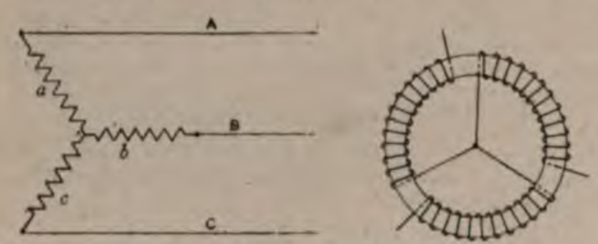


FIGS. 5 AND 6.—Three-Phase Delta Winding.

is, of course, necessary that the single-phase winding should have at least three slots per pole and phase (for a full-pitch winding) or a multiple of 3. Such a winding is illustrated in Fig. 4.

The three-phase windings can also be shown as simple Gramme windings, having only one coil per phase, as in Figs. 6 and 8, which are shown delta and Y connected respectively. Thus it will be seen that a direct-current winding may be connected into a three-phase delta-connected winding by tapping it at equidistant points, the number of leads being governed by the number of poles.

Denoting the E.M.F. induced in each winding by E, it is evident that the E.M.F. between the lines in a delta-connected armature must be E, since the lines are connected directly to the ends of the winding. In a Y-connected armature, however, one end of each of the three windings are connected together, and the other three ends are connected to the lines, as in Fig. 7; but, since the E.M.F.'s induced in each winding are not in phase with each other, the E.M.F. at the terminals is not the sum of the E.M.F.'s induced in each winding—that is, it is not 2 E, but is



FIGS. 7 AND 8.—Three-Phase Y-Winding.

the geometrical sum of the E.M.F.'s in the two phases—that is, E $\sqrt{3}$.

The output of a polyphase generator is that of the sum of each individual phase—that is, denoting the current in each wire in a Y-connected motor by C, and the E.M.F. induced in each phase as before, by E, the power of the three-phase generator is $3 \times C$ E. Since, however, the E.M.F. between the lines is $\sqrt{3}$ times the E.M.F. per phase—that is, $E \times \sqrt{3}$—we find that the power of a three-phase generator expressed by the line E.M.F. and line current must be $\sqrt{3} \times C_1 \times E_1$, where E_1 and C_1 are the E.M.F.'s and the currents, respectively, between the lines and in the lines. In a delta-wound motor, in the same manner, we find the power delivered to be expressed by the same equation.

Regarding choice of winding, in some cases, undoubtedly, one is preferred to the other. In such cases, as with alternators where rectified current is used for compounding, the Y-connection adapts itself more readily, as the commutator can be connected in the common junction of th phases. The delta winding, however, is essen generators which shall combine direct-current out input with alternating-current output or input—suc rotary converter—where, on account of the direct- feature, the winding must be of the delta form— must be continuous—as shown in Fig. 5, which rep a continuous winding tapped off at three points 1 apart. Furthermore, by the choice of one or the o is often possible to make a decidedly better motor mechanically and electrically.

An armature designed for a given working v measured between the lines would, if planned for nection, have fewer turns of larger wire than if in

FIG. 9.—Delta Winding.

for delta connection. This is sometimes convenient, useful in keeping the voltage between coils low. Th connection, on the other hand, has more turns of s wire, as the current is diminished while the E.M.F. i coil is the full E.M.F. between the lines. This prop useful under certain conditions, as it makes the E between any two lines somewhat less. For ins in a machine with very large currents, the delta wi would be preferable, since in that winding the curr each wire is smaller than the line current (the line c being supplied from two phases, as illustrated in F The contrary is the case in a machine for very high pot it is often possible to get a simple winding by a Y-c tion, since then the number of turns necessary to giv requisite voltage are less than those in a delta-conn winding.

FIG. 10.—Y-Winding.

The same winding can, of course, be connected delta according to the dictates of convenience, as in F and 10, which show the same armature connected and Y respectively. Thus it will be seen that the m of connecting the windings of a multiphase armat largely a matter of convenience, and thus does not infl the working of the machine.

In a completed armature for a polyphase generato winding and connection are usually covered by a shi each end to protect them from injury.

Venezuela Telephone and Electrical Appliances Com Limited.—Coupon No. 15 of the 5 per cent. mortgage deben due on the 31st inst., will be paid from that date at the C and Counties Bank, Limited, 39, Threadneedle-street, E.C at Messrs. Westendorp and Co.'s Bank, Amsterdam.

VEY OF THE POSSIBILITIES OF ELECTRIC HEATING AND COOKING.*

BY W. P. ADAMS, A.K.C., A.I.E.E.

of you will doubtless be able to call to mind the old which a visitant from another world was vastly puzzled g a mortal blowing upon his fingers to warm them, r, upon his hot food to cool it. It is not by any means on to find this species of incredulity occupying the members of the public when electrical engineers claim ctricity will produce the coolest light and also cook d and heat one's house. As this feeling is not confined members of the public, but is shared by some gentle- our own profession, you will perhaps be inclined to at it is pardonable in a layman. My desire this evening sible, to pave the way to a better understanding of the ties of electric heating, so that engineers may be able ne that confidence as to its merits which is necessary any real progress can be attained, and which is at lacking in many a professional mind. The feeling is that the cost is, and will be to the end of the chapter, t that its adoption can only be hoped for by those than ample means, but I hope to show that while it tedly deserves to rank as a luxury, it will be well within the f those with average incomes when the cost of current is at modified. The reason why electric heating, more espe- the direction of cooking, is able to compare favourably her methods, is that the heat can be applied just where it ired, and there is remarkably little waste. I well ber in my student days being struck with a description Norwegian cooking pot in a copy of Deschanel's "Heat," ndering if the principle could be applied to cooking by ity. I saw that if the contents of the pot were raised to point, little heat was required to maintain it at that ature. In a general way this principle is used in the oven. Notwithstanding this, heating appliances do what appears to be a large amount of electricity, and electricians, especially those more closely connected with lighting, are surprised at the large amount of current is necessary for cooking purposes, and mentally compare night be done with the same current if devoted to the tion of electric light.

ill perhaps render clearer the remarks I am about to make ve you some general idea of the current necessary for ing certain results. As it is in the direction of electric g that I anticipate the largest development in the near , I shall confine myself at first to a consideration of this t. In a kitchen suitable for supplying the needs of a of from eight to ten persons the following apparatus be necessary: oven, absorbing 2,500 watts when heating about 15 minutes, and on the average about 1,200 watts rds; breakfast cooker, wound for two circuits, each ng 600 watts; two grillers, each wound for 500 watts; pans, also wound for 500 watts, and several hot-plates ning ordinary saucepans, or in place of these several tained electric saucepans. These plates or saucepans probably absorb 1,500 watts together. The household l from such a kitchen would probably have a maximum for not more than 2,500 watts for lighting purposes. l watts which could be absorbed by the cooking appa- 7,200. It must, however, be borne in mind that these appliances are used at different times, and never er.

hall now consider the difficulties in the way of the of electric cooking. First and foremost is the question st of current. This is all important. In addition to first outlay cannot be overlooked, owing to the rather st of the apparatus. The largest field for the develop- f electric cooking is undoubtedly in private houses l from central stations, and if there is to be any large n in this direction the central stations must be prepared y current at a more moderate price than is now charged ting. It is generally recognised that electric cooking ntually prove to be the means of solving the much-vexed of securing a day load for central stations, and, in this fact, many of the central stations offer special or supplying electric currents for heating. A number central-station engineers are, however, still doubtful the advantage of adopting electric heating, partly the question of the load overlapping the lighting load. estion I shall touch on later, but I would venture to t that, if the demand is spread over a sufficient number , electric heating is worthy of consideration quite apart ctric lighting, and it would therefore pay to put down ant to meet the additional demand. In fact, I do not e day is far removed when the demand for current for heating will vastly exceed that for lighting purposes, bmit that the solution of the question lies mainly in the hands of the present suppliers of electricity. If they are prepared to adopt a liberal policy of supplying electricity for heating purposes, perhaps at little more than the actual bare cost, they will very soon find that the improved conditions under which they run their plant will begin to repay them handsomely.

The price to be charged is of the greatest importance, and I will, therefore, make a few comments upon the methods of charging now in vogue. Anyone who makes a careful study of *Lightning's* very valuable "table of costs" will observe that it is becoming usual to make the charge for heating and power about half that made for light. A very usual figure is 3d. per unit, while some supplies have brought the price down to an even lower figure. I may say at once that the ideal to be aimed at for heating and power purposes is a charge of 1d. per unit, and although it is only possible at present for one or two companies to charge such a figure and cover the bare cost of production, I think the figure is well within the range of practicability, and with a rapidly-growing load on supply stations I think it will soon become general. It is noticeable that the local authorities are moving more rapidly in this direction than supply companies. I would commend this to the attention of the supply companies. Their policy of making high charges is, to say the least of it, unprogressive. Only about four are charging so little as 3d., while 26 of the local authorities supply at 3d. or less, 13 of these charge 2½d. and less. The Wright system of charging for electricity appears to be securing considerable support amongst central-station engineers, and the maximum demand system seems to have been receiving even greater favour. With both of these systems I can foresee a trouble in connection with the supply of electricity for heating purposes. Under the Wright system it is conceivable that the demand meter may run to a most unusual height, through the inconsiderate switching on of a number of the heating appliances together, the indicator therefore furnishing quite an abnormal record upon which the charges are to be based. Again, with the maximum demand system, if the charges are to be made upon the usual understanding that the whole apparatus is to be run for an hour at the maximum charge before any reduction is made, the charge cannot come down to anything like a reasonable figure. It is, of course, obvious that the whole of the appliances will not be in use together, and I think this point is worthy of close consideration. In a certain kitchen it was found that the various cooking appliances were in use for from five to seven hours a day, during which time the highest point reached was 1·5 kw. The average consumption during the day was from eight units. It will thus be seen that if generating plant to the capacity of 2 kw. was installed for supplying these cooking appliances it would have an earning capacity of about 1,400 units per kilowatt installed per annum. I find that the number of units sold per annum per kilowatt of plant installed varies considerably among the different stations in country towns where the load is almost exclusively a lighting one, and the supply is very small during the daytime. About 400 or 500 units represent the work done during a year by 1 kw. of plant installed. In the larger towns, where there is probably a small day supply for power as well as one for lighting in dark offices and basements, the demand in larger. In Brighton, 840; Edinburgh, 640; Glasgow, 696; Manchester, 700. It will be seen that Brighton, which might almost be termed a country town, as there are no factories there to absorb power in the day, shows the best results of those named. This, I think, is traceable to the moderate nature of the charge for current. As so little has been done in a general way in this direction, it is not possible to obtain exact data indicating in any definite manner what the load curves due to heating are likely to be, but I have been able to build up from figures at my disposal a very rough load curve for cooking appliances. It is obvious that the peaks of the load will be at the different meal times. The load will run up from 6 a.m. to 7 a.m. rapidly. After this it will be fairly level to about 8.30. It will then drop rapidly until about 9, when the curve will begin to rise again for early dinner and lunch; from 10 until 1 it will be fairly level, reaching its maximum at a little after 12. After 1 it will fall rapidly until 3 or 4, when it will begin to rise a little for tea. It will continue to rise and will attain its maximum between 6 and 7. After this the decline will be fairly rapid, and there will probably be a little rise again between 8 and 8. I have obtained these rough general results from the study of single curves, making due allowance for the overlapping of the different curves in those cases where meals are taken earlier or later.

As a load for summer time, cooking should prove invaluable to supply stations, and the question of overlapping during this period does not arise. I think it is perhaps unnecessary to deduce evidence that electric cooking would be of great advantage to central stations during the summer time, but I may point out that the introduction of penny-in-the-slot gas-meters in the South Metropolitan Gas Company's area has led to an enormously increased consumption of gas in summer, mainly for cooking purposes. The gas companies suffer (if we

* er read before the Northern Society of Electrical s.

can say that such wealthy monopolies suffer at all) from light loads in the summer time in the same manner as do electric light stations. In winter, however, the conditions will be different. A certain amount of overlapping will occur owing to the prevailing fashion of late dinners, but I submit that the load for electric heating is likely to be of sufficient importance to warrant putting down additional plant to meet this. Much, of course, depends upon the acuteness of the peak as to how this question is to be met. If it can be arranged, it will be desirable to utilise for heating during the day the plant installed for lighting purposes, but if the demand for heating grows to such an extent as to greatly surpass the lighting load, the question becomes of less importance. It is not, perhaps, within my province at this moment to suggest how this difficulty is to be met, but with some stations in this country the question does not arise at the present time, as ample plant has been installed to meet the lighting requirements and still leave a balance in hand to allow for the overlapping. This will be seen by looking through the columns in *Lightning's* table of costs, giving the maximum load and the kilowatt capacity. A number of stations appear to be provided with twice the amount of plant required to meet the maximum demand. Of course, some portion of this is reserve plant, but there still remains a good balance in hand to meet this contingency. I am inclined to think that a secondary battery would prove of great value in meeting the peak difficulty, as there are several depressions on the day-load curve which could be filled up if the generating plant were employed during these times of light load for charging the accumulators. How far it is possible to economically utilise accumulators for this purpose in alternating supply stations is an open question.

While considering the charges made by the various supply companies, it is noticeable that several have adopted the enlightened policy of charging, for power and heating purposes, a price which is actually less than the total works cost. Putting on one side for one moment the question of overlapping, it is obvious that this is a right policy to adopt, as, assuming that the plant used for lighting is employed for supplying heating appliances, the charge for rent, management, etc., will remain practically the same. The following facts with regard to charges by different supply companies are worthy of note. In Edinburgh the charge for power is 2d., the works cost is ·63d. and the total cost 1·13d. per unit. In Glasgow the charge is made on the maximum demand system—6d. the first hour, and 2½d. after. The works cost is 1·32d. and the total cost 1·92d. per unit. In Liverpool the charge is 2d., the works cost 1·14d. and the total cost 1·77d. per unit. These charges are moderate, but I think in some cases would still bear reduction. It is to the large towns that we look at first for the introduction of the penny per unit charge, and if these towns can succeed in getting a satisfactory day load the time does not seem very far distant when such a consummation will be reached. I also desire to draw attention to the results obtained at Cardiff, which are interesting. It is one of those towns which adopted the policy of charging for heating and power purposes at a less price per unit than the actual works price. The returns for the year 1895 show a consumption of 400 units per kilowatt installed. The works cost was then 3·1d. per unit, and the total cost 3·69d. per unit, the charge for power being 3d. In the return for 1896 I find that 700 units were sold per kilowatt of plant installed, the works cost had come down to 2·86d. per unit, and the total cost to 3·06d. per unit. This satisfactory result may be due to local circumstances favouring rapid development, but the figures appear on the surface to be significant. I also desire to draw attention to the following supplies: Sheffield is charging 5d., with the works cost at 1·48d., total cost 2·2d. per unit; the Westminster Supply is charging 4d., the works cost being 1·24d. and the total cost 2·09d. per unit; the Chelsea Company charges 4d., with a works cost of 1·48d. and a total cost of 3·08d.; and last, but not least in more senses than one, the City of London Electric Lighting Company is charging 8d., with a works cost of 2·46d. and a total cost of 3·5d. per unit. I have the misfortune to be situated in a district served by the City of London Company, which company holds a monopoly and takes an advantage of this to maintain a charge which is worthy of the very early days of electric supply. Although their works cost compares anything but favourably with other large towns, having in many cases a much smaller output, I think you will agree with me that the charge of 8d. is somewhat extravagant, and I may say that such a charge absolutely prohibits any demand for current for power and heating purposes. It is true that a rebate is made if more than a stated quantity of electricity is used, but this is fixed so that it is of little value in the way of reducing the price. It seems almost incredible that, in these enlightened days, the foremost city in the world should be one of the worst supplied in the matter of electricity.

I have so far made no comparison between the cost of cooking by electricity and that by other means. I shall not deal with this question much in detail, as I think it more practical at the present time if a general idea is given as to what the actual

consumption of electricity will be, for the cost by o
varies largely under different circumstances. I hav
some figures to hand obtained in a kitchen where b
electricity could be used at will. The household
one, consisting of about five persons, and the cons
electricity was approximately 30 units per week wh
was done solely by this agency. When gas was
exclusively, 1,240 cubic feet of gas were used duri
The cost then of electricity at 2d. per unit is 5s. a w
the equivalent amount of gas at 3s. per 1,000 cu
3s. 9d. The figures of consumption which I have g
are the most complete at my disposal, and this is my
bringing them before your notice, but I have other resu
which indicate that the consumption of current may
below the figures given when the appliances are used i
and with care. For small installations such as we have
one may assume roughly that a unit per head per diem
for all cooking purposes. These figures will naturally
in larger establishments, and experience seems to poi
1s. 2d. a unit as a sufficient allowance in kitchens w
than 30 or 40 persons have to be provided for.
results will be obtained where there is a hot-wat
Many of you are probably aware that heating wat
tricity is a most uneconomical proceeding, at any r
present prices, and where an establishment is suffici
it is always recommended that a slow-combustion sto
to supply all the hot water for the household. In m
such a stove is already fitted.

There is one direction in which one might antici
development of electric cooking, and that is in
architects will arrange for a general hot-water sup
whole building, as I believe is now done in many ca
cooking presents such an advantage that an import
ment in this direction should take place when t
companies are convinced of the advantage of cha
prices as will be generally acceptable. I think I
sufficient to indicate that even with electricity at 3d
electric cooking is not extravagantly expensive,
other great advantages are taken into consideration,
the economical results from the perfection of the
ought to be received with prompt favour. I am h
before long those responsible for electricity supply
to make a definite move in the development of ele
ing and cooking. It is not sufficient to merely
price of electricity to a reasonable figure, as ma
corporations have already done, but steps should b
induce people to become users of electricity for othe
than lighting. It may be said that such steps are
province of electric supply concerns, but if the c
undertake the supply of light to towns, it is surely o
it is to their advantage to put every facility in the
ratepayers to use as much electricity as possible.
needs no argument to convince a company that its p
be to try and obtain as many users as possible, w
lighting or power or heating, as every unit sold mean
amount of profit. It must, therefore, be of advantag
undertaking its own supply to sell as much electricity
not in this case in the interests of the shareholders,
interests of the ratepayers. The hire system, whi
companies are much in favour of, should be adop
possible. One of the difficulties which has been met
attempt to develop electric heating is the high first
apparatus. This is largely owing to the comparat
output of heating apparatus at the present time,
owing in no small degree to the many different volt
the goods have to be made up for. You will proba
prised to learn that there are no less than 14 differe
in general use at the present time, and you will qu
ciate that this does not tend towards the cheapen
appliances. I have little doubt, if supply compani
pared to give this matter their careful attention, tha
satisfactory arrangements might be come to between
and manufacturing firms so as to meet these diffic
may be worthy of mention, in passing, that many s
panies and local authorities have no power to hire
ratus in the same manner as the gas companies; and
the probable development in this direction, I would r
that all companies and authorities applying for power
should include this in their application. Existing
can obtain the necessary powers by taking the usual le

I have now to consider the practicability of using c
heating plant in connection with plant installed f
residences and factories. In very few and well-arr
properly managed private installations does the cost
per unit, and in residences where accumulators a
would simply mean running the plant a few hours a
if electric cooking apparatus were adopted. Assumin
extra wear and tear of the plant is negligible, w
justified in doing, and that the man in attendance has
most of his time to the electric lighting plant, the
tional cost incurred is the additional fuel consumed a
waste used. This may vary between ¼d. and 2d.

the case of a gas-engine supplied with town gas at 3s. per 00 cubic feet, and consuming 20 cubic feet per brake horse-wer hour, the cost per unit would be 1·18d. In the case of engine supplied with producer gas, and consuming 1½lb. of al per brake horse-power hour, the cost would be ·26d. per it, with coal at 20s. per ton. With steam plant the cost of al consumed will vary considerably, but in no case where asonably economical plant is installed should it exceed 2d. per it. In factories where large electric lighting plants are in the same argument holds good. The probability is that the generating engines are supplied with steam from the main boiler system, and the man in attendance on the general machinery is expected to look after the electric lighting plant. The cost of generating electricity during the daytime for cooking meals for the staff of this establishment, and perhaps for the employés, is in such a case, almost a negligible quantity. It may be considered superfluous to mention that water-power installations form an ideal opportunity for the employment of electric heating, in this country the amount of water power available is but small. It will be obvious to you that in country houses lighted by the agency of water power there could be no cheaper means of cooking and heating than by running the generating plant during the day. The cost of fuel is nil, and it is a fact that in many country houses in Scotland, where coal has to be carted many miles, such installations are in existence, and there should be no hesitation in recommending the adoption of heating and cooking appliances. As a matter of fact, several houses have already adopted this plan with great satisfaction. Abroad, of course, the conditions are different. Large water powers are available in different countries, and there, at any rate, should be a field for the development of heating and cooking in which they would stand absolutely unrivalled. The largest order for electric radiators ever received was placed not long ago for heating offices supplied from a water-power installation.

I must here make a small digression to call your attention to the curious ideas some people hold with regard to electric cooking. An establishment in Liverpool had just installed a large and economical plant for electric lighting purposes, and it had been proposed to the owners that they should use it during the daytime for cooking purposes. I was asked by the electric contractors to loan some apparatus for testing, and, the conditions being distinctly favourable, this was done. A little later I was informed that the committee would not adopt electric cooking. I was anxious that the test should have been made under my supervision, but it was not thought necessary for me to be present. Enquiries were made, and I found that the committee itself had superintended the experiments and had insisted upon the food being placed on the appliances before current was turned on. As one of the elementary rules of cooking is that the apparatus should be heated up to the proper temperature before the food is placed upon it, you will understand that such an experiment was foredoomed to failure. I relate this instance as an illustration of the common idea that electric cooking apparatus is capable of doing things which no one would think of expecting from ordinary cooking apparatus, and simply for the reason that the word "electric" is used in connection therewith. Every electrical engineer at one time or another has met with peculiar ideas of this sort. There is, of course, nothing magic about electric heating and cooking appliances. The advantages which we claim for them are: (1) that they are more economical in point of heat utilised than any other appliances; (2) that they are quite without equal in point of cleanliness and convenience; (3) that there is practically no waste of material in the cooking; (4) that by their means cooking is reduced to a simple science, and absolutely uniform results can be obtained, this being due to the ease with which the heating is controlled by switching. In the oven it is usual to fix a thermometer indicating on a dial on the front of the door, and temperatures can be maintained within a few degrees. I further claim that such appliances are perfectly free from such dangers as attend the use of gas cookers. Explosions are impossible and the risk of fire is nil.

I must now beg of you to spare me a few minutes for the consideration of electric heating by radiators. I have already stated at the commencement of this paper that this subject requires consideration from quite a different point of view to that of cooking. Assuming for the moment that there is likely to be any large development, you will at once observe that this will bring no load to the stations during the summer time, and, owing to the large amount of current the radiators consume, they will make the winter load heavy. It may be that persons who adopt electric cooking may be inclined to use the apparatus during the summer time only, on account of its coolness, in the same way as people now adopt gas-ovens, resorting to the use of the kitchen range in winter. If this were to any large extent it would probably meet the case, and it might even be desirable for supply companies to give special terms for the use of electric cooking appliances in summer, and increase these charges during the winter. Whether such a plan is feasible or not will have to be ascertained as the problem develops. When estimating roughly what current radiators are to be wound for, for a given space, I generally assume that 500 watts will be necessary per 1,000 cubic feet of space in the coldest weather. This, of course, is only a very rough guide, and in every case the general conditions must be taken into consideration. In my office in the City, which has a capacity of 2,000 cubic feet, with one outside wall almost entirely consisting of window space, I rarely use a larger radiator than one absorbing 600 watts. In very sharp weather I have found it necessary to put two of these on for the earlier part of the morning, and sometimes on Mondays, after a continued frost extending over Saturday and Sunday. In this instance it will be seen that a less quantity is required than 500 watts per 1,000 cubic feet of space. In the case of a building with several thin outside walls and other unfavourable conditions, probably more than the 500 watts would have to be provided for. With radiators consuming this amount of energy you will appreciate that electric heating is not likely to receive much support when such charges as 8d. per unit are made. At the beginning of last year I was requested by an architect to fit nine radiators in a spacious office in the City. The firm was a wealthy one, and expense was not considered an important matter owing to the convenience of the electric radiators. I pointed out before the order was placed that the cost of current would probably be very high, but, notwithstanding my warning, it was decided to have the radiators fixed. After they had been running for three or four months I was informed that the cost was so excessive that their use would have to be discontinued. With one or two small exceptions these are the only radiators ever installed in the city of London; and, while the prices are maintained at the present figure, little development is likely to take place, and yet the City is an almost ideal place for the use of electric radiators, owing to the fact that the bulk of the offices close at an early hour, and that the occupiers are willing to pay a good price for so convenient and sanitary means of heating as electric radiators provide. Experience shows that even at so high a figure as 3d. or 4d. there is considerable demand for electric radiators, and this is not surprising when one considers that the heat produced is of exactly the quality that one could desire. It is not sufficiently high to deprive the air of its moisture. There are no products of combustion to vitiate the atmosphere, and the radiators are turned on and off with the same ease as the electric light. It is, of course obvious that persons of means will be the first to adopt electric heating, and that as the price diminishes so those of less liberal incomes will be able to avail themselves of this method of heating. This is simply a repetition of the experience met with in connection with the electric light. There is one direction in which electric radiators should prove valuable, and this is in ship heating. The present system mostly in vogue is steam heating, and this is constantly a recurring source of trouble and vexation, and also of expense. Electric radiators can be fitted on board ship with very much greater ease than steam radiators and piping, and give absolutely no trouble when once installed. The cost of installation, including the additional generating plant, is very little in excess of the fitting of steam heaters, and in some cases may be even less. I am sorry that the time at my disposal will not admit of my enlarging on this and many other points of interest in connection with electric heating.

During the last few minutes left at my disposal, I would briefly call your attention to other directions in which electric heating is capable of considerable development. Hot-cupboards, for use in dining-rooms and serving-rooms of private houses and clubs, have been received with some little favour; and as they are generally brought into use after the main work in a kitchen is finished, they will doubtless help to fill up the dip in the load curve which occurs after mid-day and during the progress of late dinner. While they take a considerable amount of current while heating up, they are not in use for sufficient time to make the cost of much account. Hot-plates of various types are in use for keeping plates and dishes warm during meals, in a similar manner in small establishments where hot-cupboards would not be required, and these would all be an help towards filling up the after-dinner depression in the load curve. I cannot now make detailed mention of the smaller heating appliances, but I think that their employment is one worthy of some consideration by supply companies. If they are at all largely adopted, they would be of value in increasing the day load, and it is likely that they would be employed at times when the cooking apparatus would not be in use. Take, for instance, the electric kettle. Each kettle takes from 300 to 500 watts, and they are mainly used for preparing tea in the afternoon. It is conceivable that if used in large numbers they would help to fill up the somewhat awkward dip in the curve occuring about about three or four o'clock in the afternoon, after the hot cupboards and plates had gone out of use.

In conclusion, I will ask you to be as lenient as possible when passing judgment upon this paper. I am well aware that I have been guilty of some temerity in venturing to read a paper upon a subject about which there is so little practical knowledge. My excuse for doing so is that I believe there is a reasonable probability of considerable development in this direction in the

near future; and I hope that the figures which I have placed before you may help electrical engineers and others interested to understand better the claims that this branch of electrical engineering has upon them. I have attempted to deal with the problem as widely as possible, and I hope that the aspect of affairs from the central-station engineer's point of view may receive some consideration during the discussion.

INSTITUTION OF ELECTRICAL ENGINEERS, Jan. 27.

At last night's meeting of the Institution the following were the candidates balloted for:

Member.—A. E. B. Ridley, San Francisco, California, U.S.A.

Associates.—C. C. Atchison, 2, Pandora-road, West Hampstead, N.W.; R. J. H. Beaty, 55, Wellclose-terrace, Blackmore-lane, Leeds; J. N. Bellihomji, opposite Railway Station, Grand-road, Bombay; I. Bulfin, B.A., Navarino, Bournemouth; A. Q. Carnegie, Borrea Coal Company, Limited, Siterampor, E.I.R., Bengal; E. T. Everett, 11, Albemarle-street, Clerkenwell, E.C.; S. Hearne, Public Works Department, Madras; S. Pauls, 72, Merton-road, Wimbledon, S.W.; W. Powles, 249-251, Kensal-road, W.; F. H. Read, 1, Hampton Villas, Sydney-road, Enfield Town; H. Sclater, 54, Grindlay-street, Edinburgh; J. Shaw, Isle of Man Tramways and Electric Power Company, Limited, Douglas, Isle of Man; E. F. Szlumper, Glanteifi, Kew Gardens, W.; K. M. Tarachand, Burlington House, Cumballa Hill, Bombay; H. J. Taylor, The Lawn, Melbourn, Cambridgeshire; J. A. Walker, 300, St. Vincent-street, Glasgow; W. B. Walker, 55, George-street, Edinburgh; G. C. Weston, 28, Kildare-terrace, Bayswater, W.

Students.—A. Marinier, 53, Craven Park, Willesden, N.W.; C. B. Monson, Vestry of St. Mary Abbotts, Kensington, W.; C. J. Simeon, Faraday House, Charing Cross road, W.C.; H. Stephens, The Gorse, Knutsford, Cheshire; H. J. Winton, Speldhurst, Tunbridge Wells.

The following was the paper read:

Notes on the Electro-chemical Treatment of Ores Containing the Precious Metals.

BY MAJOR-GENERAL C. E. WEBBER, C.B., R.E. (RET.), M.I.C.E., PAST-PRESIDENT.

The precipitation of gold and silver with the aid of an electric current has a history which may help my audience—many of whom, I think, are more or less acquainted with the subject—to appreciate the present situation of a question which cannot be devoid of interest to our Institution. If we go far enough back in the subject, we shall find that in 1835 to 1840 Becquerel used a saturated solution of common salt for dissolving compounds of silver and lead, and subjecting the solution to the electric current, both to hasten the reactions of the process, and better to utilise the precipitating agent.*

In 1843 Prince Pierre Bagration described in the *Bulletin de l'Academie des Sciences de St. Petersbourg* some experiments with finely-divided gold dissolved in an aqueous solution of potassium cyanide under the influence of the galvanic current, by which means he precipitated the precious metal on a copper cathode. In 1867 Julio H. Rae proposed, in the United States, a method of treating ores containing gold and silver mixed with a suitable solution, such as one of cyanide of potash in water, by the action or aid of a current of electricity; suggesting at the same time, in addition, the agitation of the solution. Although Rae's proposals are said to have never gone beyond an experimental stage,† in his description is found the combination of (1) a circular vessel to contain the ore; (2) a solvent in solution; (3) a stirrer, or agitator, on a vertical shaft, working with a rotatory motion within the vessel, the stirrer being connected with one electrode, and a conducting metal plate which supports the charge under treatment within the vessel being connected with the other electrode, of a source of electricity.

* Prof. Silvanus Thompson has sent me the following extract from "The Memorials of Andrew Crosse," published in 1857: In 1837 "I took a piece of quartzy gold ore from California, which weighed 4,306 grains, and reduced it to coarse powder in an iron mortar," "roasted," and "repowdered" it. "Of this powder I took 1,000 grains and put them into a Wedgwood mortar, having first thrown into it 200 grains of pure mercury. I then partly filled the mortar with extremely dilute carbonate of ammonia, and connected the mercury with the negative pole of a very weak voltaic battery of 12 pairs of cylinders, keeping up the action for five hours. . . . I next weighed the mercury, having carefully dried it. Its weight was 205 grains, which, when evaporated in a blacklead crucible, yielded eight grains of gold. . . . I tested the residue, . . . so that the above electrical process had only left, after five hours' action, one-seventeenth part of the gold untouched."

† Rae (Fig. 1) describes the employment of a jar or vat, A, of an insulating material, which contains a stirrer in the form of a cage, B, carried by a vertical shaft, C, which, resting on the bottom of the jar, is made to revolve on its axis by means of a pulley, D. This stirrer, combined with the plate, P, on which the axis of the stirrer rests, and on which the pulverised ore is deposited, constitutes one (the positive) electrode; the other electrode is connected with a metal plate, E, suspended in the vessel above the stirrer.

In December, 1882, Messrs. Breakell and Haycraft pat
South Australia a means of treatment of slimes by
combined with an electrical current and amalgamati
nearly all respects they copy Rae, except that they
solvent of the precious metals present in the mixtur
treatment.*

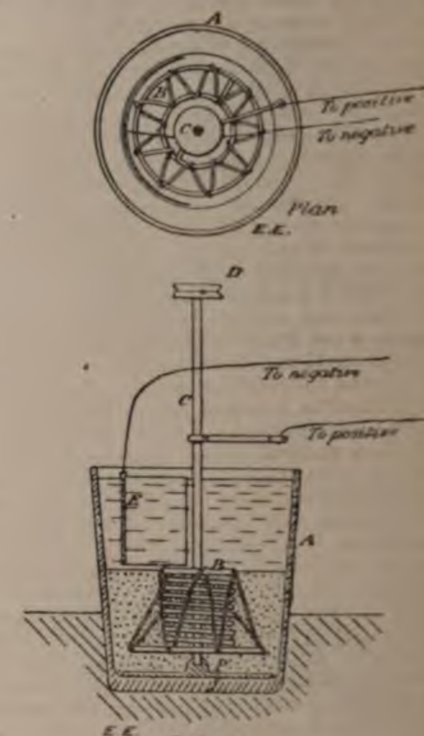


Fig. 1.

In passing, I must mention Barker's apparatus of 1
extracting gold and silver from "sands" containing t
which we find the use of a mercury cathode, combin
stirrers on horizontal shafts, which, however, did not co
the anode. Also Body's process of 1883, which com
drum and ball crusher of ore containing precious metals
had been previously ground and dissolved in a solution
ing ferric salt. The axle of the revolving drum carries

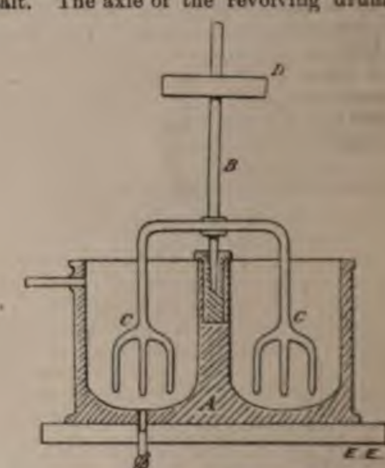


Fig. 2.

anodes, and the walls of the vessel and the balls
cathodes, on which the noble metals after solution are d
electrolytically. Mercury is used, but only for the pur
collecting the free gold and silver.

I propose to avoid as far as possible allusion to th
number of inventions which deal chiefly with el
amalgamation, but it is difficult not to refer to some
which use electrical deposition. Thus, when, in 1888, Ma
and Forrest investigated the chemistry of and patente
world-renowned process, they seem to have neglecte
having tried it, discarded, the assistance of electri

* In their apparatus (Fig. 2), A is the vessel, or "pan,"
the operation is performed. B is a revolving shaft, carryin
or rakes, C C, which is connected by a contact, prefer
mercury, on the top of the shaft, with the positive p
battery. The bearing on which the axis revolves is insulat
the vessel. D shows the position of a pulley on the sh
means of which it is revolved. The negative pole of the
is connected with the vessel, which is of iron, or such
material; so that the vessel itself, as well as the mercury
the bottom of it, constitutes the cathode.

ion with a weak solution of potassium cyanide, of a greater expenditure of chemicals, which they :o be the result, and also because they believed it ed the solution of any baser metals together with and silver which might be present in the ore, and the extra expense of their separation. I need not r to the reasons for MacArthur and Forrest's rejec- lectricity, nor to the well-known Siemens and Halske in which "circulation" of the solution by gravity is an feature, as I wish to direct your attention more par- to those processes in which the combination of similar as with "agitation" are included. Following on Rae ıkell, in 1891 Hannay described and patented in the Kingdom a process and an apparatus for "extracting m minerals containing it, by subjecting the finely ed mineral mixed with a solution of cyanide to action and agitation in the presence of mercury." In ess—which it is not understood was ever put to work ctical scale, and which it is believed, in common with ecessors, is not described so that the ordinary intelligent ing mind could erect the apparatus and work it success- ere is found the combination of (1) a circular vessel or 2) an electrolyte consisting of a solution of cyanide of m, mixed with pulverised ore ; (3) a stirrer, or agitator, tical shaft, standing in the middle of the vessel, and rotation on its axis ; (4) one electrode—the anode which se is a cylindrical block of carbon—being suspended or the middle part of the vessel. Two examples of the appa- re published in December, 1891, and in one of them r one) we find another condition in combination with e, which, so far as I can discover, but for the proposal ell and Haycraft in 1882, would be the first example in e bottom of the vessel described as of "basin shape, g mercury," as in the case of the ordinary amalgamat- is also the cathode. Examination of the description cathode will, I think, not satisfy electricians of its value without important modifications. The use of or oxidising agents other than potassium cyanide is not , and the strength of the cyanide solution, current, etc., en.*

exists an interesting description of a process patented y Mr. Molloy, M.P., who, between 1884 and 1887, had h the subject in a different manner. Although it does de all the features of treatment to which I wish to yself, its chemical reactions are not without interest bject. It involves at first sight two stages, but really ır—namely, first, the solution of the gold contained in sed ore by means of bromine, chlorine, cyanogen, or npounds ; secondly, the charging a mercury cathode, rms the bottom of a treatment tank, electrolytically, assium or other alkaline metal, free potassium being by the mercury ; thirdly, the introduction to the tank olution, and its treatment therein ; and, fourthly, the of the solvent by regeneration.†

The entire absence in the specification of the position of the other electrode, and the description of his apparatus being confined to merely the words "many forms of construction," seem to exclude claims to originality in that respect, there being no attempt to describe something that the ordinary engineering mind can construct or put to work. In January, 1893, E. D. Kendall applied for, and in August, 1894, was granted, a patent in the United States for a method which claims to be "a method" of treating pulverised gold and silver ores with sodium dioxide and a "suitable cyanide" in a water solution. The quantities of chemicals to the ton of ore are 2lb. of sodium dioxide Na_2O_2) and 7lb. of potassium cyanide (KCN), but these may vary. The treatment may be by lixivia- tion, "with or without" agitation. And the precious metals may be separated from the lixivium by "electrolysis or other suitable means." No apparatus or special means are described. Also, in December, 1893, Carl Pielsticker obtained a patent in New Zealand for the extraction of gold and silver from ores, both in th form of sulphide and in ores in which the precious metals exist in a state of "extremely fine division." The use of this process was chiefly the cause of the well-known litigation between the Cassel Gold Extracting Company, the owners of the MacArthur-Forrest process, and the Cyanide Gold Recovery Syndicate, by which an attempt to monopolise the use of potassium cyanide in all processes of gold extraction throughout the world broke down. It is for this reason, and as helping to explain the difference between "agitation" and "circulation" in a cyanide solution, that my notes include its description. Its essential features may be briefly described as "a process of separating gold and silver from their ores," which consists in treating the powdered ores with a solution of cyanide of potassium, in conjunction with an electric current of low tension used for the purpose of the deposition of the precious metals. In order that the process may go on continuously, he produces a circulation of the liquid through the space between electrodes, which are fixed respectively, the anode at the bottom, and the cathode at the top of a tank.*

(To be continued.)

are two forms of this apparatus (see Figs. 3 and 4). In

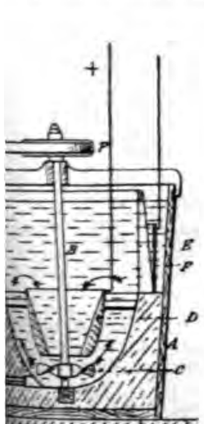


Fig. 3.

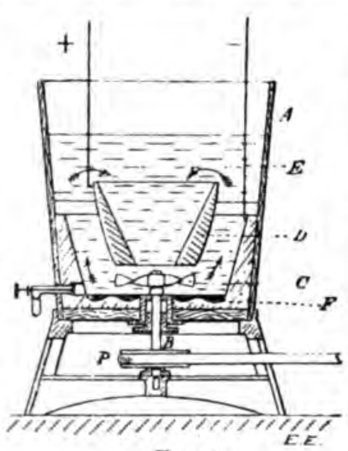


Fig. 4.

here is a cylindrical vessel, A, with a revolving vertical B, turned by a pulley, P. The shaft carries what is called peller," which serves only for the purpose of stirring the s of the vessel. In each section a hollow cup-shaped arbon is shown, which constitutes the anode, and is ith the positive conductor from a dynamo. In the 3, the cathode—which is formed of carbon plates, F, ular frame, F—is fixed above the propeller. In No. 4 is a body of mercury which lies in the "basin-shaped" e vessel.

irst stage, although it is not so described, Molloy must pulverised ore to a process of leaching to obtain his y AuCn. The following equation expresses it :

$$\text{HO}+\text{O}+4\text{KCN}=2\text{Au}2[\text{KAu}(\text{CN})_2]+2\text{KOH}.$$

In the second stage his alkali metal is an alkali salt—*i.e.*, potassium carbonate (K_2CO_3) or a sodium carbonate, etc. No reference is made to the anode used in electrolytically charging the cathode, but the object to be attained is apparently that the mercury in the cathode should take up free potassium, forming an amalgam of these. This addition may be made mechanically as an alternative. In the third stage, which is that in which the extraction of the precious metals takes place, the solution comes in contact with the previously prepared mercury. It is said that it "rests or passes over" it, so it is not an "agitation," though it may be called a "circulation" process. Although it is not easy to gather from the inventor's description that he uses electricity in this stage, it is evidently implied, because the reactions in the following equations could not otherwise be effected :

$$2[\text{KAu}(\text{CN})_2]+\text{H}_2=2\text{KCN}+2\text{HCN}+2\text{Au} ;$$
$$2\text{CNH}+2\text{KOH}=2\text{KCN}+2\text{H}_2\text{O}.$$

In the first equation we have the action of the nascent hydrogen on the double cyanide of gold and potassium cyanide, producing metallic gold and hydrocyanic acid. The gold is precipitated and absorbed by the mercury, from which it is afterwards released in the usual way. In the second equation we find that the hydrocyanic acid unites with caustic potash formed from the alkaline metal in the mercury, and re-forms potassium cyanide, which is one of the important features of the invention. The recovery of the cyanide will constitute the fourth stage.

* A is an ore tank ; P is the anode, made of protected iron or carbon ; N, the anode also, a perforated plate. The circulation of the liquid is through two other tanks, B and C, besides the ore tank, by means of pipes connecting the whole, and the movement

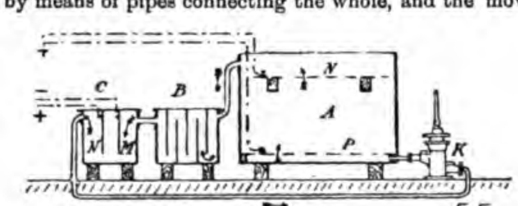


Fig. 5.

of the liquid through the system is by power working a pump, K. The second tank, B, is used to arrest suspended matter in solution ; and the third, C, is a precipitating tank, in which electrodes are placed vertically, the anode, M, being of carbon, so as to resist the dissolving action of potassium cyanide. The precipitation is on to the cathode, N, in the third vessel of the set. The same solution is circulated round and round, until all it can dissolve in the ore tank has been extracted, and all that the electricity can separate from it in the third vessel has been precipitated. The electricity is taken from the generator through two circuits, and in each a separate duty is performed. In the first tank the sludge, as it may be called, is subject to an electric current, which, we are told, may be of higher potential than that in the third tank, where it is preferably limited to 1 volt and 10 amperes per square metre of surface of cathode.

THE

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TO CORRESPONDENTS.

 Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

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A CURIOSITY IN TENDERING.

Our philosophy is very defective accordi
Shakspere, but we had an idea that there
not be much new in the direction of tenderi
work. However, the authorities at Sophia
taught us otherwise, and have made authori
what has hitherto been deemed rather sha
character. According to our advices, this Bul
city, desirous of being lighted electrically, is
for tenders from firms wishing to carry ou
work. The peculiarity lies in this fact, th
tenders are to be opened on one day, and
the amounts will become public property, b
decision upon the tenders is not to be mad
another five days, and during the intervening
the contractors are to have the chance of al
the figures of their original tenders. The decis
to be made upon the revised tenders. It is w
record what at any rate seems to be a new dep
in tendering for electrical work. We have prev
heard of one or two cases where the tenders
opened on one day and the discussion deferre
future meeting of the Board. In the mea
a new tender was sent in and ultimately acc
The one or two cases of this kind which
leaked out were generally accepted as being
exceptions to the ordinary rule, inasmuch a
accepted tender was undoubtedly made
the other figures were known, and could b
be called a *bonâ fide* tender. It is no
uncommon case, however, in minor tend
nay, in fairly important ones in other
electrical directions—to hear of contractors
ing to supply goods or do work at a c
percentage lower than the lowest tender se
There are cases where it may pay to do th
that the contractor has to pay nothing for cl
work, or for quantity surveying, or for any
incidental expenses of this kind. We do not
mend the practice—indeed, we think it savours
"sharp." The case of Sophia is different. All
the opportunity of revision after seeing the comp
amounts. But—oh, these buts and ifs—unless an
is upon the spot or within an easy post, there w
some difficulties in the way of satisfactory rev
Then another curious feature is—at least,
read the conditions—that the new adjudicatio
not take place unless someone proposes a redu
of at least 5 per cent. per kilowatt-hour. If te
are to be opened and then revised, will i
lead to the original tender in every case
increased by the percentage it is intended
the revision to take off? The authority
in one or two instances catch firms eager
work tendering upon the old plan, and when
to revise willing for "once in a way," as they
to decrease their amount in order to get the
but, to put it vulgarly, this racket will not
good for long. The original tenders will be
to be revised. We shall be surprised to
of any well-known English firm competin
this work, yet we think abstention will be w
and that though upon the face of it the directi
which it is proposed to place the work is se
there are in cases of tendering, as in other ways

between the cup and the lip. Indeed, we should not be surprised to hear that some firm which first puts on and then takes off 5 to 10 per cent. has had its tender accepted. The next development in public tendering, if on the above lines, will be an auction sale, and the provision of free entertainments and luncheons by the corporate bodies previous to the sale would, without doubt, be popular with the councillors of some towns.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

ON THE MANAGEMENT OF STEAM-BOILERS.

SIR,—Your correspondent, Mr. Walter Geo. Atkins, C.E., seems to be seeking gratuitous advertisement, and to make it readable he intersperses a certain amount of personal abuse which is wholly out of place. "Orthodox errors" may be a very grand phrase in the opinion of Mr. Walter Geo. Atkins, C E., but the meaning of the word "orthodox" is entirely opposed to that of "error," and possibly if Mr. Walter Geo. Atkins, C.E., will look in a good dictionary he may be able to understand this. Again, lime-water and "milk of lime" are not "two *totally* different things," but only different in degree; and as I carefully explained how I made the "lime-water" I referred to, I cannot see how I can be accused of making any confusion on this subject. "Lime-water" cannot be relied upon, as Mr. Walter Geo. Atkins, C.E., says, because, firstly, it is not easy to get the water to take up any definite quantity of lime at all times; and, secondly, the lime in the solution quickly absorbs CO_2 from the air, and forms carbonate of lime, which, being insoluble, falls to the bottom. Further, I have not in my article of Dec. 10 last said one word about either of the processes I mentioned being *perfect*, and I still believe that perfection is not attainable as regards water softening under the conditions referred to in my article. I still maintain that my way of using quicklime is correct, because it gives good results, notwithstanding any pet theory of Mr. Walter Geo. Atkins, C.E. I have boilers under my supervision, and run them quite successfully three months at a time with hard and variable water containing carbonate of lime, carbonate of magnesia, and sulphate of lime, and I know from practical experience of many years that what I have said in my article of Dec. 10 is correct, and therefore cannot be corrected by any "orthodox errors" of Mr. Walter Geo. Atkins, C.E. I carefully avoided using the words "milk of lime" because I wished to be as clear as possible, and thinking that my article might fall into the hands of some who have not as much learning as Mr. Walter Geo. Atkins, C.E., pretends to have, I thought it advisable to avoid the use of the word and the greasy article commonly called milk. My words with regard to not admitting any grease into the boiler may perhaps make this clear.

The meaning of the second quotation Mr. Walter Geo. Atkins, C.E., gives by mutilating my sentence would have been perfectly clear if he had given it all fairly, but no, he prefers to surmise and add to it to suit his own taste in order to do his best to make a paralogy, or perhaps I should say an "orthodox error," and then I am supposed to be quoted again as considering his bosh "very satisfactory." This mode of quoting a few words regardless of the context is absolutely contemptible. I suppose Mr. Walter Geo. Atkins, C.E., has never heard of the usual phenolphthalein test in general use with this process, and by which the stoker can and does successfully regulate the amount of lime which should be added to the water to be softened. The work of the analyst is to guide the stoker in the first instance. In my article I have assumed a difficult water, and have given full details of the treatment for keeping the boilers free from incrustation. I might have said a few words about the phenolphthalein test, perhaps, but I find that I unfortunately omitted it. My remarks with regard to sulphate of lime are quite correct, and I have proved them in actual practice on a large scale. Sulphate of lime does deposit on the inside of the boiler and forms a very hard incrustation. I have observed it mixed with carbonate of lime and carbonate of magnesia in *actual practice*, therefore it is not a wrong conclusion. Mr. Walter Geo. Atkins, C.E., does not give any particulars of the process he advocates, but one thing he says must be wrong—viz, that adding lime-water to a water containing sulphate of lime will prevent a deposit of sulphate of lime in a boiler which is never blown off. If no deposit was found in such a boiler so supplied, it must have been because the boiler had done very little work. Mr. Walter Geo. Atkins's last sentence contradicts itself, and, like its predecessor, is fairly unintelligible.

If I had to write my article over again I should not alter it in the least detail, except perhaps to add a few words about the phenolphthalein test, and, further, I find that it was good enough for one or two other technical journals to copy it *in extenso*.

Here is a copy of three analyses given by Dr. Ure in his "Dictionary of Arts, etc." a well-known standard work. These prove the truth of my statement about the deposit of sulphate of lime ($CaSO_4$):

	$CaSO_4$.	$MgCO_3$.	MgO.	H_2O.
Deposit from the surface of boiler (partly crystallised)	85·2	2·25	5·95	6·5
Deposit from tubular boiler (amorphous).................	84·94	2·34	7·66	4·65
Amorphous deposit	80·90	3·19	10·35	4·56

Yours, etc. F. G. ANSELL.

REVIEWS.

Sell's Directory of Registered Telegraphic Addresses. National List of Large Commercial Houses and Buyers' Guide. Henry Sell, 167, Fleet street, London, E.C.

The title of this very useful production is self-explanatory. The book is wonderfully "up-to-date." All information received from the Post Office up to Jan. 1 is included. Many of the changes of address consequent on the great City fire are actually incorporated in the alphabetical list, the remainder appearing in the "too late" list, corrected to Jan. 1. Important changes in cable tariffs, only decided upon by the companies concerned on Jan. 13, 1898, are also included. In connection with the telephone trunk line service worked by the Post Office, a tariff of charges for conversations of three minutes' duration between upwards of a hundred of the leading towns and cities is given. A special feature of the work is the issue of quarterly supplements, which are sent without further charge to subscribers, and contain all new registrations, cancellations, and other alterations effected at the Post Office each quarter, bringing the information always up-to-date.

FEEDING CENTRES FOR LOW-TENSION NETWORKS.

BY J. HETHERINGTON.

In the question and answer columns of this journal for Jan. 21 several arrangements of iron boxes were described and illustrated for feeding triple concentric networks from a central point away from the generating station switchboard. In a large number of low-tension schemes the members of the distributing system radiate from important centres in the town, current being brought to them from the generating station by heavy concentric feeders accompanied by pilot wires for indicating at the station the pressure at the feeding point. Sometimes as many as six triple-concentric distributors or six three-wire sets of single cables are fed at one point where all the ends are taken into one iron box to receive their supply through connecting links from the feeder cable. The box is set up in a brick pit with an ordinary street surface cover to give access for connecting, etc., a situation peculiarly trying to insulation, owing to condensation of moisture on the metal surfaces,

It is very desirable that the junction-box should be compact, and, as it must contain 20 or more connecting links, through which a thousand amperes may be flowing, it is evident that here is a detail presenting very interesting problems for the designer.

To meet the practical requirements satisfactorily, the following conditions must be complied with: The construction should be such that all the cables enter at one level, and it should allow all the connections to the cables and all the sweating and fixing of the connections to 'bus bars and cables to be done before the iron box is put on—in fact, all the gear should first be fixed, and the iron box put on afterwards to enclose it. When the iron box is on, all the cables should be rigidly gripped, so that any bending that may happen outside will not be transmitted to the fittings inside. The ends of the armour should be secured by the ironwork, while an effective seal is provided to prevent moisture creeping in between the steel ribband. The parts must when bolted together be made absolutely damp-proof (an end best attained by filling the entire space with solid compound and heavy insulating oil), and the bolts where required to be frequently unscrewed should be of iron, with brass nuts, which leave no threaded part protruding. The general design should be light, but strong, and on lines which are suitable to the ironfounder's art.

The fittings should as far as possible be interchangeable, and the links especially all of one length and shape. They should be easy of access, and so disposed that they are unmistakably identified with the conductors they feed. Brass is the material generally used, and the various parts should have heavy cross-sectional areas, say double that of the copper they are intended to supply, while the contact surfaces should be of ample size and carefully tooled square and true. The nuts for bringing the contacts together should be of substantial make, with faces squared accurately from the thread. When screwing the contacts together there should be no possibility of bolts running round with their nuts, and no risk of breaking them with a reasonably long spanner. Short-circuiting should be provided against by giving as much room as possible between parts of opposite polarity, and at the same time the best should be made of the space to keep the box fittings compact.

To combine all the above features in one design is by no means an easy task, and none of those published in the reply column succeed. While their design exhibits considerable ingenuity, the proportions of the component parts are attentuated to such a degree as to suggest a watchmaker's rather than an engineer's job. In one case a scale can be applied to test the construction, and we find links of $\frac{1}{4}$in. by $\frac{1}{4}$in. cross-section connected to 'bus bars of similar size by screws which cannot be more than $\frac{1}{8}$in. in diameter. And as far as can be seen, all the others are on a similar scale. For merely mechanical reasons it is evident that these dimensions are miserably inadequate, no matter how small the cables. The connections to the outer wires of the cables are far from satisfactory. The first box shows the wires clamped between two flat plates less than $\frac{1}{4}$in. thick. This plan is radically bad however stout the plates, for the clamps cannot be made to bite on all the wires with any reasonable number of screws, and the clamp is never rigidly related to the cable. With plates only $\frac{1}{4}$in. thick, probably 50 per cent. of the wires would be ineffectively held. An even worse method of clamping the outer wires is shown in another case, where a flat band is put round the bared wires. It is apparently some $\frac{1}{4}$in. wide, and has only one side of the wires to make contact with; but even this will be bad contact, for the wires can escape from the pressure of the clamp into the soft fibre insulation on which they lie. A better form is shown in the third box, where the wires are soldered to a substantial cone. This may be improved by turning the cone the opposite way and bending the wires back over it and then soldering. We may note, in passing, the large well-soldered connection this contributor proposes to make to the wires themselves, while he proposes to feed them through a link contact of annular shape $\frac{1}{8}$in. wide by some $\frac{3}{8}$in. diameter, and pressed together by a screw of about $\frac{1}{4}$in. diameter. In practice these connections would be red hot in no time.

The third design shows a very satisfactory disposal of the links in line over the cables they supply. Not only are they at once recognised when the box is opened, but any one can be removed without disturbing the supply to other conductors. At the same time, the radial line plan permits of the maximum number of cables in a given space. It is a bad plan to make the link part of the 'bus bar as in the second box, where it would be necessary to remove five links to entirely free one cable, and this would interrupt the feed to another. All the designs show much too little surface between the fittings. About $\frac{1}{4}$in. seems the average, and even under insulating compound this is too small for safety. It also calls for extreme accuracy in cutting the insulation; and a cable jointer working in a dirty and inconvenient hole in the street cannot work so fine as $\frac{1}{4}$in. of surface on the cable implies. An inch is a much more reasonable allowance.

Some engineers have sought to gain additional safety by screwing a brass sleeve into the iron box and connecting this to the lead of the cable by a wiped joint. The plan has not much to recommend it in any case, for moisture is at least as likely to get through the joints between the sections of the iron box as to creep along the lead through 4in. or 5in. of compound. It introduces a complication in the labour department because a skilled plumber is required to make a satisfactory job, and it makes no provision for enclosing the cut ends of the armour. Speaking from a very large experience, we have no hesitation in saying that a properly-designed iron box sealed with compound which is both waterproof and insulating will give no trouble. Careful supervision is essential to insure that no air spaces are left—a detail that jointers are apt to neglect.

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week:

FRIDAY, JAN. 28.

Institution of Civil Engineers, Great George-street.—At 8 p.m., students' meeting, "Condensing Apparatus," by H. Williams, Stud Inst.C.E.

Electro-Harmonic Society.—At 8 p.m., in the St. James's Hall Restaurant, smoking concert.

SATURDAY, JAN. 29.

Institution of Junior Engineers.—At the Westminster Palace Hotel, at 6.30 for 7 p m., annual dinner.

TUESDAY, FEB. 1.

Institution of Civil Engineers, Great George-street, Westminster. At 8 p.m., further discussion on the paper entitled "Reservoirs with High Earthen Dams in Western India," by W. L. Strange, A.M.I.C.E.

Royal Institution, Albemarle-street.—At 3 p.m., Prof. E. Ray Lankester, M.A., LL.D., F.R.S., on "The Simplest Living Things."

Royal Colonial Institute, Whitehall Rooms.—Afternoon lecture by Mr. Everard R. Calthorp on "Light Railways for the Colonies."

WEDNESDAY, FEB. 2.

Institution of Electrical Engineers.—Students' meeting at 8 p.m., "Comparison of Gas and Electricity as Used in Tramway Work on the Continent," by O. M. C. Keyl, student.

Society of Arts.—At 8 p.m., "The Cinematograph," by Jules Fuerst.

THURSDAY, FEB. 3.

Royal Institution, Albemarle-street.—At 3 p.m., Prof. Dewar, M.A., F.R.S., on "The Halogen Group of Elements."

Institution of Civil Engineers.—Students' visit at 2.30 p.m. to the London and South-Western Railway Locomotive Works, Nine Elms; students to meet at the Locomotive and Stores Department Gate, Wandsworth-road.

FRIDAY, FEB. 4.

Royal Institution, Albemarle-street.—At 9 p.m., "Some New Studies in Cathode and Röntgen Radiations," by Alan A. Campbell Swinton.

North-East Coast Institution, Westgate Assembly Rooms, Newcastle-on-Tyne.—At 7 p.m., annual dinner.

SATURDAY, FEB. 5.

Institution of Electrical Engineers.—Students' visit to the works of Messrs. Siemens Bros. and Co., Woolwich; train from Fenchurch-street, 10.5 a.m.

General Electric Company's annual dinner at the Trocadero Restaurant.

THE INSTITUTION OF JUNIOR ENGINEERS.

very numerously attended meeting of this institution was at the Westminster Palace Hotel on Friday, 21st inst., hairman, Mr. H. B. Vorley, presiding, when a lecture on oratory Testing Machines, and the Latest Example," was red by Prof. A. C. Elliott, M.I.C.E., Hon.M.I.J.E., of niversity College, Cardiff.

LECTURER, in his introductory remarks, made reference to erations affecting the question of design. Design, he n attribute of the highest intelligence, was in a special no small part of the science and practice of engineering; gh achievement in engineering design demands, among things, knowledge of mathematical and mechanical s. But abstract analysis was by itself entirely useless to gineer; to be serviceable it must be based on experi- data, and developed with, and by, experimental investiga- The testing machine was an engine for the production rtain class of data; a tool from the results of which the er might secure the realisation of his design in exact nity with a skilfully-drawn specification. To him the nterest of the machine, perhaps, arose from the circum- of its being an instrument of research. The engineering ation was a grand and wholesome thing when kept well date. The technical term "testing" was, no doubt, from the "testing clauses," though originally it meant now called "proving," a view more than sustained by that the phase "tested to destruction" still survives.

the educational and research points of view, it was le to cover experimentally the entire field of strength of ls. Financial considerations dictated that if this was accomplished immediately, a compound or universal e was requisite. The 100-ton machine at University , Cardiff, answered to this description; it had the extra- y length capacity in tension, compression, and bending , could twist to fracture a steel shaft 2½in. diameter, ear a mild-steel bar 3½in. by 1½in. section. The rity of the machine was, so to speak, its mobility and ience. All the different forms of tests could be made in ler, with a maximum interval of four minutes. The e was of the horizontal type; the specimens always ed at the exact height above the floor most suitable for tion of general behaviour, callipering, and noting of on. Messrs. Buckton, of Leeds, were the makers; they oduced most of the testing machines in this country. those, however, were vertical with the exception of the machine built to the order of Prof. Kennedy, which justly be regarded the prototype of the Cardiff machine, a which latter had revealed a possible error of the order 0th per cent. Sensibility was a quality that should be uished from accuracy. Probably the Emery machines he most sensitive; the lecturer's experience was, that l up to the full load they were too delicate to stand the work of ordinary testing.

he matter of extensometers, Prof. Elliott spoke well of echanical multiplying system, which could be trusted to 00in. He evinced a strong preference for recorders tely automatic—wholly independent of the poise weight e dexterity of the operator.

a typical example of the Buckton vertical machine, that dford Technical College was selected and described. The tory machines at Edinburgh, Manchester, Liverpool, n Central Technical College, Sydney, Madras, etc., were ated by a comprehensive set of lantern slides, and finally American and Continental machines were dealt with.

e lecture concluded with a reference to the good results had followed the extension of facilities for appeal to iment both in respect to the training of young engineers he interests of the profession generally.

vote of thanks to the lecturer, proposed by Prof. D. A. seconded by Mr. B. H. JOY, supported by Mr. J. HARTLEY STEED, brought the proceedings to a close.

GUTTAPERCHA.*

Y DR. EUGENE F. A. OBACH, F.I.C., F.C.S., M.I.E.E.

(Continued from page 22.)

ave hitherto spoken of the guttapercha tree as if there was one kind supplying this valuable commodity, and I have so purposely so as not to confuse matters, but it is now sary to be a little more precise, and to tell you that gh the guttapercha supplied during the first few years may ly have been derived from the one kind of tree only, which ribed, yet the commercial sorts of the present day are s to be the products of quite a number of different trees y unequal value.

uld not possibly attempt to describe all these to you , even if they were perfectly well known, which, however, is far from being the case; but I must mention at least two more which are of particular interest, the first being the Dichopsis oblongifolia or Palaquium oblongifolium Burck, the Taban sutra of Perak, and the second, the Payena Leerii Benth. et Hook. (Keratophorus Leerii Hasskarl), or Sundek of Perek, Niato balam baringin (or soendi) of Sumatra.

The former is very closely allied to the Taban merah (Palaq. gutta, Fig. 4), which has been described, and, in fact, its discoverer, the Dutch botanist, De Vriese, considered it merely a variety of Hooker's Isonandra gutta; however, it is now understood to be an independent species.

FIG. 5.

It is a tree of smaller size, with leaves of a more decidedly yellowish shade of brown on their under surface. The flowers have a reddish tinge, and the general appearance of the bark is said to be quite different.

The Payena, on the other hand, although likewise belonging to the Sapotaceæ, differs much more from the Isonandra. The small leaves are differently shaped, and have a reddish tint when

FIG. 6.

young; the flowers are white, and the fruit, which is fleshy and provided with a kind of horn, has a sweet taste, and is eaten by the natives. A branch with flowers and fruit of each of these varieties are illustrated on the diagrams (Figs. 5 and 6), and some small coloured pictures, besides dried specimens of them, are exhibited on the table. The gums from the two species of Palaquium are known under the name of Getah taban merah and Getah taban sutra amongst the Malays, and that from the Payena as Getah sundek, or sooni, or soondie, the latter being the correct Anglo-Malayan expression. The Malay word "getah," which has been rendered into "gutta," simply means the viscous exudation of a plant, and "getah taban" the secretion of that particular kind of tree called Taban. As it is from this tree and not from the

* ntor Lectures delivered before the Society of Arts.

pertja that the gum now called "guttapercha" is derived, it is to be regretted that the wrong name was given to it on its first introduction into Europe, but in several of the pioneer patents the correct name, "getah taban," or tuban was used. The English pronunciation of the words "gutta percha" is the nearest to that of the original Malayan expressions "getah pertja," whereas in France and Germany they are less correctly pronounced.

GEOGRAPHICAL DISTRIBUTION.

I now pass on to the geographical distribution of the gutta-percha plants. At the time when Montgomerie obtained his first specimens, guttapercha trees were plentiful in the ancient forests on the island of Singapore, extending pretty close to the town, and the dried specimens sent to Kew by Dr. Oxley came from the jungle of Bukit Timah, only about seven miles from it. Amongst the specimens kindly presented to me by Prof. Sérullas, and which I have shown you, there are several collected by him at this locality in 1887 and 1893—viz., the large fruiting branch and these precious little flowers, as well as some herbarium specimens in this frame. One of these and the little piece of coagulated latex which I hold in my hand have even been collected from a descendant of the very same tree from which the historical branch was taken by Oxley, and which had been pointed out to Sérullas by Don José D'Almeida the younger, who accompanied Oxley to Bukit Timah in 1847.

I hear from a gentleman at Singapore, who recently visited Bukit Timah (Sept. 19, 1897) in order to take photographs of the gutta trees there for this lecture, that he saw nine wild Isonandras (which are doing well, although left pretty much to themselves), and that there may be a few more hidden in the jungle. Mr. Ridley, the director of the botanical gardens at Singapore, was good enough to accompany him, and consequently there can be no doubt about the identity of the trees. Mr. Ridley, however, is of opinion that they have grown from seeds and not from shoots, as M. Sérullas thinks. Some years ago, when the former gentleman was in England, he told me that he knew of the existence of the Isonandra trees at Bukit Timah, and, in fact, had kept them under observation long before Sérullas discovered them, as he thought, in 1887.

Before 1857 all large gutta trees on Singapore had been cut down by the Malays, and at the present time there are only a few more on the island besides those on Bukit Timah, which have since grown up—viz., one in Pasir Panjang, one in the botanical gardens, and a few in a plantation in the north. The tree in the botanical garden was originally described as Isonandra taban merah, but it is now labelled Dichopsis oblongifolia, Borneo, Malaysia. It stands in the middle of a lawn in front of the director's house.

As soon as the valuable properties of guttapercha had been recognised in Europe and a demand had been created for the article, the countries all around Singapore were searched with great avidity for Taban trees, and almost a craze for getah collecting sprang up amongst the indigenous population. The consequence was that an immense number of trees of great size and age, probably hundreds of thousands, were ruthlessly destroyed during the first four or five years, and whole forests denuded of them, like those on Singapore. The exploration was conducted with such assiduity that before the year 1848 came to a close the much coveted Taban tree had already been discovered in Pahang, Johor, Malacca, Selangor, Perak, and Penang on the Malay Peninsula, besides the islands of Rhio, Gallang, and Singga in the Johor Archipelago. It had also been met with in Siak, Kampar, Indragiri, Tongkal, Jambi, and Palembang, on Sumatra, and in Coti, Passir, Pontianak, Sarawak, and Brunei on Borneo. Since that time the tre[e has] been found in the northern and north-eastern parts of Bo[rneo,] on the west coast of Sumatra, and in some other distric[ts on] the east and west coasts of the Malay Peninsula.

The region from which all genuine guttapercha is deriv[ed at] the present day is indicated by a rectangular outline o[n the] map which has been specially prepared for these lectures (F[ig. 7).] You will observe that this boundary extends 6deg. on [each] side of the equator, and from 99deg. to 119deg. eastern [longi]tude; it therefore embraces 12deg. of latitude and 20d[eg. of] longitude, corresponding to an area of 1,140,000 square [miles,] but of this only about 40 per cent. is occupied by land, a[nd] that again only a very small portion is locally suitable f[or the] growth of the guttapercha tree.

Nowhere else on the globe, outside this area of the [Malay] Archipelago, have any genuine guttapercha trees been f[ound,] and this is the more remarkable as the Sapotaceæ, to whic[h they] belong, are distributed all over the tropics, and are also of [great] antiquity, having even representatives amongst the fossil p[lants.] It might, perhaps, be asked whether gutta trees have no[t been] found in the islands adjacent to those confined by the bou[ndary] line on the map; for instance, in the large group to the [east] of Borneo, the Philippines, or the islands Celebes and Ja[va, to] mention only the more important ones. The answer is [that] hitherto no genuine guttapercha trees have been disco[vered] there. Getah trees, in the Malayan sense of the word, exi[st no] doubt, but none of the right description.

This may possibly strike you as very remarkable unless [a] satisfactory explanation can be brought forward, and [I will] endeavour to give you one. If you will glance on th[e map] you will observe that the ocean is shown in two different [tints] according to the depth of the water. The lighter tint, be[tween]

FIG. 7.—Map of the East Indies.

the Asiatic continent and the islands of Sumatra, Java, B[orneo,] and part of the Philippines, indicates a shallow sea, most[ly less] than 50 fathoms in depth; whereas the darker one, outsid[e this] region and surrounding Celebes and the Lesser Sunda Is[lands,] signifies that there the water is very deep—in fact, mostl[y over] 1,000 fathoms. From this it follows that a huge subm[arine] bank exists, which connects the aforesaid islands wit[h the] Asiatic continent, whereas the Lesser Sunda Islands and C[elebes] are completely separated therefrom by a great depth of [water.] Now this, besides other evidence deduced from the geo[logical] and zoological study of these islands, shows that Sumatra, [Java,] Borneo, and the Philippines have been separated fro[m the] Asiatic continent in comparative recent times only, w[hilst] Celebes and the others are what Wallace calls "a[ncient] continental islands."

The dash-dot lines indicate the probable configurati[on of] the two ancient continents, of which each group of i[slands] originally formed a component, and you observe how clos[e they] were to each other at the points where now the two small i[slands] of Bali and Lombok are situated. The consequence is th[at the] animal and vegetable life of these two islands, although [they are] only about 15 miles apart, differs much more than, for ins[tance,] that of Japan and Britain, which are separated fro[m one] another by an entire continent.

The undulating dotted line represents, according to W[allace,] the line of separation between the Indo-Malayan an[d the] Austro-Malayan region. This line passing between Borne[o and] Celebes refers the latter and the Lesser Sunda Islan[ds to] an entirely different biological region, sharing none [of the] peculiarities of the Indo-Malayan fauna and flora.

Having thus satisfied ourselves that Celebes and the [Lesser] Sunda Islands did not, like the others, in comparatively

belong to the Asiatic continent, it remains to be explained .va and the Philippines should be devoid of guttapercha lthough admittedly then forming part of it, like Borneo and a. The explanation is this: After the typical Malayan ind flora had been in existence on the Asiatic continent ne time, and probably during the late miocene period bout the time when the so-called "Red Crag" was ed in Suffolk), first the Philippine Islands and then Java etached from it, while Borneo, Sumatra, and the Malay ula remained still connected.

(To be continued.)

QUESTIONS AND ANSWERS.

er this heading we insert questions and answers ractical character relating to central-station work, y work, or construction work; and for each suit- uestion offer *one shilling*, and for the best solu- any question we offer *ten shillings*. We also o *shillings and sixpence* for every other answer we The answers to any question should be sent 10 days after the question has appeared, and be written on one side of the paper only. Questions sent at any time.

QUESTIONS.

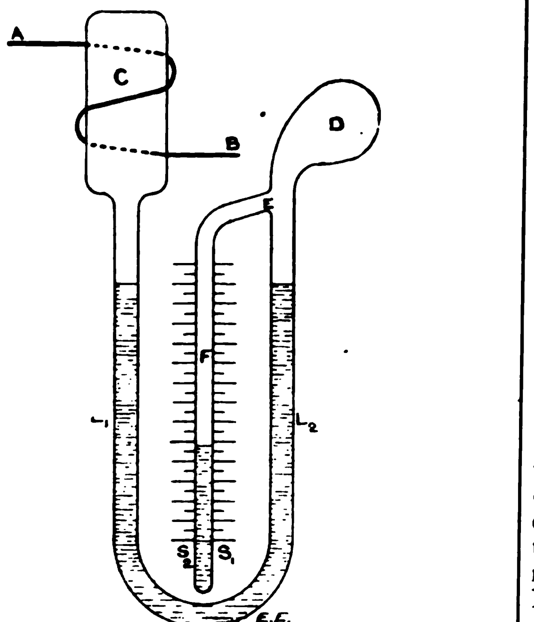
scribe, with sketches, what you consider to be the best e of switch to be used for opening the field circuits of ge separately excited dynamos or alternators.—A. D. J.

cuss the financial and other advantages derived from the e of accumulators in moderate-sized central stations.— H. R. THORN.

ANSWERS.

o 27.—Describe the Wright maximum demand indicator d the purpose for which it is used.

Answer to No. 27 (*awarded* 10s.).—Wright's demand tor is an ingenious contrivance for indicating the num current which a consumer has taken from pply mains. There are two scales, S_1 and S_2, in strument. On one is shown the greatest number peres that a consumer has passed through his at any one time. On the other scale is shown the er of units which must be consumed during a given l before a reduction can be made in the price per The way in which the indication is made is as s: A U-tube, L_1 L_2, has a bulb on each of its ends,



d D, and a tube, F, branching from just below the D. There is sufficient liquid of a certain kind (sul- c acid) in the tube so that, when the reading is zero, uid stands to the height of the point E, ready to w into the indicating branch, F. The overflowing ed by the current passing through and thus heating e turn of German-silver tape, A B, wound round the C. The air within the bulb is expanded by the heat, es the liquid down the tube L_1 and up L_2, causing o flow into F. The greater the current the more liquid there will be in F. When the bulb C is cool, the liquid stands at the same level in L_1 and L_2. The tube and scales are mounted upon a board, which is hinged at the top in order that the tube may be turned upside down to allow the liquid to run out of the branch, F, to bring it back again to zero. The apparatus is reset in this manner each time the meter readings are taken. The instrument is enclosed in an iron case, with a glass front opposite the scales. This enables a consumer to see what his maximum demand has been, and what units he must use in order to secure a discount. The cables are brought into the indicator at the top of the case and fastened in suitable terminals. The apparatus is connected in series with the meter.—T. A. LOCKE.

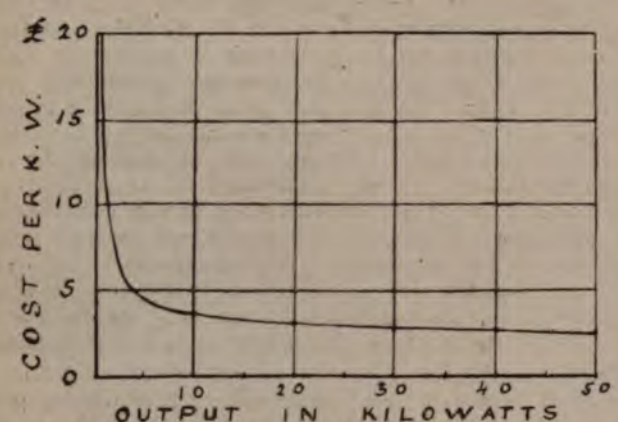
Answer to No. 27 (*awarded* 2s 6d.).—The Wright maximum demand indicator consists essentially of a glass U-tube, partially filled with black sulphuric acid, and with both ends terminating in bulbs or enlargements, and the whole hermetically sealed. From the top of the right-hand tube, just below where it begins to widen out, another tube emanates and runs parallel to the other two; it is of the same length as them, and has its bottom end sealed. Around the left-hand bulb, which is cylindrical, is a turn of strip platinoid, which is in series with the consumer's meter. On a certain current—say 10 amperes—flowing in the circuit, the platinoid strip gets heated to a certain extent, causing the air in the left-hand bulb to expand and force the liquid down the right-hand tube and up the left, a certain amount overflowing down the third or index tube. Should the current flowing get smaller, the column in the right-hand leg of the U-tube of course falls, but the amount in the index tube remains the same, and until a greater amount than 10 amperes has passed round the strip, no more liquid will overflow into this tube. A scale is placed behind the index tube, the left-hand side of it giving the units consumed before the reduced rate is reached; and the right, the maximum current that has passed at any time. The tube and scale are mounted on a mahogany board, which is hinged at the top so as to be able to tilt them up and reset the instrument, the liquid that is in the index tube flowing into the right-hand bulb, and from thence back into the U-tube, when it is in its normal position again. A flexible connection serves to join the platinoid strip to the terminals of the instrument. The whole is encased in a cast-iron box with a glass front, so that the consumer can verify his reading. The purpose for which the indicator is intended is to induce con- sumers to make their maximum demand small, but to use it for as many hours as possible, thus improving the load factor of the supply station. It also gives substantial rebates to the small consumer as well as the large, his average price per unit very probably being the lowest of the two. A comparatively high rate per unit—say 6d.—is charged for the number of units used at the maximum demand rate (this is reckoned from the reading of the indicator and an arbitrary space of time per day, say, one hour). All units consumed above this, as read by the ordinary meter, are charged for at a reduced rate—say 3d. As an example of this suppose the indicator read 20 amperes, then the units consumed in a quarter at this rate would be: 20 amperes × 100 volts (pressure of supply) × $91\frac{1}{4}$ hours = 182·5 units. If the ordinary meter read 400 units, then: 182·5 units would be at 6d., and 400 − 182·5 = 217·5 at 3d. Thus, the smaller the maximum demand the smaller the electricity bill: and the greater the quantity consumed after the reduced price has been reached the smaller the average price per unit.—HERBERT BELL.

Question 28.—What are the advantages and disadvantages of the two systems of distribution by alternate currents: (A) transformers in consumers' houses; (B) transformers in sub-stations? Give figures.

[The first two answers are bracketed equal.—ED. *E. E.*]

Answer to No. 28 (*awarded* 6s. 6d.).—Generally speaking, the use of transformers in consumers' houses is confined to districts where customers are far apart, and the great advantage of this arrangement is that the cost of mains is kept down to a low figure, while the regulation is good. The loss of energy in a main of a given size is proportional

to the current squared, and by reducing the current—by increasing the pressure—we may transmit energy over long distances without a serious loss of energy in very small mains. The loss of energy causes a further loss in light, as the effect of a 1 per cent. drop in pressure is to reduce the light given by an incandescent lamp about 7 per cent., so where the consumers are scattered it is very advisable and necessary, if the works are to pay, to take the high-tension mains into the consumer's premises. No rent need be paid for the space taken up by the transformers, and, in fact, some companies have actually the impudence to charge the consumer a rent for the transformers, or, in other words, make him pay for the privilege of saving their capital. When, however, these are said, the advantages are ended.



Curve showing the Prices per kw. of Transformers of Different Outputs.

The disadvantages are: 1. The transformers connected to the mains must be equal in capacity to the maximum demand of each consumer, and consequently a large number of small transformers must be used. Small transformers are very expensive for their capacity, as the enclosed curve, showing cost per kilowatt in various sizes, will prove; and, further, they are much less efficient than large ones, more especially when the iron losses are considered. For instance, some lately-published figures show that the efficiencies of various sized transformers, allowing a two hours' maximum load as the average output, are as follows in a very good type:

Kw.	Efficiency per cent. Full load.	Efficiency per cent. Half load.	Quarter load.	Iron losses (per cent. full load).	Copper at full load.	All-day efficiency (allowing two hours' full load as output).
1	92 7	88·6	80	6·0	2	51·5 per cent.
2·5	94·8	92·2	86 6	3·6	1·8	65·2 per cent.
5·0	95·4	93·4	88 6	3 0	1·7	69·2 per cent
10·0	96·2	94·8	91 3	2·2	1·55	75 0 per cent.

It will be seen from this that the full-load efficiency is not bad even in the 1-kw. type, but the difference between quarter and full load efficiency is 12 7 per cent. for 1 kw. and only 5 per cent. in the 10-kw. type. It is, therefore, evident that the small transformers must be kept fully loaded if they are to be efficient. The all-day loss is very great, owing to the high iron loss (6 per cent.), and under the above assumption—*i.e.*, two hours' full load per day—the all-day efficiency is only 51·5 per cent. It must be remembered that the 1-kw. transformer is the one which will be most used with system (A), as this represents 30 8-c.p. lamps on at one time—a very fair-sized house.

2. The kilowatt capacity of all the transformers must be high, as there is no possibility of any overlapping of load curves being taken into account—*i.e.*, the capacity of the transformers must be equal to the total lamps connected—so the iron losses will be very large compared with the average demand of the consumers, and a transformer in one house cannot help that in another one.

3. There are high-tension fuses, etc., on consumers' premises, and these are objectionable because they cannot often be inspected, and may have to be placed in damp cellars: they may be a danger; and, further, switching off the transformers at light load is impossible, as even if a good automatic switch were invented it would n[illegible] cut off the supply even in the daytime.

4. A great quantity of small cable is requir[illegible] usually many joints, and both these are liable t[illegible] breakdowns, small wire and joints being generall[illegible] It is possible to avoid joints by looping from h[illegible] house, as is done by the Metropolitan Company, b[illegible] increases the cost of cables, the length being increas[illegible]

The advantages of transformers in sub-stations are[illegible] 1. They can be large, and the benefits of a large efficiency and small cost per kilowatt are obtained, a[illegible] explained.

2. The kilowatt capacity need not be equal to [illegible] of each consumer's maximum demand, and advant[illegible] be taken of overlapping of load curves. This n[illegible] further saving in capital outlay and an increase in eff[illegible]

3. No high-tension mains, fuses, or transform[illegible] needed in houses; the transformers can be fre[illegible] inspected; it is impossible for any unauthorised p[illegible] touch them; the sub-station or box can be made tight; and the failure of any one transformer d[illegible] mean any serious inconvenience to consumers, as where each has only one transformer.

4. High-tension mains may be run straight [illegible] sub-stations, and thus there is little high-tensio[illegible] about; all joints are (or should be) avoided, and t[illegible] is large and reliable.

5. Transformers may be switched off at times [illegible] load without making any mains dead, and the efficiency will be much increased. There will usuall[illegible] great loss of time if this is done by hand, but of cou[illegible] preferable to use a good automatic switch, as fogs m[illegible] on suddenly or "accidents" happen to the attendan[illegible]

The disadvantages are: 1. That low-tension ma[illegible] needed, and so the saving in capital outlay is pra[illegible] that due to less cost of feeders, although it [illegible] practicable to greatly increase the number of feedin[illegible] with small expense by adopting the box system.

2. An expensive chamber has to be built for th[illegible] formers, or boxes must be sunk in the ground.

3. Any serious damage to a sub-station by fire o[illegible] will perhaps cause a serious failure of light. On[illegible] only would be affected in system (A).

4. The total capital outlay will in almost any higher than with class (A).

In conclusion, each system has its proper place: very scattered consumers; (B) for districts where t[illegible] clusters of consumers, or where there is a long strai[illegible] of consumers, such as is often found in country along a main road, or for a long-distance transmi[illegible] W. FENNELL.

Answer to No. 28 (awarded 6s. 6d.).—The adv[illegible] and disadvantages of the two systems—(A) trans[illegible] in consumers' houses, or (B) in sub-stations—will chiefly upon the character of the district which i[illegible] supplied with electricity—*i.e.*, whether the buildi[illegible] close together or far apart. In residential districts the houses are generally separated by considerable di[illegible] the cost of cables is a very serious item. High cables cost less than low-tension, because there copper in them. But to the cost for mains ha[illegible] added the outlay for the transformers. In t[illegible] of (A) these have to be each large enough to t[illegible] maximum number of lights that will ever be on one time in the house, whereas with sub-stations th[illegible] formers need only be sufficient for the actual m[illegible] demand. When an installation is first put down the outlay on (A) may be less than the capital outlay But after a time, when many houses have to be s[illegible] the outlay on house transformers may become great if sub-stations were used. Then the small apparatu[illegible] be taken out, and connection made to low-tensio[illegible] fed from sub-stations. The maximum load generally a[illegible] about 60 per cent. of the total lamp connection. T[illegible] way in which to point out the advantages or othe[illegible] the two systems is to make comparisons of the each. The estimate may be based upon, say, a de[illegible] 100 kw.

first the case (A) of, say, 63 houses with a trans- in each. Suppose the houses average 25 16-c.p. ch, and that a 16-c.p. lamp takes 60 watts. Then er required per house will be 1,500 watts. The mers required for this power will cost about £780. must be added the price of a high-tension switch y house, and a safe lock-up compartment of some which the transformer may be enclosed. The , which may very conveniently be in the form of fuses," will cost about £50. The cost of enclosing sformers varies very much. Sometimes there is a a cellar, which only needs a door and a top putting ietimes a special compartment has to be built, doors or out of doors. We may safely take the enclosing our 63 transformers at about £190, the total cost of separate transformers and es will be about £1,020.

. rough estimate for a sub-station and equipment w. may be taken as follows: Four 25-kw. trans- nay be used, costing about £300 total. Switch- h and low tension, for the transformers and low- mains will cost about £40. The underground , having 7ft. cube interior, will come to about he total cost of the sub-station complete will be about £430.

omes the question of cables for the two cases (A) First, in (A), let the houses be all scattered within of one quarter mile radius. The main high-tension n be brought to a centre, and smaller ones branched e houses. The mean length of cable required may t 1½ miles. This would cost about £320, including Thus the total cost of house transformers and rould be nearly £1,350. If, however, the buildings se together, as in a town, and 30ft. be allowed as frontage of each house, the mean distance from a centre to the farthest house would be about 150 for which a total length of cable of 600 yards would ired. This, including laying, would cost about £90. tal cost of transformers and cables in this case would efore £1,110.

take the case (B) of sub-stations, where the district ered. Two or even three sub-stations would have ut down on account of the drop in the distributors. be used they would each be of 50 kw. capacity, and cost probably £210 each, the price of the trans- s being the same as before—viz., £150 for two. d of sub-stations, special transformers could be let he ground at convenient points. These would cost the same as the sub-stations. The low-tension cables ng from the two sub-stations, and averaging about rds each in length, would, if laid as triple concentric e three-wire system, be a total length of about les, and come to, say, £1,500. The total cost, there- s about £1,960. For the same number of houses in t, and fed from a sub-station, the low-tension cables only cost about £360, including laying, or a price he sub-station of about £800.

ction boxes and services would come to about the n both cases, and so need not be reckoned in our risons.

purposes of better comparison the relative costs are th in the following table:

A.

—	Trans-formers.	Chambers.	Switch-gear.	Cables.	Total.
tial district	780	190	50	320	£1,350
ted district.	780	190	50	90	1,110

B.

tial district	300	120	40	1,500	£1,960
ted district.	300	90	40	360	790

pital expended is practically of no account except as the interest and sinking fund paid, which of course s as the capital increases. But then the apparatus hich the money is spent should bring in a revenue ill cover the increased interest and sinking fund account. The revenue is governed very much by the losses in the different apparatus. In this special case the losses are in the copper and iron of the transformers and in the cables, and they are greater in small transformers than in large ones. Although the efficiency is high at full load, yet because the transformers are only working at full load for a very short time per day, the average efficiency is only low. Consequently it may be advisable to use fewer and larger transformers. The losses in the cables are only serious at full load, and they may be reduced by putting in larger cables. This must be determined by comparison, and "giving and taking" of the various losses and costs. As the losses in the transformers and cables increase, the interest and sinking fund will decrease. The cost of the small apparatus is greater than that of the large, but the cables for the former cost less than for the latter. If the costs and losses be set out in the form of two curves, they will cross at some point, and thus the system with the greatest economy may be found. From the figures it would appear that house transformers are the cheapest in prime cost for a residential district, and sub-stations for a congested district. With transformers in sub-stations, in the summer time, when the load is not sufficient to require all the apparatus, one or two may be cut out, and thus save the all-day losses, which, however, cannot be reduced in a house transformer. It is very difficult to say which is the most advantageous system, for the advantages of one may be the disadvantages of another. Each case must be judged upon its own merits.—T. A. LOCKE.

Answer to No. 28 (*awarded* 2*s.* 6*d.*).—In comparing the advantages and disadvantages of the two systems of distributing alternate currents—viz., the system of providing a transformer for each consumer and the sub-station system—it is necessary to take into consideration the nature of the area which is to be supplied. In extended areas, where the number of consumers connected per mile of mains is small, the best system to employ would probably be the house transformer system, as it allows the current to be supplied direct to the consumer's house at a high pressure through small and inexpensive cables, thus doing away with the larger and more expensive low-pressure distributors necessary to the sub-station system.

The great disadvantage of the house transformer system is due to the inefficiency of transformers when not working at full load, and also that the transformers being connected directly to the mains, and thus the primary is always in circuit, which produces an "iron loss" whether any load is being taken from the secondary or not. These two reasons combined make a great difference between the full-load efficiency and the all-day efficiency, thus tending to reduce the economy of the system. Take, for example, a 5,000-watt transformer, the full-load efficiency being about 95 per cent., the lost watts being 260, made up of an "iron loss" of, say, 120 watts per hour (a loss that will be constant independent of the load), and a copper loss of 140 watts per hour, which will vary approximately inversely as the square of the current. Now, the 24 hours' load would probably be divided up as follows:

Load.	Hours.	Output.	Input = output + iron loss + copper loss.
0	8	0	960
$\frac{1}{10}$	4	2,000	2,485
$\frac{1}{4}$	3	3,750	4,136
$\frac{1}{3}$	3	5,000	5,406
$\frac{1}{2}$	4	10,000	10,620
Full	2	10,000	10,520
	24	30,750 watts	34,127 watts

Thus the all-day efficiency is about 90 per cent., which is quite a different matter to the 95 per cent. efficiency for full load.

Coming now to the advantages for the sub-station system: (1) The transformers being "banked" in a sub-station, they can be switched in or out of circuit as the increase or decrease of load demands, thus keeping the transformers which are in circuit always fully loaded, and so obtain a higher efficiency; (2) no high-tension mains enter consumers' houses; (3) new consumers can be con-

nected without disturbing the supply of current to others; (4) no consumer is dependent upon one transformer. Against these advantages must be placed the cost of building the sub-stations, and the comparatively large cost of the low-pressure distributors.

Of the alternate-current lighting plants at present existing in the United Kingdom, the majority use the sub-station system, there being but very few using the house transformer system alone. In some cases a combination of the two systems is adopted, the sub-stations being placed in the thickly-populated districts, and high-pressure mains running to outlying districts, from which the consumers are supplied through house transformers in the usual way. Another modification of the two systems is the burying of transformers at intervals underneath the streets, from each of which several consumers are supplied.—F. A.

LEGAL INTELLIGENCE.

MORECAMBE DISTRICT COUNCIL AND ELECTRIC LIGHTING.

An arbitration took place on the 24th inst. at Morecambe Council Office with respect to matters in dispute between the Council and the old Electric Light and Power Company, Limited, on the former taking over the latter company's undertaking.

Mr. Mellor, barrister (instructed by Mr. William Tilly), appeared on behalf of the Council, and Mr. Overend Evans, barrister (instructed by Mr. J. T. Sanderson, Lancaster), represented the company, the respective arbitrators being Mr. Thursfield, city electrical engineer, Chester, and Mr. Gibbings, city electrical engineer, Bradford.

The principal point at issue was that the District Council agreed to give £3,897 for the Electric Light and Power Company's undertaking and portion of plant, main cables, and fittings, and a deed executed in February, 1896, contained a covenant stipulating that until the Local Government Board and the Board of Trade's sanction were obtained, and the undertaking formally taken over, the company were to keep the plant in the same state of repair as at the original valuation. The Council now alleged that the plant had deteriorated in value through being improperly stored, and the main cables not properly looked after, the latter being stated to be now useless for the Council's system, and worth £2,000 less than at the time of the valuation.

In support of this contention, **Mr. Parkinson**, resident engineer, gave evidence as to recent tests, and was corroborated by **Mr. Woodson**, electrical engineer, Lancaster Wagon Works; **Mr. Hedgecock** of the British Insulated Wire Company; and **Mr. Burton**, of Messrs. Callender and Co, London.

The **Chairman** and **Surveyor** also spoke to the unsuitable place in which the stores were kept.

On the other side it was contended that the mains were practically as good as when originally valued, except for 10 per cent. allowance for depreciation.

On behalf of the company, **Mr. Clirehugh**, consulting engineer, Manchester, and **Mr. Davidson**, from Messrs. Glover and Co., Salford, who supplied the original cables, were called to show that the Council's tests were not taken under favourable circumstances, witnesses' tests giving 4,000,000,000 ohms, as against 45,000 ohms by Mr. Parkinson. It was further contended that the cables could be put right for £50.

The proceedings lasted several hours, and at the close the arbitrators intimated they would personally test the mains.—*Liverpool Mercury.*

COMPANIES' MEETINGS AND REPORTS.

DIRECT UNITED STATES CABLE COMPANY, LIMITED.

The half-yearly ordinary general meeting of the Direct United States Cable Company, Limited, was held on the 25th inst. at Winchester House, E.C., Mr. E. M. Underdown, Q.C., presiding.

The **Chairman**, in moving the adoption of the report, said their relations with the allied companies were of the most cordial description, and every kind of mutual accommodation was carried out between them, and the best spirit shown in acting up to what was generally known as the "pool." Their share in the "pool" was very satisfactory, but it was not generally understood what the advantages to the public were from that combination. By the pooling arrangement the public had the advantage of seven cables—four of the Anglo-American, two of the Western Union, and their own—which was most useful when the traffic accumulated or interruptions occurred, which did and must constantly occur. By this arrangement the traffic was never suspended nor practically interrupted, while at the same time the independence of the Company was maintained. With the exception of one year, more traffic was carried over their cable last year than in any of the previous 15 years.

Sir James Pender, M.P., seconded the motion, which was adopted.

WARD ELECTRICAL CAR COMPANY, LIMITE

The statutory meetings of creditors and shareholders
Company, already referred to by us, were held on Wedn
the Board of Trade offices, Carey-street, Lincoln's-inn-fiel
A. S. Cully, assistant official receiver, presided.

The **Chairman** said that although the winding-up o
made on Nov. 10 last, the statement of affairs had only
been submitted. The original patents secured by the
appeared to have lapsed, and the Company was now
unenviable position of possessing no assets whatever be
interest in the shares in the London Electrical Omnibus C
Limited. The statement of affairs showed unsecured l
£863, creditors fully secured £2,435, while the assets con
cash in hand £1. 9s. 1d.

During the discussion which ensued, Mr. Ward said it
wish to present the shareholders with shares in the
Electrical Omnibus Company, Limited. That company
in a position to make a considerable profit by running
omnibuses. The shares would then become valuable, and
no doubt that the shareholders of the old company woul
them.

The shareholders decided to leave the matter in the
the official receiver as liquidator, and the creditors' mee
adjourned *pro forma* in the absence of a quorum.

CONTRACTS FOR ELECTRICAL SUPPLI

CONTRACTS OPEN.

Leon (Spain).—Tenders are invited for electric lightin
town of Valderas for 17 years. Specifications are to be
from, and tenders addressed to, Municipal Authoritie
above town. Tenders by Feb. 11.

St. Chamond (France).—Tenders are invited for ligh
town by electricity or otherwise. Particulars are to be
from, and tenders addressed to, Municipal Authorities
place (Department Loire) by March 31.

Braila (Roumania).—Tenders are invited for the electr
ing of the town. The deposit required is £600. Spec
are to be obtained from, and tenders addressed to, the M
Authorities at Braila by Feb. 20 (March 4), at 4 p.m.

Tarifa (Spain).—Tenders are advertised for the lightin
town for 20 years. Specifications are to be obtained fr
tenders addressed to, the Municipal Authorities of th
town, province of Cadiz, Spain. Tenders by February 1.

Novorossisk (Russia).—Tenders are invited for the cons
etc., of an electric lighting installation for the town. Th
is 5,000 roubles. Specifications may be obtained from, an
addressed to, the Municipal Authorities of the town by Mar

Brussels.—Tenders are invited for electric lighting
Government offices, rue de Chêne, Brussels. The estim
is 8,860·72fr., and the deposit required is 900fr.
cations are to be obtained from, and tenders addre
Provincial Government Offices, Brussels.

Jordesillas (Spain).—Tenders are invited for electric
of the town for 20 years. The estimated cost is 2,500 pe
annum, and the deposit required is 1,385 pesetas. Spec
are to be obtained from, and tenders addressed to, M
Authorities of the above town. Tenders by Feb. 6.

Novorossisk (Russia).—Tenders are invited for the con
etc., of an electric tramway. The deposit required
roubles. Specifications, etc. (in French), are to be obtain
and tenders addressed to, the Municipal Authorities, No
(Russia), by March 1 (13). The time has been exten
November 15.

Redditch.—The Corporation are prepared to receiv
for station building, dynamos, etc., described in anothe
Particulars may be obtained from Mr. T. A. McMullen, M
consulting engineer to the Corporation, Hornchurch, E
tenders must be addressed to the clerks of the Corporatio
Browning and Hobson, not later than Feb 14.

Brighton.—Tenders are invited by the Town Counc
supply and delivery of dynamos, motors, switchboards
necessary wiring at the Municipal School of Sci
Technology. Specifications may be obtained on appli
the office of Mr. Francis J. Tillstone, town clerk, To
Brighton. Sealed tenders, addressed to the Town C
endorsed "Tender for Dynamos," must be left at his off
10 a.m. on 31st inst.

Edinburgh.—The Lord Provost and Magistrates and
invite tenders for the wiring of the police station, A
Specification, form of tender, and plans of buildin
obtained at the office of the Resident Electrical Eng
Dewar-place, Edinburgh, on deposit of £2. 2s., which de
be returned on receipt of a bona fide tender. Tenders
sent to Mr. Thomas Hunter, W.S., town clerk, City C
Edinburgh, by Feb. 5.

Madrid.—The Secretary of State for Foreign Af
received a despatch from her Majesty's Chargé d'A
Madrid, enclosing copy of a Royal decree announcin
public auction for the contract for repairing the nati
marine telegraph cables during the next five years will b
Madrid on Feb. 22. Further particulars as to the
question may be inspected at the Commercial Departme
Foreign Office any time between 11 and 5.

Rochdale.—The Corporation invite tenders for the following: (Contract No. 1) steam dynamos, balancer and boosters, etc. Specifications, conditions of contract, and form of tender may be obtained at the offices of the engineers, Messrs. Lacey, Clirehugh, and Sillar, 10, Delahay-street, Westminster, on payment of £5. 5s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed and endorsed "Electricity Works," must be delivered at the office of Mr. Jas. Leach, town clerk, Town Hall, Rochdale, by Feb. 19.

Wolverhampton.—The Public Works Committee invite designs and tenders for motor-vans for street scavenging and the conveyance of road materials. Outline specification and form of tender can be obtained on application to Mr. J. W. Bradley, C.E., borough engineer and surveyor, Town Hall, Wolverhampton. Firms tendering do so at their own cost in every respect. Drawings and a full description of the motive power, capacity, and other particulars, addressed to the Chairman of the Public Works Committee, to be delivered by February 7.

Guipuzcoa (Spain).—The Secretary of State for Foreign Affairs has received a despatch from her Majesty's Consul at Bilbao, reporting that the Provisional Board appointed in connection with the electric tramway which it is proposed to lay from Zumarraga to Zumaya, in the province of Guipuzcoa, invite plans and tender, to be received by February 28, for the construction and equipment of the line. Further particulars of the conditions of the tenders for the above-named tramline and branch, which together measure 30 miles, may be inspected at the Commercial Department of the Foreign Office between 11 and 6.

Brighton.—The Council are prepared to receive tenders for the completion of the electric light wiring, etc., of the Town Hall, Brighton. The drawings may be seen at the office of the borough engineer and surveyor, Mr. Francis J. C. May, M.I.C.E., Town Hall, Brighton, and specifications and forms of tender may be obtained at the Town Clerk's Office, Town Hall, Brighton, on payment of £1. 1s., which amount will be refunded on receipt of a bona fide tender. Sealed tenders, addressed to Mr. Francis J. Tillstone, town clerk, and endorsed "Tender for Electric Lighting, Town Hall," must be left at the Town Hall before 10 o'clock in the forenoon on Jan. 31.

Sophia (Bulgaria), March 5-17.—(*a*) For electric lighting of the town, town hall, and fire brigade barracks; (*b*) for an electric tramway for the town and surroundings. Only bona fide electrical firms are allowed to tender. Tenders must be in by March 5-17, at 11 a.m. A deposit certificate of the National Bank of Bulgaria of £6,000 must accompany each tender; also documents showing that the contracting firm has already successfully carried out similar works. If up to the 10th-22nd of March, at 10.30 a.m., a proposal of a reduction of at least 5 per cent. per kilowatt-hour of the lowest tender is received, a new adjudication will take place on the same day at 11 a.m. Specifications are to be obtained from the Mayor of the above town (8s. prepaid), where tenders are to be addressed.

Leicester.—The Sanitary Committee invite designs and tenders for motor vehicles for the collection of house refuse. The motive power, capacity, and all other particulars are to be described in a full specification, accompanied by drawings and delivered at the office of Mr. E. George Mawbey, C.E., borough engineer and surveyor, Town Hall, Leicester, addressed to the Chairman of the Sanitary Committee, by January 31. The loaded wagons would have to ascend an incline of 1 in 20, turn in a limited space, back and tip over a beam about 14in. high by 12in. in width, and when empty descend a road having a gradient of 1 in 15. The Committee do not bind themselves to accept any proposal, and firms tendering must do so at their own cost, no fees being allowed for the preparation of drawings, etc.

Ashton-under-Lyne.—Tenders are invited by the Baths Committee for the installation of the necessary wires, fittings, etc., for the electric lighting of the Corporation baths. The current will be supplied from the town mains. Copies of specifications, general conditions, and form of tender can be obtained on application to Mr. J. Neal, borough comptroller, Town Hall, Ashton-under-Lyne, on payment of a deposit of £1, which will be returned on receipt of a bona fide tender and specification. Any information relating to the work may be obtained from the consulting engineers, Messrs. Lacey, Clirehugh, and Sillar, 78, King-street, Manchester. Tenders to be delivered to the Borough Comptroller, endorsed "Tender for Electric Light Installation at Baths," by 12 noon on Feb. 2.

Wimbledon.—The Urban District Council invite tenders for the supply, delivery, and erection of the following works in connection with their electric lighting scheme: (Section A) water-tube boilers, pumps, etc.; (B) condensing plant, steam-pipes, etc.; (C) overhead crane; (D) high-speed steam-engines and alternators; (E) switch-board; (F) underground mains, conduits, etc. Copies of the specifications, with form of tender and general conditions, can be obtained at the offices of Mr. A. H. Preece, A.M.I.C.E., 39, Victoria-street, Westminster. Applications for any or all of above must be accompanied by a cheque for £5. 5s., which will be refunded on the receipt of a bona fide tender. Tenders, sealed, and endorsed "Tender for Section —, Electric Lighting," must be delivered at the office of the Urban District Council, Wimbledon, by 6 p.m. on Feb. 2.

Bradford. — The Tramways Committee of the Corporation invite tenders for the equipment of about nine miles of street tramways to be worked by electric traction: (Contract No. 1) for steel poles, bracket arms, etc.; (No. 2) for trolley wire, insulators, and overhead equipment; (No. 3) for cars, including trucks, motors, and trolley-pole complete. Conditions, specifications, and bill of quantities may be obtained at the offices of the City Surveyor and the City Electrical Engineer, Town Hall, Bradford, on payment of £5, which sum will be returned on receipt of a bona fide tender. An undertaking must be given by each contractor that he will pay to the workmen employed by him not less than the minimum standard rate of wages. Sealed tenders, endorsed "Tender—Electrical Equipment," to be sent to Mr. George McGuire, town clerk, Bradford, by Feb. 1.

Shoreditch, E.C.—The Shoreditch Vestry invite tenders for the erection of an underground transformer sub-station in Worship-street, Shoreditch, E.C., together with stairways, street refuge, and fittings complete. Specifications, quantities, and forms of tender can be obtained, and the drawings can be seen at the offices of the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of a fee of £3. 3s., which sum will be returned on receipt of a bona tender. The contractor whose tender is accepted shall enter into a formal agreement, under seal with sufficient sureties, for the fulfilment of contract. Trade union rates of wages and hours to be observed. Sealed tenders, endorsed "Electricity Supply, Tender for Sub-Station," to be sent to Mr. H. Mansfield Robinson, vestry clerk, Town Hall, Old-street, E.C., at or before noon on 31st inst.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one-fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to July 1, 1898.

Stockport.—Extension of Time.—Tenders are invited by the Corporation for the supply and delivery of the following articles, together with the fixing thereof, at the electrical generating station in Millgate, Stockport, or elsewhere within the borough as may be directed—namely: (B) two mild-steel "Lancashire" double-flued boilers, each 28ft. long, 8ft. internal diameter, and for a working steam pressure of 200lb. per square inch, together with their brick settings, smoke flues, dampers, and all other matters necessary to leave the boilers in complete working order. (C) Three sets of steam dynamos, together with their foundations, beds, trenches, and other matters connected with the working of above machines. Each steam dynamo to consist of a steam-engine of the inverted vertical type of 90 h.p. indicated, with 180lb. steam pressure, at 450 revolutions per minute; the engine being fixed on the same base-plate and coupled direct to a shunt-wound dynamo having an output of 56 kw. of electrical energy. Also a feed-water heater of 150 h.p. nominal, as well as a 6-ton overhead traveller, likewise two feed pumps, each of 2,000 gallons per hour, together with all the steam, exhaust, water pipes, and other connections in and around the generating station. (D) An electric storage battery of 136 cells, and having a total capacity of 750 ampere-hours, together with the stands, switchboard, contact switches, connections, acid, charging of the battery, and all matters necessary for the efficient working of the battery. (E) Electrical instruments and other apparatus upon the general switchboard and elsewhere, together with all electrical connections between the various machines, and other apparatus or things; the wiring and other arrangements and fittings for the lighting by electricity of the generating station. (F) Underground armoured cables, street boxes, and other appliances, to be laid in and under certain streets of the borough, in the neighbourhood of the generating station in Millgate. The Corporation reserve to themselves the right to do the trenchings, and the making good of the streets, and in other places. The works to be carried out in accordance with the plans and specifications prepared by Mr. James N. Shoolbred, C.E., 47, Victoria-street, London, S.W., electrical engineer to the Corporation, at whose office, as also at the Millgate Gasworks, Stockport, the plans and specifications may be inspected during ordinary office hours on and after 17th inst. Copies of specifications and general conditions can also be had there, on payment of £1 per copy of the specifications of each of the various sections lettered alphabetically, or of £5 per copy of the entire set of the specification, which amounts will be returned on the receipt of a bona fide tender. A separate tender must be sent in for each of the various sections. Tenders, enclosed in an envelope, sealed, and endorsed on the outside "Electricity Works," must be sent, addressed to the Chair-

man, Electric Lighting Committee, Gas Offices, Millgate, Stockport, by 12 noon on Feb. 3, the time having been extended. Contractors will have to undertake to pay the standard rates of wages and observe the standard number of hours.

RESULTS OF TENDERS.

London.—The following tenders have been received by the Metropolitan Asylums Board for alterations and additions to electric fire-alarm system at the South-Eastern Hospital :

		A.
G. Stegmann, Clapham Junction, S.W.	£121 10 0	£6 10 0
Private Wire and Telephone Installation Company, Cannon-street, E.C. (accepted)	122 10 0	10 10 0
Cox Walkers, Darlington	139 13 6	10 0 0
J. and F. Mahon and Co., Victoria-street, S.W.	144 12 8	30 0 0
J. Sax and Co, Limited, Coldharbour-lane, S E	144 18 0	10 0 0
Electrical Erection Company, Brown-court, Edgware-road, W.	165 0 0	3 10 0
W. J. Fryer and Co., Limited, Sloane-square, S.W.	184 0 0	8 0 0
Fowler, Lancaster, and Co., Birmingham	194 13 6	4 5 0
Stuart and Moore, South Ealing, W.	261 19 0	13 0 0
Jackson and Coleby, Thayer-street, Manchester-square, W.	387 10 0	30 0 0

A. Annual charge for maintenance.
Engineer's approximate estimate, £140.

BUSINESS NOTES.

London Electrical Cab Company, Limited.—A new issue of 86,388 shares is advertised for by this Company.

Southampton.—We hear the Corporation have decided to offer the tramway company £40,000 for their undertaking.

Dorking.—A report on an electric lighting scheme was submitted to the Council last week, and its consideration deferred.

Mansfield.—The Town Council have discussed in committee the question of opposing the General Power Distributing Company's Bill.

Paddington.—The Vestry have declined to support the application of the Municipal Electric Supply Company to supply electricity to the parish.

Rochester.—The subject of the Chatham and Rochester electric trams is still filling the local papers with comments and letters, wise and otherwise.

Portsmouth.—A town's meeting on Wednesday approved by a large majority a resolution in favour of the acquirement and working of the street tramways.

Hornsey.—Notice of opposition has been received to the Urban District Council's electric lighting scheme from the Hornsey Gas Company and the Great Northern Railway.

Treeton.—The Parish Council have provided for the lighting of the whole village by electricity, the outlay being only £750. One of the lamps is said to give a light equal to 3,000 c.p.

Crieff.—At the meeting on Monday the Commissioners seemed favourably disposed towards Mr. Yorke's proposals, reported in our last issue, and it was decided to meet with Mr. Yorke and enquire further into the matter.

Leicester.—The Electric Committee have reported that the total output of electric current from the central station, for the half-year ending Dec. 31 last, was 204,084 Board of Trade units. The number of consumers was 350.

Chislehurst.—The Council have formally approved of the provisions of the Chislehurst Electric Lighting Order, 1898, proposed to be granted by the Board of Trade to the Chislehurst Electric Lighting Supply Company, Limited.

Bedford.—At the next Council meeting the formation of a committee to consider the desirability of applying to the Postmaster-General for a license to construct and work a telephone exchange for Bedford will be proposed.

Kidderminster.—We understand that the Kidderminster and Stourport Electric Tramway will be completed by about the end of February, so that the public are within measurable distance of the time when it will be available for use.

Uttoxeter.—The National Telephone Company, who a little over three months ago opened an exchange in Uttoxeter, are about to extend their pole route to Ashbourne, where an exchange will be opened as soon as the work is completed.

Westminster Electric Supply Corporation, Limited.—We are informed that the recent issue of £200,000 3½ per cent. first mortgage debentures was subscribed four times over, and letters of allotment and regret will be posted in due course.

The Thames Embankment.—At their next week's meeting, the London County Council will discuss a proposal to invite tenders for the electric lighting of the Embankment, which is estimated at a capital expenditure of over £25,000 and an annual expenditure of £3,500.

Aberystwith.—The Improvement Company are laying a cable from the railway station to North-parade. This is being done primarily to enable the *Observer* office and the Terminus Hotel to be illuminated by electricity, but other installations are also contemplated.

Central London Railway.—It is stated that the General Electric Company of New York has received an order from the Central London Underground Railway for 32 locomotives, each of 800 h.p., weighing 45 tons, and able to draw five cars, weighing 150 tons, 15 miles an hour.

Private Bills in Parliament.—Among the schemes which have complied with the standing orders of Parliament are the Central Electric Supply Company (powers and works in Marylebone), the General Power Distributing Company, and the London, Walthamstow, and Epping Forest Railway.

Hill, Gifkins, and Co.—This firm inform us that in connection with our note on p. 91, under the heading of "Partnerships," there is a misunderstanding, as they have merely entered into a business arrangement with Messrs. Beanland, Perkin, and Co. for the sale of the arc lamp in question.

Glasgow.—The electrical department report that the necessary mains required to be laid down on the Springburn tramway route will cost £12,566, which includes provision for private lighting purposes. The cost of the electric energy for the whole of the proposed 104 lamps is estimated at £1,872.

St. Marylebone.—The Metropolitan Electric Supply Company intend to lay a cast-iron conduit, for the purpose of their high-tension mains, from Manchester-square station to Marylebone-passage and thence to Rathbone-place station, a proceeding to which the Vestry have formally signified their objection.

Wisbech.—A letter was read at the last Town Council meeting from the Mutual Telephone Company, asking the Council's acquiescence to a movement to take from the Post Office the monopoly which was exercised over telephone arrangements as against private companies. It was decided to acquiesce in the movement.

Personal.—We hear that Mr. Fred Spencer, of Walsall, formerly engineer to the Blackpool Electric Tramway Company, has received the appointment of general manager to the Halifax Corporation Tramways. Mr. Spencer's son, who showed great promise at Blackpool, has been appointed to succeed his father as electrical engineer to the South Staffordshire Tramways.

Bradford.—At the last meeting of the Gas and Electricity Committee it was decided to commence at once the laying of the cables for the new Corporation electric tramways to Great Horton and Bolton Woods. Tenders for the supply of engines and dynamos for the trams were considered and deferred. The work of tramway construction will, it is understood, be pushed on with all possible speed.

Kensington.—At a meeting of the Vestry on the 26th inst., permission was given for the following extension of mains being proceeded with, subject to the usual conditions: High-street, Notting Hill, by Johnson-street—Notting Hill Electric Lighting Company; Drayton-gardens, Kensington-road by Leonard-place, and Hogarth-road—House-to-House Electric Light Supply Company.

Messrs. Rosling and Appleby.—This firm has sent us a highly-decorated card, which we suppose they are supplying to their agents. The illustrations consist of a direct-coupled set and a belt-driven dynamo. The colours used for their reproduction are green and gold. The lettering announces the fact that coal-cutting, hauling and pumping plant, and all electrical mining machinery is supplied by the firm.

The Holophane Globes.—We note that the 1898 catalogue issued by the Holophane Company, Limited, shows a reduction in price for these most useful globes which ranges from 25 per cent. to 50 per cent. The value of these globes as giving more light in a given direction, and generally a better distribution of light, has been fully established. Hence this reduction in price for a most useful commodity is most acceptable.

Nantwich.—At the last Council meeting a letter was read from the Mutual Telephone Company asking the Council to co-operate with them in getting the Post Office authorities to grant certificates to other companies than the National Telephone Company for the establishing of lines, and thus prevent a monopoly, and bring about a reduction in the companies' charges. The matter was referred to the General Purposes Committee.

Bolton.—The Mayor (Sir B. A. Dobson), with Councillor Dr. Panton (chairman of the Electricity Committee), Mr. Alderman Miles, Mr. Councillor Proctor, and Mr. Ellis (electrical engineer), have just returned from a visit to Havre and Rouen, where they inspected the electric traction system in operation in those cities. The deputation were much impressed with what they saw, and learned many valuable hints for future guidance.

Walsall.—Mr. W. O. E. Meade-King, M.I.C.E., Local Government Board inspector, will hold an enquiry at the town hall, Walsall, to-day relative to the application of the Walsall Town Council for sanction to borrow £7,000 for purposes of electric lighting, £5,500 for works of surface-water drainage, and £1,100 for purposes of street improvements.—A draft provisional order of the Midland Electrical Construction Company has been approved.

Newcastle.—The following amendment has been carried by the Corporation: "That in the next application to Parliament power be sought for the Corporation to work their own tramways, but that, until the scheme to be prepared by the recently-appointed new Tramway Committee for providing the city with tramways has been considered by the Council, it is inexpedient to come to a determination as to whether the working of the tramways should be undertaken by the Corporation."

New Catalogue.—Messrs. Verity's, Limited, have sent us a folding list of the standard switchboards which is worthy of every commendation. The individual types of boards are each illustrated

by a general view and diagram of connections. Adjoined are details in list form of the various sizes, current capacities, and prices of the boards made of the type in question. The types include main switchboards, with measuring instruments, multiple dynamo boards, accumulator boards, and distributing boards.

West Hartlepool.—Active preparation is being made in West Hartlepool for the installation of the electric light in the town. For £1,000 a site has been secured near the paper works, and it is supposed that £30,000 will cover the cost of the entire scheme. In taking the matter in their own hands the Council hope that it will prove remunerative within two years. The low-tension continuous-current system will be employed, as it is considered the best adapted for a compact area, and can be used for motor purposes.

F. Hutchins and Co.—Messrs. F. Hutchins and Co., experimental engineers, 13, Victoria-street, Westminster, inform us that they have lately taken new premises at Gray-street, Blackfriars, which are now fully equipped for carrying out experimental work. Besides workshops for the manufacture of technical apparatus and inventors' models of all kinds, they have private rooms which can be placed at the disposal of patentees and others, with engine power, use of tools and instruments, supply of electric current, etc.

Laxey and Ramsey Electric Railway.—We understand that in connection with the extension of the Douglas and Laxey Railway to Ramsey in the Isle of Man, it is contemplated employing a storage battery which will be of very large dimensions. The order for the same has been placed with the Chloride Electrical Storage Syndicate, Limited. This must assuredly be regarded as a guarantee of satisfactory working of their batteries that are already in use in connection with the Douglas and Laxey section, and also the Snaefell branch of the line.

Ealing.—The *Middlesex County Times* asks: "Is it not time the Ealing District Council admitted the failure of its arc lamps and purchased others? The lamp gives a magnificent light—but intermittently; and the failure is in the same ratio as the light. A serious road accident occurred last week, caused, it is alleged, by one of the central lamps in the Uxbridge-road being out. The bill will, of course, be sent to the Council, and the Council is morally, if not legally, bound to foot it. In the long run new lamps for old would prove an economical policy."

Southwark.—At the last meeting of the St. Olave's Board of Works the Works and Finance Committee recommended that the Board offer no objection to the application of the County of London and Brush Provincial Electric Lighting Company, Limited, to the Board of Trade for a change of system from continuous to alternating currents for the supply of electric light. During the discussion which ensued it was pointed out that the alternating system was far more dangerous than the continuous system, and finally the question was referred back for reconsideration.

Summit.—At the last Council meeting the Clerk read a letter from the National Telephone Company asking for permission to erect poles on Todmorden-road to Summit. A discussion took place and eventually the surveyor was instructed to view the road along with the company's representative, to find out exactly where it is proposed to place the poles, and then report to the Council. It was also resolved that the county district surveyor, who, as the representative of the County Council, in whom the main roads are vested, is interested in the matter, should be informed of the application.

Anglo-American Telegraph Company.—The directors, after placing £12,000 to the credit of the renewal fund for the half-year recommend a balance dividend of 19s. 6d. per cent. upon the ordinary consolidated stock, and a balance dividend of £1. 19s. per cent. upon the preferred stock for the year ending Dec. 31, less income tax. After paying these dividends there will be a balance of about £200. The above dividends, together with those already paid, will amount to £3 per cent. on the ordinary consolidated stock, and £6 per cent. on the preferred stock for the year 1897.

Weston-super-Mare.—A public meeting was held last week to consider the advisability of the District Council introducing an installation of the electric light in the town. The following resolution was carried: "That this meeting is in favour of the introduction of the electric light; but, having regard to the serious state of the town's finances and the difference of opinion that exists upon the subject among the members of the Urban District Council, the interests of the ratepayers will be best served if the installation be effected and the business worked and conducted by an independent company."

Douglas.—At a meeting of the Douglas Town Council on the 24th inst., the question of the improved lighting of the town was considered. Tenders had been received from the Isle of Man Tramways and Electric Power Company for electric lighting, and the Douglas Gaslight Company for incandescent gas lighting. The Town Clerk reported that the electric tender worked out to just over 9d. per candle power on the year's working, and gas to 1½d. It was decided to accept the gas company's tender for one, two, or three years, but Prof. Fleming was engaged to report as to electric lighting with a view to the Corporation putting in an electric installation.

Wakefield.—The Electric Light Committee have recommended an increase of the wages of Mr. C. A. Midgley, assistant electrical engineer, for extra hours and labour until further orders. The committee have decided to give instructions to the city surveyor to at once put the approaches to the electric light station, near the railway arch, into a passable state for traffic. The minutes of the committee also showed Mr. Hammond had reported that he had tested the amount of current taken by the arc lamps, and found it far below that necessary to produce good lighting, and that he had called upon the Brush Company to remedy this, the lamps not yet having been taken over.

Blackpool.—"The decision of the Electric Lighting Committee to postpone the overhead system for the present," says the *Blackpool Gazette*, "is a very wise one; it gives us 12 months to look round. Mr. Quin deserves great credit for the promptness and ability with which he accepted the situation. With public opinion dead against him in the town, it would have been a mad thing to have attempted to rush the overhead system, and he seems to have evolved a scheme which will enable us to put up with the present system for another season without any heavy capital expenditure. At least Mr. Quin deserves congratulating for the resource he has displayed in adapting himself to his circumstances."

Catalogue Received.—We have received from the Sturtevant Engineering Company, of 73, Queen Victoria-street, a catalogue illustrating the Cutler-Hammer motor-starting switches and speed regulators. These switches are designed to effectually shield the motor from harm when through any cause whatever the current is interrupted, or the motor overloaded, or subjected to an excessive supply of current. In the case of speed regulators, the speed of the motors is regulated by the insertion of resistance into the armature circuit, the speed decreasing as the resistance is inserted. The full details of these switches and the principles on which they act are fully described in our issue of July 23, 1897.

Barking.—A Local Government Board enquiry is announced into an application by the District Council to borrow sufficient money to enable them to lay down an electric light installation for the purpose of lighting the town with electricity. Barking has, owing to a dispute with the gas company as to the price of gas, been lighted with oil ever since 1875. More than one-third of the entire rates of Barking are paid by the Beckton Gasworks, who, however, have no power to supply the town with gas, a local company having the monopoly. As the Beckton Company intend objecting to the scheme, and a petition has been signed by some of the inhabitants, the majority of whom work at Beckton, against electric light, the enquiry will be of considerable interest.

Liverpool.—The report of the electrical engineer states that up to Dec. 31 the equivalent number of 16 c.p. lamps connected to the supply mains was for private lighting 60,690, and Corporation lighting 6,971, making a total of 67,661, being an increase of 2,706 for the month. The number of units supplied during December was to private consumers 300,658, and for the Corporation 64,455, making a total of 365 115, against 257,700 for the corresponding period of 1896. — A part of the loan of the City Council's million and a half sterling 2½ per cent. redeemable stock, which has so far been anything but a success, is to be devoted to purchasing the tramways, £650,000 for electric tramways, and £400,000 for electric lighting installation and works for the city.

Annual Dinner.—The annual dinner of the employés of Messrs. Rosling and Appleby, electrical engineers, Trafalgar Works, Bradford, took place at the County Restaurant, Bradford, on the 21st inst., when about 100 partook of the ample fare provided. After dinner, Mr. Overend, the works manager, took the chair, and the toasts of "The Queen," "The Firm," etc., were proposed. Messrs. Spellman, Susfield, Cork, Brown, Rooney, A. Brown, Bower, Fletcher, Hughes, Smith, and Long contributed a series of sentimental and humorous songs, accompanied by Messrs. Rider Bros. on the piano. Violin solos were rendered by Mr. Greenhalgh, and pianoforte solos by Mr. H. Eurich. A very enjoyable evening was spent, and great credit is due to the stewards, Messrs. Twitchel and Mullard.

Drake and Gorham.—This firm has sent us a list of the numerous installations they have completed during the past year. The list is too long for reproduction, but we notice in it the name of one of the biggest isolated installations in the country. This is the Prudential Assurance Company's installation for 6,500 lamps of 16 c.p. The plant consists of several sets of slow-speed direct-coupled dynamos, running at about 85 revolutions per minute, which are upwards of 300 h.p. each. The large installation of 254 Jandus arc lamps in the Linotype Company's new works, as well as 257 incandescent lamps, was also carried out this last year. The firm have patented a system of iron conduit pipes which is stated to be giving excellent results, and which effects a large saving in labour over the method of screwing.

Vienna.—The *Daily Chronicle* correspondent telegraphs: "The Vienna Municipality has at last contracted a loan of 30 millions florins, requisite for the new municipal gasworks, with the Deutsche Bank at Berlin. The latter will take the 4 per cent. scrip at 98 for 100. Practically, however, the terms are more onerous, as the German syndicate has to obtain a concession for the new electric tramways in Vienna. If the Commercial Court's judgment in the lawsuit against the English gas company, which has been lost by the municipality, be confirmed by the Supreme Court, the English company, who were to be turned out from Vienna in October, 1899, will be entitled to continue the business for upwards of 20 years in all the suburbs by an amalgamation of which with Vienna proper, a few years ago, Greater Vienna was formed."

Alloa.—The Burgh Commissioners have practically decided to introduce an electric light installation. The total cost of the installation is estimated at about £3,000, and the annual sum required to meet interest and reduction of capital is put down at £434. The Gas Commissioners propose to pay one-half of the annual charge (in lieu of giving a further reduction in the price of gas), and with the saving which would be effected in the burgh's gas account by the substitution of the electric light for the present

illuminant, the total extra cost to the town for the proposed installation will only be £134—representing an addition to the rates of a penny in the pound. Thirty-four electric lamps are to be distributed throughout the main thoroughfares of the town. The question is to be definitely decided at the next meeting of the Commissioners.

Hull.—At the last meeting of the Guardians a resolution was carried to the effect "That the Works Committee be requested to take into consideration at an early date the advisability of installing the electric light throughout the whole of the workhouse premises." It was pointed out that they could manufacture the electric light with the existing boilers, supplemented with necessary engines and installation, at 2½d. per unit. The saving as between electric and gas was estimated at 20 per cent. in favour of the former, besides which there would be the additional advantages of cleanliness and freedom from fire.—At the meeting of the City Electric Lighting Committee on Wednesday, the income of the committee was estimated at £11,250 during the year, and the expenditure at £970 less. It was stated that the income had been placed as low as possible, and it was confidently expected that it would be greatly exceeded when the new extension now being carried out was in full working order.

Electric Construction Company, Limited.—The fourth annual dinner given by Sir Daniel Cooper, Bart., G.C.M.G., to the staff and long-service employés of this Company, took place in the Agricultural Hall, Wolverhampton, on the 8th inst., Mr. James W. Barclay in the chair. The menu provided left nothing to be desired, and the toast list comprised the following: "The Queen and Royal Family," the Chairman; "The Electric Construction Company, Limited," Mr. Barclay; "Sir Daniel Cooper, Bart., G.C.M.G.," Mr. Spence, to which Mr. Courtenay responded; "The Works," Mr. Dickinson, responded to by Mr. Blackburn; "The Directors," Mr. Buchanan, responded to by Sir Henry Mance; "The Staff" Mr. May, responded to by Mr. Boyden; "The Men," Mr. Moore, responded to by Mr. Farey. Various musical selections were rendered during the evening. The following telegram was sent to Sir Daniel Cooper: "Your 220 guests offer best thanks, and enthusiastically wish you many years of good health and happiness, cheering twice three times three."

Western Electric Company.—We have previously announced in our columns that this Company intended to take up cable manufacturing, and that a factory was to be built for the purpose. We are now informed that they have taken over the business and factories of the Fowler-Waring Cable Company. The letter from the Fowler-Waring Company announcing the fact reads as follows: "We beg to inform you that we have disposed of the business of cable manufacturers hitherto carried on by us to the Western Electric Company of 79, Coleman-street, E.C., who take over the business as from Jan. 1, 1898. All debts due to us in respect of the said business up to Jan. 1 should be sent to the secretary at this office; and all debts and liabilities in connection with the said business incurred, accrued, or owing at the close of Dec. 31, 1897, fall to be discharged by this company. We trust that you will favour the Western Electric Company with your future orders. Their wide experience and extensive connections in cable and other electrical manufactures are ample guarantee of your orders being carried out in the best possible manner."

Cardiff.—At the last meeting of the Council a letter was read from Messrs. Downing and Handcock, solicitors for the promoters of the Penarth electric lighting scheme, to Cardiff Parliamentary Committee on Monday, in which they stated that they had received a copy of the objections of the Cardiff Corporation to the scheme. There did not appear to be anything substantial in any of these objections. "We cannot believe," added Messrs. Downing and Handcock, "that your Council are desirous of wasting the ratepayers' money in putting forward such unsubstantial objections. We shall be glad to hear whether you are really serious in these objections, as, of course, if the objections are persisted in we shall have to look round for the best means of protecting our clients." Alderman Carey did not think such a letter called for any comment from them. The town clerk, however, was empowered to reply expressing astonishment at the remarks contained in Messrs. Downing and Handcock's letter, and to state that the Corporation's objections were certainly of a serious character, bearing in mind the important matters the Corporation are considering at the present time.

Colwyn Bay.—At the last meeting of the Tramway Committee Mr. E. W. Johnson attended and reported the result of the interview which he and the chairman of this committee and the surveyor had with counsel with regard to the attitude assumed by Lord Mostyn in the matter of the application of the Council to lay down tramways within the urban district of Llandudno. Mr. Johnson also read a letter which had been received from Lord Mostyn's agent stating that his lordship would not consent to the proposal to take the tramway over his land, and declining to see the deputation appointed by the Council to wait upon him. The opinion of the counsel was that the Council were entitled to lay down the tramway along Gloddaeth-street and also along Mostyn-street extension as far as Nantygamar-road, but he would advise further on the matter on receipt of certain particulars which he asked for. The consideration of the matter was adjourned until receipt of the opinion. Mr. Marks, in moving the adoption of the minutes, would like to inform the Council that the work in the streets, as far as laying the electric lighting plant was concerned, was likely to be commenced this week. After considerable discussion the minutes were carried.

Wolverhampton.—The *Midland Counties' Express*, referring to the tramways question, now under consideration, says: "In view of the expiry of the tramway company's lease, something decisive will have to be done in the direction of acquiring the tramways and municipalising them, or giving the company a new lease. Now here is a 'tip' for the committee. Why not do away with the tramways altogether and substitute motorcars to meet the traffic? The motorcars are undoubtedly the cars of the future. No parliamentary powers would be required to introduce them, there would be no special line to maintain in order, and no waste of horse power. I am told that motorcars large enough for all practical purposes could be run at a cheaper rate than tramcars, and that there is abundant plant at the Corporation electric works to supply the electricity required. Here is an opportunity for the Corporation to show their enterprise. They are often behind other towns in some matters, but in this instance they might be able to forge ahead of other corporations, more especially as everything can be found at their own doors."

Kingston-on-Thames.—The estimate of the revenue and expenditure for 1897 shows a revenue of £4,092. 3s. 4d., whereas the actual amount received is £3,899. 17s. 6d., or £193. 13s. 10d. less than the committee anticipated. On the other hand, the cost of the works is £3,061. 0s. 9d., or £148. 7s. 6d. less than the estimate. The total loss, including repayment of capital, was very closely estimated at £814. 9s., and worked out at £821. 1s. 10d. Last year the committee were able to report that they had met the works cost; now they report that they have not only paid the cost of the works, but the whole of the interest on the borrowed money. If, as in the case of an ordinary company, the capital had not to be repaid, they would this year have paid a dividend of 3¼ per cent. on their outlay. As their estimate for 1897 had proved so close and accurate, the Chairman said at the Council meeting, the Corporation might fairly assume that the estimate for the present year would come within something like the same amount, and he was glad to say that they estimated that the total loss this year would be £19. 12s. 6d., after paying not only the works cost but the interest and repayment of capital.

Appointments Vacant.—The Southend-on-Sea Corporation invite applications for the appointment of electrical engineer, at a salary of £200, rising by annual increments of £25 to £300 per annum. The person appointed will be required to prepare plans, sections, detail drawings, and specifications, and to supervise the necessary works for the introduction of electric lighting in the borough in accordance with a scheme recommended to the Council by an eminent engineer. He will also be required to undertake the responsibility for and supervision of the electrical plant at the pier, which is used for lighting and tramway purposes. Applications, accompanied by copies of three recent testimonials, which will not be returned, and stating age, qualifications, experience, and where at present engaged, to be delivered at the office of Mr. William Gregson, town clerk, by 12 noon on Feb. 2. Canvassing the members of the Council will be a disqualification.—The Corporation of Southampton announce a vacancy for an assistant electrical engineer to take charge of an eight hours' shift at their station. The salary is £1. 10s. per week. The person appointed must reside in the borough. Applications must be addressed to the Town Clerk by Feb. 1.—The Dundee Gas Commissioners have a vacancy for an improver in their electricity department. Salary, 20s. Applications by Feb. 7 to Mr. W. H. Tittensor, city electrical engineer.

Fire in Electrical Works.—On Saturday morning last the works of Messrs. J. Turner and Sons, Denton, were the scene of a most destructive conflagration, which broke out in the large showroom adjoining the machine department, and, spreading with great rapidity, soon enveloped the whole structure. The building contained a large quantity of finished electrical machinery, comprising dynamos, motors, electric ventilators, switches and switchboards of very costly description, and various finished parts of dynamos, completed armatures, etc. There were also some tons of wire and cable, the insulating material of which caused vast volumes of flame to ascend. The above, in addition to a large array of Turner's patent hatting machinery and general engineering accessories, was completely destroyed. The alarm was first given about three o'clock in the morning, when the surrounding neighbourhood was quickly aroused; and several of the workmen who live near were quickly on the spot, and made great efforts to isolate the flames from the main premises containing the different mechanical departments of the works. The fire brigade, with commendable promptitude, soon arrived, and by dint of good management and a plentiful supply of water eventually saved the working part of the buildings. Thus, fortunately, none of the operatives are thrown out of employment, and all business can be carried on as usual. We understand the damage will amount to about £3,000, which is partly covered by insurance.

Edinburgh.—The Tramways Committee of the Town Council, after several meetings with the directors of the Edinburgh Street Tramways Company and with the lessees of the tramways from the Corporation on the subject of the purchase of the Portobello section, have made a provisional agreement, under which it is proposed that the Corporation should purchase the Portobello section of the company's property, including lands and buildings belonging to the company, for the sum of £40,000. Further, the committee have made a provisional agreement with the lessees to lease from the Corporation, exclusive of the heritable property at Portobello, and the movable property—for which they are to repay the Corporation in cash—on the same terms as they hold the existing lines in the city. Recommendations on the lines of these agreements will be made by the committee to the Town Council, on the confirmation of which they, of course, depend. The arrange-

further contingent on the agreement between the Leith ouncil and the company for the purchase of the Leith lines urried through.—The Cleaning and Lighting Committee of rn Council on the 24th inst. agreed to recommend the by electricity of the following roads and streets as from day next: Minto-street to Newington Station, 16 lamps; street to Ardmillan-terrace, 13 lamps; Raeburn-place ly Bank, 10 lamps; Broughton-street to Canonmills, ; Haymarket-terrace to Donaldson's Hospital, 7 lamps; Meadow-walk to Argyle-place, 12 lamps; and Gorgie he Board school, 16 lamps. The proposal is that the ould be lighted at the cost of £15 per annum.

ire Sanitary Inspectors' Association.—A meeting of ers of the Yorkshire branch of the Sanitary Inspectors' on was held on Saturday afternoon in the Council- of the Leeds Town Hall. The president (Dr. J. Pridgen cupied the chair. Mr. George Darley (Leeds) read a "The Destruction of Towns' Refuse by Fire." The system, he said, as worked at Leeds and Oldham, had roved as a result of the enquiry made by experts in the points raised in a notable law case, as well as ubsequent adoption at Bradford, Ashton-under-Lyne, gh, and Hamburg. The system had obtained the silver the Sanitary Institute and a gold medal of the Brussels nal Exhibition. The reading of the paper was followed by on. A member from Hull said that the Corporation of had adopted the Horsfall system upon a condition that s should work the destructors by their own stokers for , and then, if satisfactory results were not shown, the n should not carry out its contract. The results had t satisfactory. Mr. Drake (Huddersfield), answering from the president, said that a large amount of the ld refuse was disposed of by means of tips. Mr. Darley a good deal of tipping of dry ashes occurred at Leeds. s (Halifax) said that Halifax was very well situated in tipping places. The Hon. Secretary expressed the at all tipping of refuse ought to be severely condemned, s of great danger to present generations and those which to come. Mr. Darley also exhibited some plans of s.

mmunication Telephones.—A new type of instrument lass of telephones has been recently placed upon the y J. D. F. Andrews and Co., Fulham Electric Works, ridge Station, Fulham. The features of improvement y pressing a push button corresponding to the station to to the electric call bell is rung and communication effected speaking, and when the conversation is completed the nt is reinstated in its normal condition by replacing the on a hook; or, if after finishing conversation with one it is desired to speak to another, this may be done by ressing another push by which the one previously pressed t of connection. If, on the other hand, it is desired to more than one station at once, the pushes relating to each tion must be pressed simultaneously, and when conversa- nished the instruments are set at rest automatically by placing the receiver on its hook. The pushes are per- ly connected to the various lines by a flat spring, and they ed in a row opposite an oscillating bar, against which any them may be pressed The push springs are so contrived hen they are pressed they hook into the bar, and in so doing it and release any spring that has been pressed. The ting bar is connected to the home receiver and microphone. push can be pressed beyond the oscillating bar on to another nected to the battery direct for purpose of ringing the call When the receiver is replaced after speaking, the hook upon it is hung is contrived to catch on the oscillating bar and it so as to release any line springs that may be connected to and the instrument is then ready for another call.

[illegible].—The year ending on Dec. 31 has been very successful ds the Council's electric light venture. The expenses were , made up of the amount paid to Messrs. Parker, Limited, , rates, taxes, and insurances. The receipts were £4,985; gross profits amount to about £2,585. This sum, the Chairman at the last meeting of the Council in presenting the Lighting mittee's report, they could not consider as net profits. If they been a trading company they could have considered them net , and distributed them as the shareholders thought best, but a corporation they had to pay interest on the money wed, and to lay by a substantial sum towards the sinking d. The interest upon the capital borrowed was £1,269, calcu- from the time that the money had been used. The amount by for the sinking fund was £732, which would leave them balance of about £560. This was their net balance. Some they ought to pay their preliminary expenses He thought had paid everything they could be expected to pay, but they bill staring them in the face called "preliminary expenses," h they were not allowed to borrow in order to get rid of. It quite fair that they should not say anything about that this but carry it forward to be dealt with in a very liberal manner year. It was an amount of about £600 or £700 incurred they employed Prof. Kennedy, and before they called in Kelvin. That was money very well spent, for it gave them amount of experience which they had benefited by in the ccess of their new venture. There was another feature in this electric supply, and that was that they had not had year to calculate their real revenue, because they were way of business to commence with. The receipts for three-quarters averaged £700 per quarter. The first was the winter quarter, and very few people were on the mains, and then came the two summer quarters, the average for the three being, as he had already said, £700 a quarter. They would be glad to hear, however, that their last winter quarter, ended Dec. 31, brought in close upon £1,800. The report was adopted.

Redditch.—Mr. J. A. McMullen, electrical engineer, of London and Rugby, who is engaged upon a scheme for supplying the town with electricity for lighting and other purposes, attended a special meeting of the Redditch Urban District Council on the 20th inst. for the purpose of presenting the plans and specifications. In the amended scheme presented, Mr. McMullen recommended single-acting gas-engines, working with one or two cylinders, preferably two, as generators. He had designed the engine-room so that it would accommodate plants each capable of producing 1,750 lights (16 c.p.), with one small plant of 450 lights. To commence with he had shown one 1,750-light and one 450-light plant, with an additional spare plant of 1,750 lights. This would safely supply 2,200 16-c.p. lamps at once. This meant 3,300 connected to the mains, and there was also a complete spare set in case of a breakdown. As to distribution, he recommended an alternating system in its simplest form, so that no expensive labour was required. The site for the central station was arranged to be at the south-east corner of some of the Council property in Summer-street. He recommended armoured conductors buried direct in the ground, rather than pulling the mains through conduits. From the canvass of the town it was evident there would be an immediate demand for about 2,000 16-c.p. lamps. Such a number would consume about 60,000 units, bringing in an income of £1,500 per annum at 6d. per unit. The estimates would show a necessary capital cost of £8,000. On the estimated capital of £8,000, 6 per cent. would have to be paid for interest and sinking fund, equal to £480 per annum. The yearly working out could therefore be taken as follows: works cost, £650; interest and sinking fund, £480; additional depreciation, £160—total, £1,290; showing a profit with 2,000 lights of £310 per annum. Asked what would be the cost of carrying the scheme to the White Hart Hotel at Headless Cross, Mr. McMullen said the cost of laying the mains would be about £750 per mile, and the scheme could be extended to any distance the Council would be likely to require. In reply to Mr. Malins, the Engineer said the power would be 200 volts. If the electricity was required by any manufacturers for plating purposes a low voltage could be secured, even with the alternating system, by using an alternating-current motor transforming it into a direct current. A special circuit would be required for the public street lamps, as then all could be lit at once. If Headless Cross was to be included in the scheme it would be necessary to make provision for another high-pressure circuit. The Chairman said Mr. McMullen would now proceed to act under the instructions he had received and advertise at once for tenders.

Burton-on-Trent.—At the last meeting of the Council, the Gas and Electric Light Committee reported that during the past month there had been expended in wages and Christmas allowances £1,223. 13s 10d. Alderman Lowe, in moving the adoption of the report, referred to the recent failure of the electric light, and expressed the deep regret of the committee and Mr. Ramsden, who, he said, had had a most anxious time. Mr. Ramsden had prepared some memoranda on the subject, and this was as subjoined: "The whole of the failures in the supply, with one exception, which was when some of the fuses in the street transformers melted, have been traced to the breaking down of the indiarubber insulation of the copper conductors in the streets, and in no single instance has the light been off for five minutes through any defect, accident to, or in the method of working the machinery at the works. It is impossible for me to say definitely why the insulation has broken down, as I cannot find on the closest examination that there is any general deterioration of the indiarubber near where the defects have occurred. Of course, if the insulation had remained perfect, no breaking down could take place, so that the conclusion to which I have come is that either there were defects or impurities in some of the indiarubber when it was manufactured or that it was damaged in the laying. You will remember when the contracts were made that we bought Silvertown mains, which were then considered to be the best which were made. Before the mains were laid and also after they were laid and connected to the transformers, they were tested by the usual insulation tests with quite satisfactory results, but gradually, since then, the insulation resistance has lowered, and at the present time it is very low. When the failures occur they do so without a moment's notice; we have no indication at what point in the mains the defects have occurred. They have varied from close to the works to St. Paul's-square, and the only thing that can be done is to stop the supply and search for the place, which is a very tedious and difficult process. I may mention that it is impossible to continue the supply until the defect has been remedied. In the Ashby-road district and in Union-street, where we bought the pipes and mains and laid them with our own workmen, we have so far had no defects. No one more than myself is aware of the serious results and consequences of these breakdowns; they are having my most careful consideration, and I am enquiring from other electric light works where similar mains have been laid what has been their experience, and if they have had trouble, what steps they have had to take to get over their difficulties." Alderman Lowe, continuing, said the committee intended to go to all reasonable cost to make the light as perfect as they could get it, and he hoped the Council and their customers would bear with them. The committee had not gone into the question of duplicate mains. The report was adopted.

New Catalogue.—The Zurich Incandescence Lamp Company forwards us a new catalogue of their lamps. In this, although many of the old types of lamps still appear, we notice many novelties. The best of these, and the one most likely to come into general use, is the single-filament high-voltage lamp illustrated herewith. The filament, shaped originally like a gridiron and then bent round, is most stable and in this respect is much better than the ordinary high-voltage filament. Also the shape adopted gives practically a ball of light, which is exceedingly handy for projection purposes. The energy consumption of these lamps is from 3·5 to 3·7 watts per candle, but much lower figures can be obtained if desired. With the above watts per candle the lamps last well. We also notice in this list illustrations

of the Stearn patent changeable-voltage lamp. These lamps are made with twin filaments and sent out for use at from 100 to 115 volts as ordered, and by a patent arrangement in the cap can at any time be made to work at double the initial voltage, giving the same candle-power and efficiency as at the initial voltage, by the mere changing of two small screws. The new list is well arranged, and the illustrations and printing leave nothing to be desired.

St. Pancras.—At the last meeting of the Vestry, a report with plans and estimated cost of carrying out certain large extensions at the Stanhope-street, Regent's Park, generating station, in order to meet the continuously increasing demand for current, was adopted. The scheme submitted provides for the erection of a new chimney shaft and buildings, including an additional boiler-house, heightening and widening a portion of the engine-room, so as to accommodate four 750-h.p. engines. It also provides for general stores, time, storekeeper's, and weigh offices at the entrance to the yard, battery room over boiler-house, condensing plant over engine-room, with air-pumps on engine-room floor, boilers, lock-up coal bunkers under elevated roadway, ash elevator, and other minor accessories. It is unnecessary to instal the whole of the plant in the new buildings at the outset. A proportion only will be required—viz., two 750-h.p. engines and dynamos, the bank of four boilers shown on plan, boiler feed pumps, feed-water heaters, a proportion of the condensing plant, switchboards, overhead travelling crane, ash elevator, lock-up coal bunkers, etc. The new chimney shaft will be some 200ft. high, 8ft. 6in. internal diameter, and so designed as to accommodate all possible extensions on the present site. Mr. Sydney Baynes, chief electrical engineer, who has prepared the scheme, estimates that the capital expenditure on the portion of the building and plant completed by the end of the present year will be about £21,440. This sum includes the cost of the chimney and flues, and represents the amount payable to the contractors, inclusive of £9,440 which will be due for the engines already ordered, and the whole completed scheme will involve a capital expenditure of £26,439, which the Vestry were invited to sanction. A discussion of some length ensued, and Mr. Menzies, the chairman of the Electricity Committee, replying to it, said that with regard to the balance of £46,000 they owed to the bank, that was part of their capital, and not a debt in the ordinary sense of the word. It was not a deficit. They had valuable property, a revenue of between seven or eight thousand pounds, five or six thousand pounds' worth of stock, £24,000 coming from the County Council, so that they had not only sufficient to meet their balance, but a little over. They were making £4,000 a year from Stanhope-street station alone, and that, be it remembered, was profit after paying interest on debentures and repayment of capital. There was, it was true, a deficit on the King's-road, but
he hoped that would be cleared off next year. Wi
the gas account, some years ago 450 lamps were
They were not, however, disused, but spread over o
the parish, and put up where needed, so that it w
gas consumption went on as before. They did not
new station, because they could do at Stanhope-street
required for the whole parish for some years to com
regard to the contracts, although it was not their cu
to accept the lowest tender, they believed in public
and in relying to a great extent on the experience of
in these matters.

Bromley.—The Urban District Council further d
proposed transfer of their electric lighting powers
company at their last meeting. A number of com
were received on the subject from the Board of Tra
mated their readiness to approve of the transfer, a
company's solicitors ; and a lengthy debate followe
letter on the subject was from the Board of Trade,
returning to the Council a copy of the draft deed o
the electric lighting powers, and stating that they w
pared to approve the deed in that form on learning th
referred to previously had been subscribed. Anothe
the same Board stated that they required to be furn
Council with a list of subscribers and the amount of
scribed. They also enclosed a copy of a letter rec
subject from Messrs. Todd, Dennes, and Lamb, t
their reply thereto. The letter from Messrs. Todd,
Lamb was to the effect that their clients—the Br
Electric Light and Power Company, Limited—ha
necessary steps for satisfying the Board's requirem
least £5 000 worth of capital should at once be subs
thousand and eighty-four shares had, they stated, bee
and allotted. Those shares were of the value of
represented £5,420 worth of capital. They had e
deed of transfer, and had requested the clerk to the Br
District Council to have another part of the same de
so that the document might be sealed at the Council's m
18th inst. They would, they added, be glad to hear from
Trade there was now no other condition to be fulfille
gave their approval to the transfer, and asked the Bo
to intimate if such was the case to the Council.
Trade replied to the above as follows : "Gentl
reference to your letter of the 12th inst., giving par
the amount of the capital of the proposed transfere
above-mentioned order, which has been subscribed,
by the Board of Trade to state that they will be
approve the deed of transfer as soon as it is execut
add that the Board are communicating with the Di
in the matter." Three letters on the subject were
from Messrs. Todd, Dennes, and Lamb, asking th
complete the matter. In one communication they ga
of the shareholders who had taken among them £5,
as follows : Messrs. Medhurst, Taylor, Gripper, U
Cakebread, Bassett, and Edmundsons, Limited.
forwarded the draft deed of transfer for the Counci
stated that the company were prepared, when the
settled, to commence works with a view to the li
operation at an early date. Messrs. Willett and
asking the Council's instructions with reference to
ment of the deed of transfer. The following res
carried *nem. con.* : "That the question of electri
adjourned for a fortnight, and that the clerk be dire
to Messrs. Todd, Dennes, and Lamb asking to be fu
the names of the subscribers to the company, with t
shares taken by each, a copy of the memorandum
of association, a copy of the contract entered
company with Messrs. Edmundsons, Limited, an
the prospectus the company have issued or prop
and that it be referred to a special committee
Council to consider the information supplied,
The Clerk then read a letter referring to the ele
question urging the Council to retain the order wit
and privileges for the benefit of the ratepayers, the
convinced that it would prove a most lucrative sour
if worked as the Council would work it, not primarily
holders' interests, but in those of the consumers, and
following resolution which had been passed at a meetin
Market-square : "That we, the inhabitants of Broml
meeting assembled, respectfully ask the District Cou
the example of St. Pancras, Islington, and other ve
and boroughs, to retain the electric lighting pow
possess in the interest of the ratepayers, and light
themselves, and that the profit derived from the sa
to the credit of the rates." It was decided to reply
stating that the Council had the question under consi

Meeting of Ironmasters.—A meeting of the me
South Staffordshire Iron and Coal Trades Association
the 20th inst. at the Queen's Hotel, Birmingham, for
of considering the scheme for providing electricity fo
power throughout the district of South Stafford
Midland Electric Corporation for Power Distributi
There was a large attendance, presided over by
Hingley, Bart. (chairman of the iron trade), and incl
Cochrane (chairman of the coal trade), G. L. Adde
sulting engineer to the Corporation), A. L. Lowe (so
Corporation), E. Wones, J. Dudley, D. Jones, E.
The Chairman said that in the district the iron and
depended upon old fashioned methods, which involv
steam-engines, boilers, and fuel, and involved mu

while on the Continent of Europe and in America electric ad been more extensively used. In some parts of those ts, and, indeed, even at home in Glasgow, boilers and had been discarded to a great extent and made into scrap. l electric power had been applied with great economy and o each machine and tool. Such changes were expensive, ıufacturers must face the expense and abandon their ioned ways if they wished to defy competition. ious local authorities had taken up the question of g electric light, and in a certain sense they had uite properly and for the protection of the ratepayers, ı the matter came to be investigated they found that in strict where the electric supply was in the hands of the horities it was conducted in an expensive manner, whereas te enterprise they were assured that electricity could be at much less cost. It must be obvious to those engaged 'acturing that to have power carried to their doors without ; their own capital, and without burdening the district es, would be much better for them than for the local es to borrow money and supply it. At present many of l authorities were obtaining powers granting them a y of electric light and power, and each authority would dependent works on a small scale, and conduct them not nost economical manner. Where local authorities had set up generating stations they made a charge to the con- f 3d. per unit or thereabouts, whereas the promoters of and Corporation assured them that the power could be by a private enterprise on a great scale at one-half iird that cost. The advantage of that must be obvious facturers, and not only would it be to the advantage of eady engaged in trade, but every working-man of spirit rprise could have his small manufactory, could set up a tool otor, and bring in a wire to drive it, in exactly the same way gas. Colonel Cochrane said the Mines Drainage Board had it difficulty in dealing with the water and preventing the being drowned out. If they could get electric power l to the low-lying places, they could simply and economi- al with storm and other water by making reservoirs. The would save the Mines Drainage Commissioners from the y of spending a capital sum of £30,000 to £40,000 in ; down pumping engines to get water from the mines which o be dealt with on the surface. It had been said that the night be a diminution of the demand for slack, but he did ak that would happen. He would not have a word to say t the local authorities providing the power if they could put d such an advantageous scheme as that which the Midland ation had. But, if because their areas were not sufficiently to enable them to produce power at anything like the hat one company supplying the whole district could, in the interests of the ratepayers, the numerous local ities should stand on one side and let the power com- do what the authorities were unable to do. The Chair- moved the following resolution: "That in the opinion s meeting the proposal for electric power distribution dustrial and manufacturing purposes in this district is y of consideration, and should be encouraged instead of d by local authorities, subject to fair conditions, so as to economical terms to consumers." Sir Alfred Hickman, in ing the resolution, said the company quoted a price varying d. to 1d. per unit, and said that "until the area of supply own, it must be impossible to settle the rates to be charged. estion of area depended on the local authorities." In his s the question of area depended on the price charged. At hampton they had works and were able to supply elec- at 3d. per unit, but if the price was to be 1d., he thought ficient authorities would welcome the company. Mr. W. e said that at his collieries electric haulage and pumping as found most successful and economical. Mr. Garcke h Electric Traction Company) said that a large portion scheme for supplying electric traction to the district could carried into effect because of the difficulty of getting power he local authorities at anything like the price which the ny would offer it. Colonel Cochrane said the only question hether the local authorities could supply them as cheaply. could, then, of course, they should leave themselves in the of the local authorities. The resolution was adopted, and eting closed with a vote of thanks to the chairman.

Catalogue.—We have received from the General Electric ny their new telephone and electric bell catalogues, the consisting of a 60-page brochure and the latter of 90 pages. paring these editions with those preceding them, the first which strikes one is the numerous reductions in prices of ll-known lines manufactured by the company. There are ny important additions and extensions, particularly in the somewhat less interesting but important branches of the bell and telephone accessories. We notice the following al additions: the wire gong bells, made on a carefully system, so that the tone given out is quite distinctive but ly sweet, similar to that emitted by the well-known the old-fashioned timepiece. In the company's make of ll, worked by two E.C.C. dry cells, it will be noticed that imparted by the little motor and the weight hammer a heavy blow being given. The double motor bell is a ation of this principle (see Fig. 1). In this there are giving two distinct notes which emit in rapid succession, tuned in harmony, produces a most pleasing effect. We the indicator pages have been rearranged and new dded, so that the range in price is very considerable. the accessories we notice some very cheap pushes, as superior qualities for best work. There is a very good multiple pushboard illustrated, which is very suitable for an office table. Each plunger is recessed in a little cup of ebony, and being thus counter-sunk if a book or anything is allowed to rest on top of the pushboard it does not depress the plunger and ring the bell, this defect having frequently been experienced hitherto. The battery pages of the list are very much extended,

Fig. 1.

and we notice that reductions are made proportionate to the quantities of Leclanchés taken, and that if exact quantities of one, three, or six dozen are ordered, they are sent out in special cases without extra charge. The whole of these Leclanché cells are made in the company's special battery department in London, under careful supervision, to ensure the correct mixing of the carbon, manganese, etc., of every porous pot which goes out. The telephone list shows many extensive additions—in fact, there is scarcely a page which does not contain two or three distinctly new departures. We should specially mention the intercommunication systems, No. 50B. as

Fig. 2.

illustrated, and 10-way small desk set (Fig. 2). This general system of intercommunication is accompanied by a complete list of accessories, the whole having been carefully standardised, so that they are easily fixed. We should advise our readers to get these catalogues, which are sent gratis to everyone in the trade.

PROVISIONAL PATENTS, 1898.

January 17.

1258. An improved cord grip ceiling rose for electrical work. Frederick William Heaton and Harry Smith, Salford Switch Works, 27, Sidney-street, Salford.

1290. Means for augmenting lifting-power by electricity. Hugo Wolff and Wilhelm Brase, 111, Hatton-garden, London. (Complete specification.)

1294. An improved coin-operated telephone instrument for public call. Frederick John Clendinnen and George Andrew Philip Weymouth, 322, High Holborn, London. (Complete specification.)

1301. Electric signalling apparatus. Felix Benedict Herzog, 46, Lincoln's-inn-fields, London. (Complete specification.)

1303. Improvements in magnetic ore separators. Gerald James Cream, 53, Chancery-lane, London.

JANUARY 18.

1336. An improved method of preserving propeller shafts from galvanic action at the junction between shaft and liner. George William de Tunzelmann, 2, Penywern-road, Earl's Court, London.

1379. Improvements in electrical insulating conduits and in the method of and apparatus for making same. Philip Middleton Justice, 55, Chancery-lane, London. (The Lithosite Manufacturing Company, United States.) (Complete specification.)

1380. Improvements in the regulation of dynamo-electric machines and motors. Frederic Ayres Johnson, 55, Chancery-lane, London. (Complete specification.)

1391. Improvements in electromagnetic brakes for cars. Edgar Peckham, 62, St. Vincent-street, Glasgow. (Complete specification.)

1416. Improvements in telegraphic transmitters. Samuel Price, Walter Polk Phillips, and Roderick Henry Weiny, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JANUARY 19.

1464. Improvements in and relating to holders for incandescent electric lamps. William McGeoch, 96, Buchanan-street, Glasgow.

1465. Improvements in and relating to moulds for shaping glass globes for gas or electric lights or like articles. John Buchanan, jun., 96, Buchanan-street, Glasgow.

1489. An automatic interchangeable electric and mechanical advertiser. Harry William Cox and Charles Tom Taylor, Park-row, Nottingham.

1493. A new or improved system comprising a method of and means for making connection between an underground conductor and vehicle motor such as a tramcar or the like. Harry Louis Butler, 22, Glasshouse-street, Regent-street, London. (Complete specification.)

1535. Improvements in incandescence electric lamps and processes for the production thereof. Carl Auer Ritter von Welsbach, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

JANUARY 20.

1557. Improved clockwork-operated mechanism for switching electrical current. Arthur Stanley Scull, Lloyds' Bank-buildings, Bristol.

1564. Electric striking mechanism for clocks and the like. Harry Whidbourne, 30, Greenbank-avenue, Plymouth.

1628. Improvements in and relating to secondary batteries. Walter Ambrose Crowdus, 45, Southampton-buildings, Chancery-lane, London.

JANUARY 21.

1678. Improvements in and connected with dynamos and electric motors. Frederic O'Connor Prince, 37, Cursitor-street, Chancery-lane, London.

1686. Improvements in secondary batteries and in means for combining electric lamps therewith. Walter Ambrose Crowdus, 45, Southampton-buildings, Chancery-lane, London.

1687. Improvements in electric signalling apparatus. Silvanus Phillips Thompson, Morland, Chislett-road, West Hampstead, London.

1691. Improvements in electric switches. John George Dixon, 70, Palace-chambers, Westminster, London.

1697. Apparatus for the electrolytic treatment of bleaching liquids. Max Haas, 37, Chancery-lane, London. (Complete specification.)

1702. Improvements in electric batteries. Maurice Reynard, 47, Lincoln's-inn-fields, London.

1706. Code telegraphing and circuit-testing apparatus for fire alarm and other purposes. Richard Pearson, 53, Chancery-lane, London.

1715. Improved device for locking electric lamps. William Isaac Douglas, 75, Chancery-lane, London.

JANUARY 22.

1735. Improvements in electrical accumulators or storage batteries. Andrew George Adamson, Thomas William Allan, and Allan and Adamson, Limited, 154, St. Vincent-street, Glasgow.

1742. Improvements in and relating to electromagnetic engines or motors. Colin McCallum, 96, Buchanan-street, Glasgow.

1803. Improvements in and relating to electric arc lamps. Llewellyn Burbank Codd and John Alfred Codd, 323, High Holborn, London.

1828. Improvements relating to the transmission of drawings, handwriting, and the like by telegraph and telephone. John Walter, 75, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1896.

30123. Means of telegraphing through long uninsulated or badly insulated submarine or other submerged cables and maintaining communication notwithstanding a break in the continuity of the conductor. Brown.

TRAFFIC RECEIPTS.

Dover Tramways.—The traffic receipts for the week January 22 were £107. 17s. 6d. The total receipts for 1898 are £333. 12s. 8d. The mileage open at present is 2½

Bristol Tramways.—The traffic returns for the week January 21 were £2,380. 10s. 11d., compared with £1,727 for the corresponding period of last year, being an inc £653. 9s. 6d.

Birmingham Tramways.—The traffic receipts for th ending January 22 were £3,517. 9s. 8d., as compar £2,900. 3s. 2d. in the corresponding week in 1897, b increase of £617. 6s. 6d.

Liverpool Overhead Railway.—The traffic receipts railway for the week ended January 23 amounted to £ compared with £1,217 in the corresponding week of the year, being an increase of £137.

City and South London Railway.—The returns for t ended January 23 were £1,075, compared with £1,114 for th sponding period of last year, being a decrease of £39. T receipts for the half-year amount to £4,334, compar £4,387 for the corresponding period last year, being a of £53.

South Staffordshire Tramways.—The traffic returns week ending January 21 were £634. 2s. 6d., as compa £572. 10s. 0d. in the corresponding week of the previo The aggregate receipts for the year are £1,783. 3s. against £1,710. 12s. 4d. in the corresponding period previous year.

Dublin United Tramways.—The traffic receipts for th ending January 21 were £2,850. 13s. 11d., as compar £2,319 1s. 11d. in the corresponding week in the previo being an increase of £531. 12s. 0d. The number of pa carried was 521,949 in 1898 and 400,992 in 1897. The ag returns up to date are £8,530. 5s. 4d., as compar £7,506. 11s. 1d. last year, being an increase of £1,023. 14s. mileage open is the same as last year—viz., 34 miles.

COMPANIES' STOCK AND SHARE LIST

Name.	Paid.
Birmingham Electric Supply Company	5
Brush Company, Ordinary	2
—— Non. Cum., 6 per cent. Pref.	3
—— 4½ per cent. Debenture Stock	100
—— 4½ per cent. 2nd Debenture Stock	100
Callender's Cable Company, Debentures	100
—— Ordinary	5
Central London Railway, Ordinary	10
——	6
—— Pref. Half-Shares	1
—— " "	5
Charing Cross and Strand	8
—— 4½ per cent. Cum. Pref.	5
Chelsea Electricity Company	5
—— 4½ per cent. Debentures	100
City of London, Ordinary	10
—— Prov. Cert.	10
—— 6 per cent. Cumulative Pref.	10
—— 5 per cent. Debenture Stock	100
City and South London Railway, Consolidated Ordinary	100
—— 4 per cent. Debenture Stock	100
—— 5 per cent. Pref. Shares	10
—— " " " '96	10
County of London and Brush Provincial Co., Ordinary	10
—— 6 per cent. Cum. Pref.	10
Crompton and Co., 7 per cent. Cum. Pref. Shares	5
—— 5 per cent. Debentures	—
Edison and Swan United Ordinary	3
—— 5 per cent. Debentures	5
Electric Construction, Limited	2
—— 7 per cent. Cumulative Pref.	2
Elmore's Copper Depositing	1
Elmore's Wire Company	1
W. T. Henley's Telegraph Works, Ordinary	10
—— 7 per cent. Preference	10
—— 4½ per cent. Debentures	100
House-to-House Company, Ordinary	5
—— 7 per cent. Preference	5
India Rubber and Gutta Percha Works	10
—— 4½ per cent. Debentures	100
Kensington and Knightsbridge Ordinary	5
—— 6 per cent. Pref.	5
London Electric Supply, Ordinary	5
Metropolitan Electric Supply, Limited, Ord. No. 101-50,000	10
—— " " " 50,001-82,500	10
—— 4½ per cent. First Mortgage Debenture Stock	100
National Telephone, Ordinary	5
—— 6 per cent. Cum. First Pref.	10
—— 6 per cent. Cum. Second Pref.	10
—— 5 per cent. Non. Cum. Third Pref., No. 1-119,234	5
—— " " " 119,235-250,000	4
—— 3½ per cent. Deb. Stock, Red.	100
Notting Hill Company	10
Oriental, Limited, £1 shares	1
—— £5 Shares	5
—— £4½ shares	4½
Oriental Telephone and Electric Company	1
Royal Electrical Company of Montreal	—
—— 4½ per cent. First Shares Mortgage Debentures	100
South London Electric Supply, Ordinary	2
St. James's and Pall Mall, Limited, Ordinary	5
—— 7 per cent. Pref.	5
—— 4 per cent. Deb. Stock, Red.	100
Telegraph Construction and Maintenance	12
—— 5 per cent. Bonds	100
Waterloo and City Railway, Ordinary	8
Westminster Electric Supply, Ordinary	5
Yorkshire House-to-House	5

NOTES.

lescriptor.—This ingenious instrument was on .e Friday night meeting of the Royal Institution

rine Cable to Cuba.—We gather from a aper that tenders for a direct cable from Spain vill most likely be advertised for early in the ionth. We trust that this proposed new con- tween Spain and Cuba will be more successful ther recent attempt at conciliation or annihiliation bans.

ical Education.—A technical institute is to be Stratford-on-Avon, and the money is forthcoming, the present a suitable site cannot be procured. of common land was selected, but the Local nt Board ruled that it was only held in trust by ration from the burgesses, and could not be used urpose in question.

ss Telegraphy.—A Mr. William Lynd is the urer on this subject, and his lecture delivered was on the so-called Marconi system. The escribed to his audience the details of this system, t had been proved that by the use of a vertical he point of transmission signals could be sent proportional to the length of the vertical wire periments with the apparatus were shown.

erved Honour.—We are glad to hear that n Hefner-Alteneck has been given an honorary by the University of Munich, on account of his to the theory of electricity and to the modern ent of electrotechnics. The new doctor is well the inventor of many improvements in the design uction of dynamos in the early days of electric He also invented the Hefner or amyl acetate lamp, now used in Germany, instead of the candle, in ry.

arine Telephony. — Our contemporary, the *Review* of New York—which, by the way, has n up long clothes—announces the fact that the boat the "Argonaut" has been connected to more Telephone Exchange under the number s the boat was at the bottom of the harbour we ng particularly novel in the fact. It is stated, that the wire on the boat is connected to a reel, it can be used at distances of several miles if . We are surprised to see that our contemporary on the fact that clear speech is possible under the s of trial.

ary.—Lord Sackville Arthur Cecil, half-brother Marquis of Salisbury, died on Saturday afternoon Holwood, Beckenham. His lordship was well both in the railway and telegraph worlds, having been assistant general manager of the Great Railway, and general manager of the Metropolitan Railway. At the time of his death he was n of the Exchange Telegraph Company, and of the Eastern Telegraph Company, the Brazilian ne Telegraph Company, the Globe Telegraph and ompany, and the Pacific and European Telegraph y.

ectric Organ.—A new organ was opened at the Mission Church at the Bute Docks, Cardiff, last hich is worked by an electric action. This organ is by the Hope-Jones Organ Company, the founder has devoted a large amount of skill to per- he electric control for organs. In this case the is placed some distance from the pipes which enables the organist to appreciate the combined effect of the music he is playing. The electromagnets used to control each individual pipe have been illustrated and described in a previous number of our paper. The work on these electromagnets, and on the pneumatic relay by which they open the pipe, is a good example of careful design and of the accurate reproduction of interchangeable parts in quantity.

Founders' Shares.—The St. James's and Pall Mall Electric Light Company are holding a special meeting on the 8th inst. to confirm a resolution for the redemption of the founders' shares. By the proposed arrangement, 120 fully-paid £5 ordinary shares will be given to each holder of a £1 founders' share. As the present value of the ordinary shares in this company stand at £19, this is equivalent to the handsome sum of £2,280, or, at the present rate of dividend, an annual income of £87. As the dividend per founders' share for last year reached £75. 10s. 4d., and under the articles of association these shares are entitled to half the surplus profit after 7 per cent. has been paid to the other shareholders, the above terms of redemption are fair ones to the ordinary shareholders. It is, however, a very large unearned increment, and the general shareholders have thus paid heavily for the promotion of the company.

Electro-Deposition.—We are asked to announce that a special course of lectures and laboratory instruction has been arranged by the City and Guilds of London Institute at the Finsbury College, Leonard-street. Prof. Silvanus P. Thompson, F.R.S., will deliver two lectures during the course on the allied electrical matters. The laboratory instruction is under the direction of Mr. E. Rousseau. The course of instruction covers the modern processes of electrotyping, electroplating with silver, steel-facing, nickel-plating, cobalt-plating, coppering, and electro-brassing, etc. Students are also taught how to make moulds, also to manage the baths, and the regulation and measurement of the current, etc. Students entering for this course will receive individual instruction during 10 Wednesday evenings, commencing Wednesday, Feb. 2, 1898, at seven o'clock. The fee for the course is 10s., but apprentices under 20 years of age are admitted at half the ordinary fee.

Motors and Arc Lamps on Hire.—The Bradford day load from motors is rapidly on the increase, and the facilities given for the hire of motors from the Corporation will still further assist to this end. We note, from the circular now sent us by Mr. Alfred H. Gibbings, the annual rent includes the supplying and fixing of the motor and the necessary starting switch, and also a fortnightly inspection by a member of the electrical staff. The consumer has to provide all oil, brushes, etc., which must be obtained from the Corporation stores. The wiring is also done by the consumers. The rent varies from 30s per annum for a ½-b.h.p. motor up to £25 per annum for a 6-b.h.p. motor. The charge for current is 2½d. per unit. Mr. Gibbings has also arranged to let out arc lamps at annual charges varying from 10s. 6d. to £1. 1s., double-carbon and enclosed arc lamps commanding the higher figure. The charge for current to these lamps is 5d. per unit.

Sparking at the Commutator.—Mr. Thorburn Reid's paper on this subject does not contain any new ideas, but is a concise and clear statement of previous knowledge. He describes minutely the action of the coils undergoing commutation, and considers that there are two steps tending to sparkless commutation. The first is the increasing of the brush contact resistance, and the second the decreasing the impedance of the coil under commutation. In fact, the author holds that perfect commutation can only be practically secured by making the impedance

of the coil negligible as compared with the contact resistance. We think that the author has not given sufficient attention to the question of the reversing field. If the armature reaction is large and the magnets fairly weak, no proportioning of the impedance of the turns in one segment or of the brush contact resistance will give sparkless collection. No figures or constants are given in the paper.

Highwaymen.—The *Street Railway Review* states that at 10 p.m. on Dec. 26, a trolley car on the lines of the Schuylkill Valley Traction Company was held up by four highwaymen near Swedeland. The conductor was shot and killed on refusing to surrender his money, but four women who were passengers were not molested. In the same issue we are informed that a hat-pin as a very dangerous and effective weapon was demonstrated by a Chicago miss, who rendered valiant service to a cable car conductor in fighting two highwaymen. The conductor was receiving a fare from a young lady, when his arms were pinned to his side by one robber, and the other began to rifle his pockets. The conductor struggled bravely, but was being overcome, when the young lady pulled a long and pointed pin from her hat and began to prod the legs of the robbers. This proved more than they could stand, and they took to flight. Woman-like, the girl fainted when the danger was past.

All-British Cable.—The Direct West India Cable Company announce that their cables from Bermuda to Turks Island and Turks Island to Jamaica are open for traffic, and that therefore messages for these islands can now be accepted for transmission at the rate of 3s. a word. They point out that theirs is the only "direct" and all-British cable route to Jamaica and other West India islands (the other alternative routes being *viâ* the United States and Cuba or the unsettled Central American States), that it is new, and therefore of the latest construction, and that to ensure all messages going over this cable they should be marked "*viâ* Bermuda." The company desires to emphasise that they are determined to make the service popular by assuring speed, accuracy, secrecy, and general reliability, and by according every consideration to customers, by which means they hope to maintain the cheap rates to the West Indies and British Guiana, for the purpose of which the company was incorporated.

Electric Lighting in Ceylon.—The following details of an offer from Messrs. Boustead Bros., accepted by the Municipal Council of Colombo, are taken from *Indian Engineering*. The company agrees to replace 548 present gas lamps in the streets by 548 incandescent electric lamps of 60 c.p. each, and to erect suitable lamp-posts, lamp-holders, and shades or reflectors, with the necessary overhead mains and feeders for supplying the same, at a cost to the Municipality of Rs.25,000 (about £1,600). The company undertake to supply current to the above lamps at the rate of 200 hours per month, including lamp renewals, maintenance, attendance, and repairs, for the sum of Rs.30,000 per annum. This works out at about 2·3d. per Board of Trade unit. The contract for public lighting is to extend over five years. Private consumers will be charged at the rate of 50 cents per Board of Trade unit, which is equivalent to about 7¾d. The above terms seem reasonable, but we think that the concession is a limited one, as another company actually established electricity works in Colombo some two years ago.

Dust Destructors.—The heat-producing properties of household refuse has always been a vexed question, and there has been some uncertainty as to how much credence should be given to published results of trials in calculating the average power available. We know of several such published results where, as a factor of safety, dividing by
3 does not give too high a result. During
week the Leyton destructor has been brought pr
before the public. In this case the house refu
to burn sewage sludge. The sludge is pressed a
the furnace in the ratio of one ton of sludge
refuse. These proportions are obtained from
working. We are informed that abundance of s
is available after the necessary steam for provid
draught has been used, and the local authorit
to use it for electric lighting purposes. If th
can regularly evaporate the moisture of the sew
they do well and serve a useful purpose, but we
quantity of spare power. The clinkers and ashe
furnaces are said to fetch 6d. and 1s. 6d. per
tively, and with this asset the authority should b

Electricity in Agriculture.—Milton Whi
of the Division of Soils of the Department of A
in his annual report to the secretary, says, accor
Scientific American: "The electrical method of
determination has been still further perfected.
stations have been equipped with electrical instr
various parts of the country, and in several impor
of soil. Records have been kept at these st
periods varying from two to four months, and it
found that the method can be used by anyone wit
care. As a result of these field records, I feel
satisfied with the operations of the method, an
satisfied that it will prove of great value in soil
tions, as well as of practical and commercial va
great value of the method is that the electrode
manently buried in the field at any depth desire
field can be cultivated or cropped as usual. The
resistance between the electrodes is read from a
this resistance varies according to the square of
contents. By once thoroughly standardising the
and by the use of tables furnished by the di
moisture contents of the soil can be determin
time from the electrical resistance of the soil."

Examinations.—We notice in the *Stree*
Review that at St. Louis the general manager of t
street railway recently submitted all the drivers
ductors to a written examination. Prizes var
£5 to £2 were given to the best set of answer
class. The tramway men on that side of the Atl
have plenty of spare time, as 50 questions were
conductors and 50 for the drivers. Certainly,
them could be answered by "yes" or "no," othe
period of examination would have to be extended
12 hours. The conductors are asked such pertinent
as "During any difficulty or altercation with a
what should you strive to do?" And, again, "
ever been reported or reprimanded for unge
conduct?" We suppose full marks would in the
be given to the man who "got his blow in first,"
the negatives to the last would not be few. Th
questions are pertinent, and are apparently to be
certain instructions given. The idea of holding the
tion seems a good one, but we should be sorry to
competition with previous coaching. Thus we do
the answer to the following: "In running thro
to what advantage should motors be operated?"

Overhead Wires.—The telegrams from Ame
that while the overhead wires may be cheaper than
now and again they bring about troubles that are
overcome. We give the *Times* telegram, dated Feb
in full as follows: "A snowstorm approaching in se
memorable blizzard of March 12, 1888, swept
York State and the New England States yesterda
ways and railways were blocked, and many trai

dded in the snow and had to be abandoned. The was especially severe in and about Boston, which city completely cut off from communication from midnight night until noon to-day. A telephone message was received at Worcester stating that Boston is completely aded. Only two or three street cars are running in hington-street, and railway traffic to and from the city ctically suspended. Over 200 horses have been killed lling trolley wires, and the carcases are lying in the ts. The trains which left Boston yesterday evening all brought to a standstill after getting a short way of the city. All the streets, except Washington-street Tremont-street, which have been partially cleared, are usable for pedestrians." It is gratifying to find that an life has not been sacrificed, but a holocaust of over horses is a large price to pay, in addition to the cost pair.

-operation in Engineering Societies.—A joint ting of the Chesterfield and Midland Counties Institu- of Engineers and the Midland Institute of Mining, l, and Mechanical Engineers has been arranged, and be held at Sheffield on Saturday next, Feb. 5. The ting will be held at 2.30 p.m. in the large room of the rary and Philosophical Society in Leopold-street. After usual formal business, the following papers will be read aken as read: "Explosions in Air Compressors and ivers," by Mr. T. G. Lees; "The Pneumatophor and alue for saving life after Colliery Explosions," by Mr. remer; "Notes on the Change in Character of the sley Seam between Rotherham and Pontefract," by Mr. k John Durnford. The following papers, which have ared in the *Transactions* of the Federated Institution, also be open for discussion: "Latest Developments the Practical Application of Alternating Multiphase hinery for Electric Power Transmission," by Mr. W. n; "The Workmen's Compensation Act, 1897," by Mr. R. Wain; "Adequate Ventilation and Noxious Gases, special reference to the Recommendations of the ish, French, Prussian, and Austrian Firedamp Commis- s," by Mr. E. W. Thirkell; "On Some Dangers attending Use of Steam-Pipes," by Mr. A. L. Steavenson; and the s of Steel Girders and Props in Coal Mines," by Mr. . Melley.

lectro-Chemical Equivalent of Carbon.—This ract gives the conclusions of a paper by A. Coehn. n carbon is employed as the anode in the electrolysis quids which evolve oxygen, it is not only mechanically tegrated but also chemically acted on, the nature of latter action appearing to depend on the electrolyte loyed. For example, a current of 0·12 ampere is ed through six cells furnished with anodes of pure on and cathodes of platinum, and containing sulphuric diluted with 1, 10, 20, 50, 100, and 500 volumes of r; after 10 hours the most concentrated solution is rless, the most dilute dark brown, and the others of inter- iate shades of colour. At higher temperatures there is less hanical disintegration, and the electrolyte is more strongly ured than at lower temperatures. The mechanical disinte- tion is inconsiderable at 100deg. in a solution contain- equal volumes of water and concentrated sulphuric acid. etermination of the loss of weight of a carefully purified on anode under these circumstances gave the number s the electrochemical equivalent of carbon, but some hanical loss had occurred. A further series of determi- ns were made at the ordinary temperature with uric acid diluted with from 10 to 500 times its volume ater, the particles of carbon lost mechanically being cted and their weight subtracted from the total loss of of the anodes. The electrochemical equivalent thus determined varied from 2·7 to 3·0. The number obtained is thus independent of the concentration or temperature of the acid, notwithstanding the apparent difference in the action.

The Tramway Question.—The Nottingham Corporation have sent a deputation to Edinburgh to see the cable trams there, with a view to ascertaining what is the best system of mechanical traction for Nottingham. The Lord Provost received the deputation, and reiterated the old argument that in Edinburgh they had a city which would have much of its beauty spoiled with electrical overhead wires, and they therefore came to the conclusion that that system was not to be thought of. They had been very greatly pleased with the two cable routes they had in operation for a number of years, and within the course of the next few months they hoped to have the cable system completed from Leith out to the confines of the city. Alderman Brownsword, in responding, thanked the Lord Provost, Magistrates, and Council for their hospitable reception. He said they had purchased their tramway system in Nottingham, and both the Council and the shareholders thought they had made a good bargain, so they were mutually satisfied. They were now looking round for some system of mechanical haulage, and they had taken the liberty of coming to Edinburgh to ask advice and obtain information as to what was the best kind of traction they could adopt. Many of them came with the feeling that electrical traction was the best, but what they had seen that day would give them the option of choosing the one or the other, and they would go home knowing a great deal more about cable traction than when they came north. We trust that electricity will hold its own in Nottingham, and that street lighting by arc lamps will be introduced at the same time.

Edison.—We have hardly ever read a letter that has given us more genuine pleasure than the one of Edison's given below, in which he gives a point-blank denial to half the absurd tales that have been reported and put upon his shoulders by the reporters: "I wish to protest against the many articles appearing in the sensational papers of New York from time to time purporting to be interviews with me about wonderful inventions and discoveries made or to be made by myself. Scarcely a single one is authentic, and the statements purporting to be made by me are the inventions of the reporter—the public are led from these articles to draw conclusions just the opposite of the facts. I have never made it a practice to work on any line not purely practical and useful, and I especially desire it to be known, if you will permit me, that I have nothing to do with an article advertised to appear in one of the papers about Mars.—THOMAS A. EDISON.' We have had occasion again and again to point out the inherent absurdity of the tales told, and trust this authoritative denial will in the future prevent our English papers receiving telegrams or reprinting paragraphs which contain utterly foolish and ridiculous statements. It is almost a surprise that the paste-and-scissors papers of to-day have not gone mad about the ideas contained in the book by a writer for boys entitled, if our memory serves us, "A City of Gold." The electrical notions in "The Yankee at the Court of King Arthur" and those in the book just referred to are pretty reading, but hardly possess scientific accuracy. Of course we never know what to-morrow will bring forth in things electrical; and as an inventor claims to have invented an electrical gun that will shoot voltages by means of the directive power of searchlight rays, it is better to say, Wait for the verification of these strange proceedings rather than to cry "Impossible."

An Electric Lift with Hydraulic Brake.—Mr. F. Hérard has contributed to *L'Electricien* an article on an

electric lift fitted with a hydraulic brake designed by Messrs. Guyenet and De Mocomble. The article commences with a few moral remarks on the defects of other electric lifts, to prove that safety has been sacrificed to economy in working, and concludes by a comparison to show that the lift described is both more efficient and safe than any other ever devised or worked. We miss, however, any statement as to where the lift in question is at work, and note that the figures of cost are paper figures only. Coming to the mechanism devised by Messrs. Guyenet and De Mocomble, it contains practically all the parts required for both an electric and hydraulic lift. The electric part consists of a winch driven by an electric motor which is connected by a rope to the underside of the counterweight of the lift. The lift has underneath it all the usual mechanism required for an hydraulic lift. This consists of a single piston and cylinder with a travel equal to that required of the lift. The water is supplied to this piston from a tank placed in the basement of the buildings, at a sufficient height to give a small pressure always on the underside of the piston. In between the cylinder and reservoir is a stopcock, which is controlled from the lift, and which is used as the stopping and starting gear. The levers working the rheostat of the motor are also connected to the rod used to turn this stopcock. An oil dash-pot in between the controlling rod and these levers prevents the current being put on too rapidly. General details of the electric gear are given, and it is incidentally mentioned that the armature is short-circuited to produce a braking effect when desired. How this is done by the starting lever moving backwards it is not easy to see, but perhaps some special ratchet gear is employed. Where we have most fault to find with the author is in his calculation of the power required. He assumes at once that perfect balance is obtained by the counterweight, and adds nothing whatever for the friction in the hydraulic gear. Thus he assumes that the weight of three persons is all that has to be moved, and from that, plus a certain amount of loss in the electrically-driven winch, he obtains the energy required to lift a certain distance, and at a certain speed. This he compares with figures actually obtained from other hydraulic and electric lifts, and of course finds a wonderful balance in favour of his paper figures. We should say, from the drawing given, that his figures multiplied by 3 would be more nearly the practical results of the so-called improvement.

The Embankment Lighting.—The Highways Committee of the London County Council reported, with reference to the electric lighting of the Embankment and Westminster Bridge, at Tuesday's meeting of the Council that they have thoroughly revised their previous scheme. When in July last they reported their proposals included Waterloo Bridge, but on the same day the Bridges Committee brought up a report stating that the Charing Cross and Strand Electricity Supply Corporation had asked permission to lay its mains across Waterloo Bridge, and the Council acceded to the request "provided that the corporation do supply light to the lamps of the bridge and maintain them free of cost." That part of their scheme which related to Waterloo Bridge being thus rendered unnecessary, the Council postponed its consideration. In compliance with the instructions of the Council they had thoroughly revised the scheme, and, of course, in view of the arrangement above referred to they had not made any provision for the lighting of Waterloo Bridge by means of the proposed installation. They had, however, in the revised scheme, in deference to the wish of the Council, made provision for the electric lighting of the parapet lamps of the Embankment, for which no provision was made in the scheme previously submitted. Thus the saving effected by the elimination from the scheme of provision for th lighting of Waterloo Bridge would be more than counte balanced by the addition of provision for the parap lamps of the Embankment. They now propose that 14 arc lamps should be provided. The lamps on each side o the carriageway of the Embankment would be abou 240ft. from each other, those on the parapet wall abo 66ft. apart, while those on Westminster Bridge an Northumberland-avenue approach would be placed at co venient distances. It was proposed that the whole of th parapet lamps and the alternate lamps on each kerb of th Embankment, and also some of the lamps on Westminste Bridge, should be extinguished at midnight, thus decreasin to an appreciable extent the cost of maintenance. Th parapet gas-lights now in use were extinguished at mid night, so that no departure from the present practice wa proposed. The capital expenditure for the installatio would probably be about £25,300, and would consist of th following items: buildings, £6,900; boilers and machinery £9,600; mains, £4,200; lamps, standards, etc., £4,300 salaries, £300. The probable annual cost of maintenanc would be £3,509, made up as follows: maintenanc £2,387; rates and taxes, £110; and capital charge £1,012. The amount of the capital charges is calculate on the repayment of capital cost being spread over a perio of 42 years.

The Solar Eclipse.—A series of consecutive photo graphs of the recent total eclipse of the sun, suitable fo reproduction by the various living-picture apparatus, hav been taken by the Rev. J. M. Baron, F.R.A.S. Thi gentleman had charge of the observing station at Benares and used an instrument specially designed for the purpos by Mr. Nevil Maskelyne, of the world-known firm c entertainers at the Egyptian Hall. Mr. Maskelyne say that the experiment has proved eminently successful. Th film will be sent here forthwith for development, and th results ought to be both interesting and valuable from scientific point of view. The instrument is a combination c telescope and cinematograph. Owing to the shortness of th duration of the phenomenon to be observed, it was foun unnecessary to use clockwork to drive the mechanism. Th eclipse lasted 100 seconds, and as the film travelled at speed which permitted from 400 to 600 pictures to be take during this time, the effect of the apparent movement o the sun was minimised to an imperceptible degree. Th film travels over three sprocket wheels, the top and botto ones of which are continuous feeding, while the middle on feeds intermittently. The film passes an aperture wi radial slots alternately opening and closing, and eve time the aperture is closed the film moves a space forwar The image taken gives a diameter of ¼in. of the disc of t sun, and with the corona included the picture is 1in. by ¾ Each plate measures 1in. from top to bottom and 1¼in. fro side to side. In the centre of the apparatus, in a dire vertical line with the focussing glass, is a reflecting pris which can be reversed, thus throwing the image upon ground glass, and so enabling the operator to watch what going on inside. In order not to admit too much light, a also to prevent the heat of the rays of the sun duri partial eclipse from damaging the film, it was necessa to shield it. This has been achieved by a very simp method suggested by Prof. Maunder, of Greenwich. hole was pierced in the cap of the telescope, and t was provided with an additional cap. The telescope wa directed at the sun, the small cap only being removed, an the large cap was left on until the period of the tota eclipse. The settlement of dew on the lense, owing t the sudden drop in the temperature of the air, had t be provided for. Mr. Maskelyne devised an arrangemen

; of an indiarubber tube, which was inserted near , while its other end protruded into a glass jar ı glass wool saturated with sulphuric acid. By an indiarubber syringe dry air was injected into ope. If the photos come out as well as those present at the Egyptian Hall, where we gathered e information, they should prove more than a ttraction for our astronomers.

ial Light Railways.—Mr. E. R. Calthrop, been expounding to the members of the Royal Institute the value of light railways in colonies, underlying principles that should guide their con- . The importance of railways is hardly realised; s not so, then many speculators would preferably n railway shares than on mines. The one must , the other may sometimes, warrant speculation. ate enterprise take up the Suakin-Berber railway? ng run it would pay. Is Cairo holding out a hand ayo and Buluwayo to Cairo—that is, shall we rans-African railway scheme complete? Without further into the matter we may now give Mr. 's view. "Let us take," he says, "the theoretical the construction of a railway in a new country ll the traffic is brought down to a port and ven quantity per mile, and therefore propor- o the length built of the railway. Take a m of capital, say £600,000; what lengths ay can be built for this? At £3,000 per ı will get 200 miles; at £6,000, 100 miles; at nly 66·6 miles. As you increase your length you your traffic area. Take it that each mile produces r high figure of 600 tons per annum. The line £9,000 per mile brings to the port a traffic of tons per annum; that costing £6,000 per mile 60,000 tons; and the line costing £3,000 per mile 120,000 tons per annum. The ton mileage carried these theoretical conditions illustrates still more the value of increasing the length of a railway and ng to its traffic catchment area. The ton-miles— the number of tons carried one mile—are respec- for each length of railway 1,350,000, 3,030,000, and ,000 ton-miles. It is necessary to remember that ffic to be carried in any district through which a y is about to be constructed is the same per mile of whether you put down an expensive broad-gauge line heap narrow gauge. You must clearly understand, , that if you select an expensive type of y to open up undeveloped country you must be ed to accept, permanently, rail charges very con- bly higher, and as a consequence the slower develop- of the country and its resources. Let us assume Her Majesty's principal Secretary of State for the is prepared, with the object of raising capital on cheapest terms, to offer an Imperial guarantee of, say, per cent. on a fixed capital sum of £600,000. If the y is to be self-supporting, it is obvious that while ,000 per mile line has to pay working expenses, be ained, and pay the guaranteed interest amounting to yearly out of a traffic of 39,960 tons brought to port, the £3,000 per mile line trebles the security on of its 120,000 tons of traffic. It is not the capital ed on a railway which constitutes security, but amount of its traffic in relation to capital cost. The contributed per ton to the guaranteed interest of in the case of the £9,000 per mile line is 9s. 9d., to 3·47d. per ton-mile; in the second case to equal to 1·54d. per ton-mile; and in the case of line to only 3s. 3d., equal to ·39d. per ton-mile. the longer the length of line you get for your money, the poorer the character of country you can enter upon and still obtain profitable results. If it be possible to halve the estimated cost per mile of any projected line, you will get either twice the traffic area for the same money, or, if the line be restricted to the same length, the profits which it may earn will be, per cent. of capital cost, twice that of a line of double the cost, and consequently the prospects of a financial success are made much more certain. What is wanted for Colonial development is cheap railway communication and plenty of it; and if with a proper traffic capacity you can get two lines for the cost of one making a good return on their capital, I think you will agree that railway construction and extension will be much more rapid in the future than it has been in the past."

Polyphase Motors.—Mr. Paul Boucherot recently read a paper before the Société Internationale des Electriciens on the properties of polyphase motors with short-circuited armatures, with particular regard to their starting against a load. It is well known that the curve representing the torque of such a motor at different speeds take very different shapes with different resistances in the armature circuit. If this resistance is small the starting torque is also small, although the current taken is very large. The torque then increases with the speed up to a maximum, and fall to zero again at the synchronous speed. The author proceeds to argue that if the resistance of the armature circuit is sufficiently great, it is possible to get the torque varying inversely as the speed, which he considers to be a condition required for industrial purposes. Such a motor would, however, have a large percentage of slip at normal speeds. He proposes to get over this disadvantage by having two windings on the armature, one of low and one of high resistance. Then the sum of the two curves of torque would be a curve still decreasing with increase of speed, but at a much smaller angle, and the slip at normal speed would be smaller. The armatures of such motors can be designed with two concentric series of holes. The external holes contain the high-resistance squirrel cage, and the interior holes the low-resistance squirrel cage. The inner and outer holes are connected by a groove tending to keep down the self-induction of the circuits. In starting, the author claims that the outer cage only acts, and he states that the low resistance of the inner one chokes back all lines of force tending to cross it. The high speed of the revolving field tends to assist this action. On the other hand, at full speed the low-resistance cage does practically all the work. The author says that the only inconvenience of this motor is a low power factor. This comes out at 0·7, but he adds that this is not so important as is thought by some. Another type of motor for the same end consists of having two armatures and two field-magnet systems. These last are so arranged that one can be displaced radially round the axis. With motors constructed on the above principle by Messrs. Brequet, a starting torque of 2 to 2½ the normal is obtained, with a current only the same proportion bigger than the normal. This is not anything especially good, as better results have been obtained by German manufacturers. In the first place, the reasoning is faulty, as the ordinary low-resistance armature does give a torque decreasing with the speed after the maximum has been passed. As the motors are necessarily worked above this maximum, no alteration is required, and the added resistance causes the speed to vary greatly with change of load. It also means loss of efficiency. Better results can be obtained by differential coupling of the armature circuit at starting, as devised by Mr. Görges and others.

THE GLASGOW DISTRICT SUBWAY.

(Continued from page 103.)

The Main Switchboard and Switchboard Connections.

The main cables on leaving the dynamos pass below the floor-level in wrought-iron pipes to the back of the main switchboard. The main switchboard consists of three enamelled slate panels, each 5ft. 6in. high, and the two outside ones being 3ft. 1in. broad and the middle one 3ft. 10in. broad; these three panels are securely bolted to an iron frame, the whole being mounted on a pitch-pine screen, with panelled bottom and heavily moulded top. The general arrangement of the supporting frame will be seen from the general arrangement (Fig. 1), and the appearance of the board and pine screen from the photo-

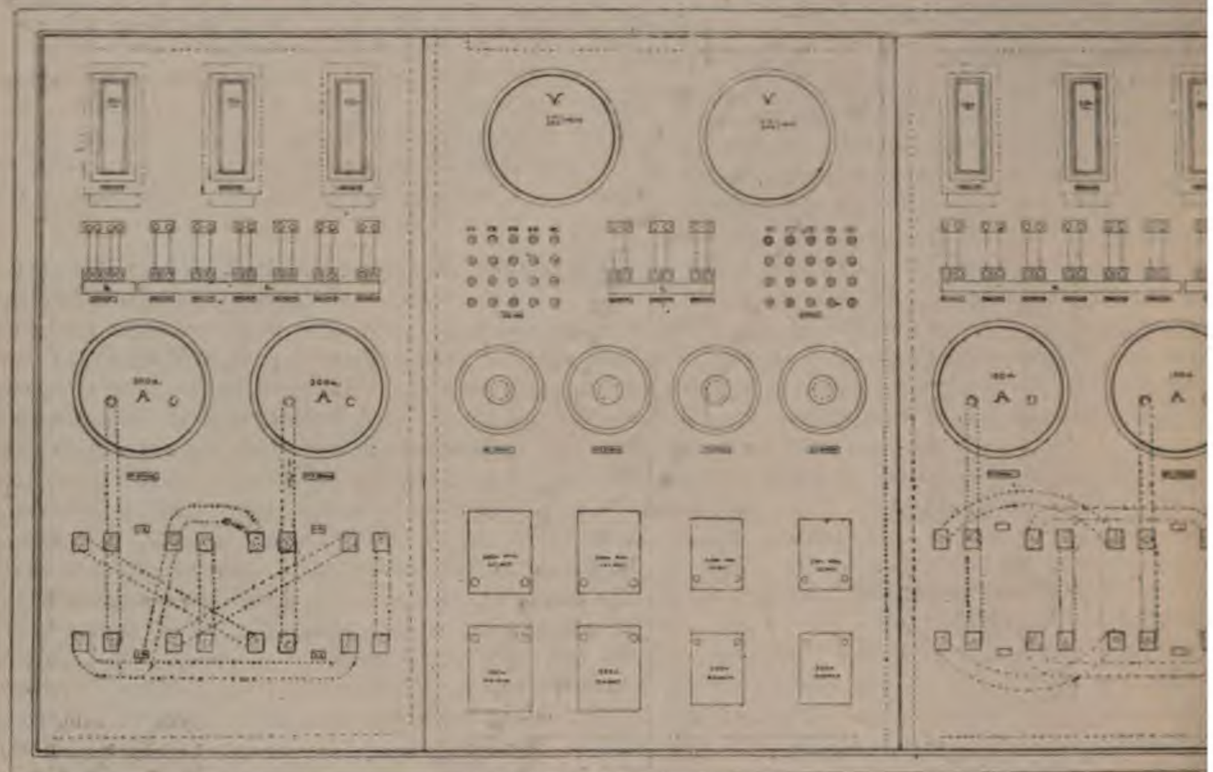


FIG. 1.—Front Elevation of Switchboard.

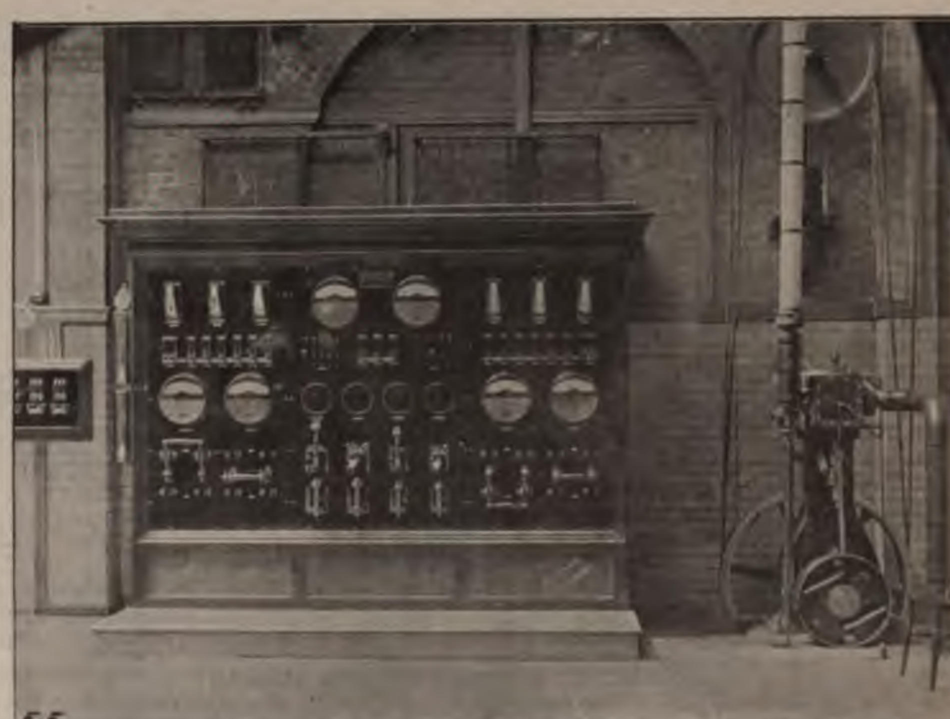


FIG. 2.—General View of Switchboard used in Glasgow District Subway Electric Lighting Station.

graph (Fig. 2). The screen stands some 24in. out from the wall of the engine-room, so that an is afforded at the back for making the necessa tions, and also for mounting the shunt regulating in a safe and convenient place.

The cables run first to maximum and minimum of Mr. Napier Prentice's well-known make, the being on one pole and the minimum being on pole. These eight cut-outs are on the middle pa bottom, they being almost the only heavy-current carried by this panel. The rest of the panel is tak the shunt regulating switches, and the voltmeter switches, and also the main fuses on the middle wire of the three-wire system.

The main circuits, after passing through the cut-outs, pass to the main double-pole throw-ove two of which are arranged on either of the two

rd, the negative conductor passing through an n each case, which are placed immediately above ective dynamo switches, the two right-hand being graded to 150 amperes, and the two left- to 300 amperes each. The change-over switches os No. 1 and No. 2, which are for the low-tension and are on the left-hand side of the board, are so hat either machine can be put on either side of wire system. Thus, in the photograph, dynamo shown switched on to the negative side of the re, and if the switch of dynamo No. 2 had been e position it would have been on the + side of l wire, and, of course, either switch being thrown

a strip contact piece, the detached portion of each being for the elevator circuit. The main portions of these bars carry circuits for the following circuits—viz. (1) power station arc lamps on 440-volt circuit, (2) power station incandescent circuit, (3) power station feeder, (4) car shed feeder, (5) Hillhead feeder, (6) Buchanan-street feeder; while the neutral 'bus bar only has three circuits—viz. (1) power station lights, (2) power station feeder, (3) Hillhead feeder.

The fuse terminals are arranged so that a plug connects them direct on to the 'bus bars, and they are all arranged in duplicate, so that in the event of fuse blowing a spare one can be immediately plugged in.

On each of the feeders running to the four feeding

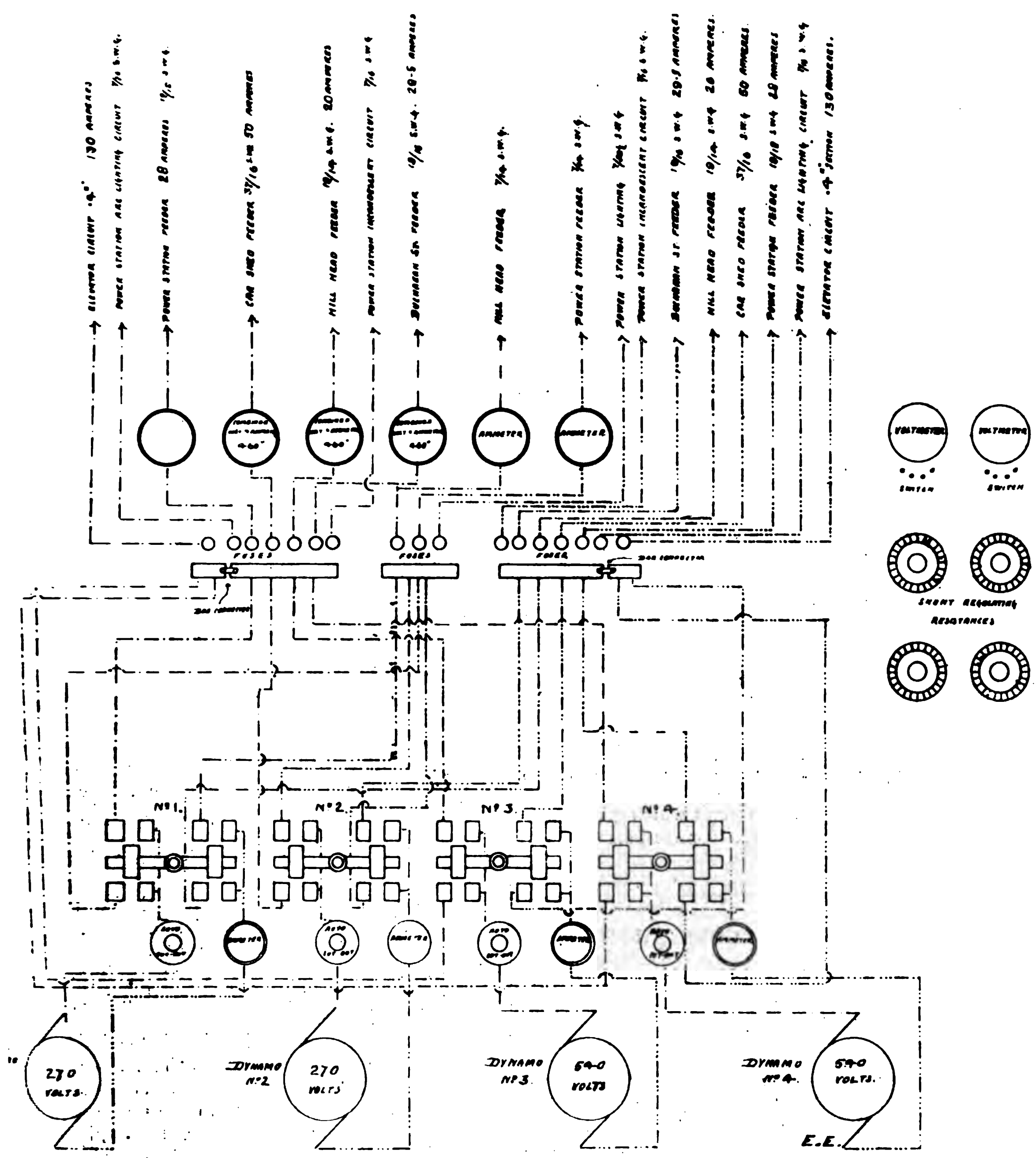


FIG. 4.—Diagram of Switchboard Connections.

the opposite contacts would have put that machine other side of the neutral wire. The other two over switches are arranged in a similar manner as the changing over, but in this case they change from the two outside cables of the three-wire system elevator circuit, which is a two-wire high-tension ly. As will be seen from the photograph, these are very strongly made, no current passing through it, and the two poles well removed from one another. 'bus bars are placed on a line along the top he three panels, the left and right hand panels ectively the negative and positive 'bus bars, the having the neutral bar. The positive and each consist of two parts bolted together with

points—viz., car shed, Hillhead, Buchanan-street, and the power station—are arranged special combination volt and ammeter, which shows, by means of two pointers on the same scale, both the current in the feeder and the voltage at the power station end of the feeder. The scale is marked off in amperes, and the pressure half of the instrument is so adjusted that when its needle is pointing to the same reading on the scale as the current indicator, the voltage at the station end of the feeder is the correct amount above the normal to give the normal voltage at the other end of the feeders. The arrangement of the instrument is very simple, and will readily be understood from the sketch (Fig. 3). The current and pressure portions of the instrument are precisely similar, but are totally

distinct from one another, the two needles showing one on either side of a vertical scale.

The car shed and Buchanan-street being fed on the two outside wires only have only one of these instruments each, while the other two feeding points being fed on the three wires have two instruments each, one on either side of the neutral wire.

There are two large-scale voltmeters mounted at the top of the centre panel, and under them there is a series of plug holes. The voltmeters are so arranged as to read round about 270 with an open scale, and by means of a resistance that can be put in circuit with the instrument, and which is equal to the resistance of the instrument, readings can be taken from the high-tension circuits, the readings of the voltmeter of course being doubled. One is connected up so that by means of a four-pronged plug it can be connected across any of the 'bus bars, and the other is arranged so that in a similar manner it can be connected across any of the machine terminals. On the side

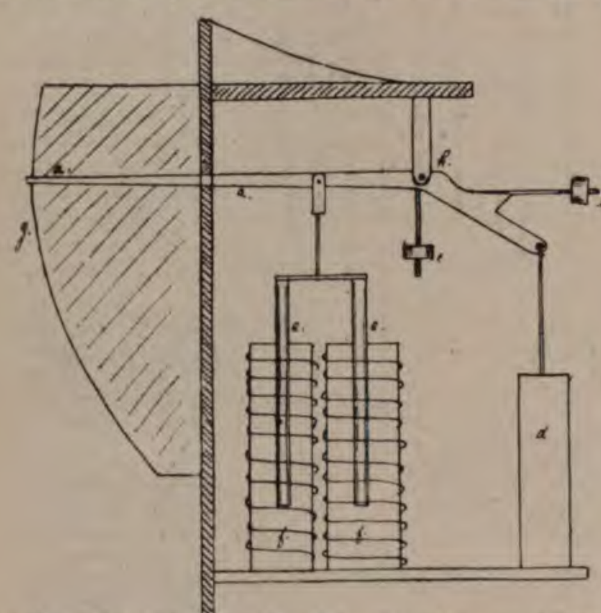


FIG. 3.—Sketch of Feeder Ammeter and Voltmeter. *a a*, light needle pivoted at *h*, and free to swing about that point; *b* and *c*, adjusting weight, to bring needle to zero; *d*, oil dash pot to steady movement of needle; *e e*, soft iron cores; *f f*, high-resistance solenoid; *g*, scale on face. N.B.—In the case of the current indicator, there is only one soft iron core and solenoid.

of the pitch-pine screen, and just visible on the photograph, are two of Lord Kelvin's recording voltmeters, which can be connected up to any machine or circuit which gives cause of complaint. The diagram of the connections on the switchboard is shown in Fig. 4.

NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

[*Copyright.*]

LXXI.

The first step necessary in the manufacture of a peroxide plate from any oxide of lead is to produce a "setting" of the material, so as to obtain a mass that will not disintegrate or fall into a kind of mud when it is immersed in water or dilute sulphuric acid. In the case of the pure peroxide of lead it has hitherto been impossible to produce this "setting," otherwise the peroxide might, no doubt, be advantageously employed in the "pasting" of grids or the manufacture of plates of conductive peroxide. The setting or hardening process was, as we have seen, first effected by Prof. Frankland by the action of sulphuric acid upon a mass of protoxide or sesquioxide of lead, an action which is efficacious because, instead of being sudden and violent, as was commonly supposed even by chemists, it is in reality slow and gradual (XLIII.). It should be observed, however, that litharge frequently contains a large proportion of carbonate of lead, produced by absorption of carbonic acid from the air; in this case the first action of sulphuric acid is sudden and violent, and the material obviously cannot commence to set or harden until the eff[ect] ceases and the carbonic acid is expelled. Suc[h] or carbonated oxide of lead should not [be used] for the manufacture of battery plates; the[y] should be "caustic," or freshly "burnt." The ca[rbonate is] readily decomposed and converted into protoxid[e] red lead in presence of air) at a temperature belo[w] An observation of Mr. C. Capito, who has [had] experience in the pasting of plates of the E.[P.S.] should also be noted here. He found that a pa[ste of] lead mixed with dilute sulphuric acid of speci[fic gravity] 1·100, gave an adherent deposit on formation, [a] powdery deposit is produced if the density of [the acid] used in making the red-lead paste is 1·200. [The] acid answered well, however, for mixing the lith[arge] used for the spongy-lead plates.

The chemical action which results in the con[version of] some portion of the oxide of lead into sulphate is gradual in the lithanode process described in [a previous] section, and the product is more homogeneous [and less] liable to superficial disintegration.

The next important requirement in the ma[nufacture] from oxide of lead of a perfect peroxide plate of [...] is to allow the set material to expand freely, an[d] obtain its normal and final molecular structur[e] electrolytic process of conversion into peroxide of [...] the material cannot expand it will become cru[...] liable to disintegration under the effect of the [...] force resulting from its oxidation. And if the m[aterial] expand only by overcoming the rigidity of a me[tal re]taining frame, the latter will usually become defo[rmed or] warped by the effect of the expansion. The subsequent contraction of the active material, [...] effect of its drying, will then obviously occasion [bad] contact between the active material and its enclos[ure] of metal. Thus, referring to the E.P.S. plates [manufac]tured at Millwall, Prof. Ayrton and Messrs. C. [...] and E. W. Smith, in their paper, entitled "Not[es on the] Chemistry of Secondary Cells,"* made the [following] observation: "The reason, we understand, for t[he manu]facturers only forming the positive plates for 18 h[ours] leaving the purchaser to form them for the rem[aining] hours, is that if the positive plates be *well formed* [and] dried for carriage, the plugs become loose, wh[ich is not] the case if the positive plates be only slightl[y formed] before drying."

The above considerations sufficiently indicate [the desir]ability, when a support or conductor of the m[aterial in] *grid* or alveolar structure is adopted, of casting [it of an alloy] fusible at a low temperature, around plates or [...] fully-formed peroxide active material, or lithano[de of good] conductivity. When this plan is adopted, the b[...] the support, and the defective contact, arising [from the] expansion of the active material in the p[rocess of] "forming," are effectively obviated. But, in vi[ew of the] decomposition of peroxide of lead at temperatu[res above] 440deg. F., the fusing point of the casting alloy [must be] much lower than that of the metal usually em[ployed in] the casting of grids.

Another important point is that of dimini[shing the] density of the active material at the surface of th[e] enclosed mass. This was originally effected by [...] crystals of magnesic sulphate in the surface of the [...] plates. It was found, however, that this salt, [...] ammonic sulphate, is decomposed by oxide of [lead with] production of sulphate of this metal and of small [particles of] magnesia corresponding in form and size to th[e crystals] used. These particles of magnesia were by [no means] readily dissolved out, and were the cause of [...] trouble in the form of efflorescence and "creep[ing," from] which a lead accumulator should be quite free. [At a] later period, the use of small crystals of the deca[hydrated] sulphate of soda ($Na_2SO_4,10H_2O$) was suggested [by] Mr. N. Story Maskelyne, F.R.S. The readiness w[ith which] this salt parts with a portion of its water of crys[tallisation] was, however, an objection to its use. I have f[ound that] the anhydrous sulphate of potash (K_2SO_4) is pref[erable for] the purpose in view.

* *Journal* of the Institution of Electrical Engineer[s], No. 90, p. 682.

LXXII.

›cond lithanode patent, No. 16,608, 1886, was due ›servation that when protoxide of lead is mixed in ›roportions with pure sulphate of lead, and is made aste with water, the mixture commences to "set" few minutes, to form a dense and hard mass, which disintegrate when immersed in a fluid. The follow- culars are quoted from the final specification of ntion:

invention consists in the production of dense yet oherent and self-supporting plates or masses, wholly t wholly convertible into peroxide of lead, by mixing le of lead (with or without an admixture of peroxide with an insoluble or nearly insoluble salt of lead; tes or masses being afterwards converted wholly or into peroxide of lead (without such masses being ntly in contact with the surface of an oxidisable ›r, or rigidly confined within a frame) by an elec- or, preferably, by a combined chemical and elec- process, the masses having the necessary freedom nsion by the effect of such conversion.

arrying out the invention I prefer to mix monoxide rith an insoluble or nearly insoluble salt of this referably the sulphate of lead), and to form the into a plastic mass with water, whereby the mass l to gradually 'set' after it has been moulded to ›ed form. I thus obviate its disintegration when bsequently immersed in a fluid. This 'setting,' a necessary condition for the production of coherent f peroxide of lead, is due to a rearrangement of the s in the moulded mass, consequent upon a chemical tion occurring, in presence of moisture, between the alt and the monoxide; the result of this combina- ›g a sub-salt or basic salt of lead. The addition to ›e mixture of a certain proportion of hydrated of lead, as obtained by electrolysis, augments the rity of the moulded mass, thereby facilitating the n of the whole mass into peroxide of lead."

ddition of peroxide of lead to the materials which, ›tting," are to be converted into active material, or ting of the surface of the plate with peroxide as ›d in Section LXX., or, lastly, the process of ng" now to be described, is practically of absolute in order to remedy the want of conductivity of ›ound [x(PbO)$PbSO_4$], analogous to if not identical nkland's buff lead salt (LXIX.).

ates may be superficially peroxidised or "browned" rsion in a hot solution of an alkaline or earthy rite. The temperature is not mentioned, but the n takes place with sufficient rapidity at about F. In operating on a large scale, the plates are edgeways, about ½in. apart, on the perforated tom of a tank containing warm water. Beneath bottom is placed a quantity of calcined magnesite, form of magnesia in coarse powder, into the midst chlorine is introduced through tubes of glass or aterial not attacked by this gas. Heat may be ›y blowing in steam, but the temperature must not ed to rise above (?) 120deg. F., otherwise great active chlorine may occur, owing to the production esic chlorate ($Mg2ClO_2$). The reaction between ›ous chlorine and the magnesia, resulting in the n of magnesic hypochlorite (Mg2ClO), is expressed ›quation:

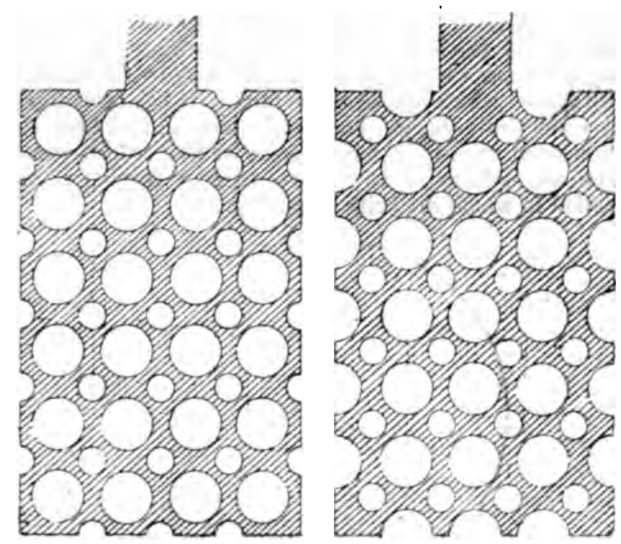
$$2MgO + 4Cl = 2(MgOCl_2) = MgCl_2 + Mg2ClO.$$

LXXIII.

›s said that the "browning" or some equivalent means ›g conductivity to plates of the compound of oxide ›phate of lead is *practically* necessary, because such have been converted into peroxide, though very ›lly, merely by bringing into contact with them, at one point only, a strip or wire of lead constituting ›de in an electrolyte of dilute sulphuric acid or of an ›e or earthy sulphate in solution. At the point of ›t with the anode, a particle of peroxide of lead is ›d on the plate, and from this point as a centre the ›de slowly spreads throughout the plate. Whilst this t is progressing, torrents of oxygen gas are being evolved from every portion of the electrode, unless the latter be coated with an insulating material, such as gutta-percha or celluloid, excepting at the point of contact with the plate.

When the plate contains a percentage of peroxide, or has been "painted" or "browned," the forming or conversion into peroxide is much more readily effected. But even in this case the conversion has usually been attended with great waste of power owing to the evolution of large quantities of oxygen from the ineffective portion of the lead anode. An ordinary method was to bend up a strip of stout lead near to one end, to stand the prepared plate in the bend of the strip (reversing the plate from time to time), and to make the strip an anode by connecting it to the positive pole of the dynamo machine. Enormous volumes of gas were by this means evolved in waste. But this method, even when no attempt was made to coat a portion of the outer surface of the strip with an insulating material, such as thin vulcanite cemented with marine glue, was far superior to the plan of arranging the plates on "a supporting anode surface of lead inclined at an angle of 50deg. to 60deg. from the horizontal, and furnished with a ledge of non-conducting material, upon which rest the lower edges of the plates." With this arrangement the wasteful evolution of gas from the submerged anode surface was in no wise mitigated, and the lower surface of the plate was alone acted upon, at least for a considerable period of time, or until the plate has been several times reversed. The forming process should be continued until a broken plate no longer exhibits a yellow strip of unconverted protoxide.

This waste of power in forming and charging is apparently unavoidable in the case of a pasted grid, and has not hitherto been obviated in the case of lithanode plates. The accompanying drawing represents two anodes,



to be used in forming lithanode plates, which are intended to remedy the useless expenditure of power. Each of the anodes has a backing of stout vulcanite or celluloid, and the perforations shown extend through the backing as well as through the lead, of which the anodes are preferably formed. The smaller apertures may be dispensed with, but would appear to be advantageous in bringing the enclosed plate into better contact with the electrolyte. For the plate to be charged is enclosed under pressure between the two anodes; and it will be seen, by superposing the latter, that the large apertures in one anode are concentric with the small apertures in the other. The anodes consequently transmit the current through the plate in opposite directions; the active anode surfaces being the rings of metal around the smaller apertures.

Even with this device there is some waste of current in forming; the edges of the apertures, which are not in contact with the enclosed plate, nor protected by insulating material, evolving considerable quantities of oxygen gas. *Per contra*, some persulphuric acid and ozone accompany this oxygen, which is evolved in close proximity to the enclosed plate, and doubtless contribute to its peroxidation

THE ZEEMAN EFFECT.

BY E. EDSER, A.R.C.S.

If the flame of a Bunsen burner, in which is placed a filament of asbestos soaked in some salt of sodium, be burnt between the poles of a powerful electromagnet, no very noticeable change will be observed by the unaided eye when the electric circuit of the magnet is made or broken; a slight alteration in the form of the flame, due to its diamagnetic property, will alone attract attention. If, however, an image of the flame be formed on a narrow vertical slit, and the spectrum (formed by reflection of the light from this slit by a Rowland concave grating) be examined, a very remarkable change will be noticed on making the magnetic circuit. If the magnet is so placed that the light which falls on the slit has proceeded from the flame at right angles to the magnetic lines of force between the pole-pieces, on making the magnet circuit each of the two characteristic sodium lines will be found to be tripled, in some cases quadrupled. If, further, the spectrum be examined through a Nicol prism, it will be found that all three (or four) lines are polarised, the outer two at right angles to the inner line or lines. On the other hand, if the magnet be so placed that the light falling on the slit leaves the flame along the direction of the lines of force between the pole-pieces, each line will be doubled, and on examining these lines in a suitable manner both will be found to be circularly polarised in opposite senses. Similar phenomena have been observed with other lines in the visible spectrum. Thus Mr. T. Preston has been able to photograph the spectra of iron under the circumstances indicated above, and has found that most of the lines are affected in the manner described.

The explanation of this interesting phenomena is very simple, but is nevertheless of great importance as influencing our ideas of the constitution of gases. Let it be supposed that the sodium vapour in the flame consists of charged atoms, whose vibrations give rise to the etherial disturbances which we know as light. It has been found that a positively-charged body when moving in a magnetic field is acted upon by a force similar to that which would act on an element of an electric current flowing in the direction in which the body is moving.

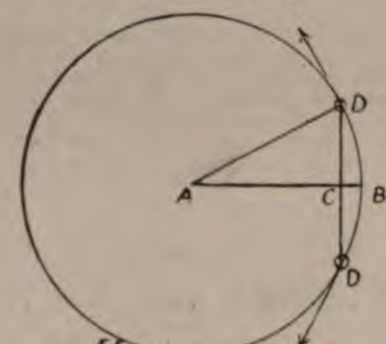


FIG. 1.

Consider a positively-charged atom vibrating harmonically along the line A B (Fig. 1); and further assume that the magnetic lines of force pass vertically downwards through the paper. Then if A B represents the amplitude of the atomic excursion, the position C of the atom at any instant can, by a well-known theorem, be found by supposing a radius, A D, to revolve uniformly so that a complete revolution is made in the time occupied by one atomic vibration, and dropping a perpendicular, D C, from the instantaneous position of the end of A D. If we supposed two charges, each equal to the given one, to start from B and revolve with equal uniform velocities in opposite senses round the circle, then since $CD = -CD'$, the actual effect produced by the vibration along the lines A B will be half of that produced by the two revolving charges. Consider the effect of the magnetic field on these two charges. D is moving at right angles to the magnetic field, and therefore will be acted on by a force similar to that experienced in the given magnetic field by an element of a circuit round which a current circulates in an anti-clockwise direction—*i.e.*, D will be attracted towards the centre of the circle. Further, as the force is [...]dicular to the direction of motion of the ch[...] work will be done, and the charge will move [...] same linear velocity as before. As, howev[...] radius of the circle becomes less, it will com[...] revolution in less time than previously. By [...] reasoning, D' will be seen to move with the sam[...] velocity as heretofore round a circle of greater rad[...] therefore to complete a revolution in a longer ti[...] previously. For each linear vibration in the plan[...] paper we must therefore substitute two circular vi[...] occupying respectively a less and a greater interval [...] than the original vibration. Any vibration perpe[...] to the paper will readily be seen to be unaffected [...] magnetic field.

If we imagine ourselves in the plane of th[...] watching these vibrations, those perpendicular to th[...] will give rise to etherial or light vibrations also [...]dicular to the paper, and of the same wave-length [...] there is a magnetic field or not. This corresponds [...] central line described above. (The occasional dou[...] this line is due to a reversal by the sodium vapour [...] outer part of the flame.) On the other hand, t[...] circular vibrations in the plane of the paper will g[...] to light vibrations also in the plane of the pa[...] respective wave-lengths being less and greater th[...] of the original light. These correspond to the tw[...] polarised lines observed in the spectrum when the m[...] circuit is made.

On looking at the vibrating atoms along the direc[...] the magnetic field (*i.e.*, perpendicular to the pap[...] vibrations perpendicular to the paper will prod[...] optical effect, whilst the circular vibrations will gi[...] to two rays of different wave-lengths circularly pola[...] opposite senses.

INSTITUTION OF ELECTRICAL ENGINEERS, J[...]

Notes on the Electro-chemical Treatment o[...] Containing the Precious Metals.

BY MAJOR-GENERAL C. E. WEBBER, C.B., R.E. [...] M.I.C.E., PAST-PRESIDENT.

(Concluded from page 111.)

It is claimed for the use of a current of higher p[...] specified to be used in the ore tank that "the precious [...] are attacked more energetically by a cyanide solution in [...]tion with a current of electricity than without." We a[...] told that "free gold is certainly more quickly dissol[...] cyanide of potassium in conjunction with an electrical [...] than without one."

To recapitulate: This process has, in common with I[...] his successors, the combination of a solution of potassium [...] with an electric current, by which it assists solution and [...] precipitation on a cathode; and, in common with M[...] effects the treatment in more than one stage, and by m[...] "circulation." In this latter respect Molloy and Pielsti[...] at one with the process of Siemens and Halske, in contra[...]tion to the processes in which "agitation" is essential. [...] reference to my observations further on as to "agitat[...] may be here observed that in such processes the density [...] sludge at various points in the system of circulation [...] depend on its rate of motion. Edwards, in April, [...] described, in the United States, an apparatus very sim[...] Hannay's, except that the position of the carbon an[...] altered, and they are apparently placed so as to line th[...] of the treatment vessel. In 1894 an invention was pr[...] in the United States, and subsequently patented there [...] other countries by Messrs. Pelatan and Clerici, for an e[...]lytic process and apparatus for extracting gold and silve[...] their ores and other compounds. The process has [...] described as a single continuous one—an essential fe[...] because as such it has proved itself equal to effect i[...] operation all that can be expected of it. In other wo[...] receives the pulverised ore in a wet condition, and, after [...] stirred up, and water, if necessary, added, so as to b[...] condition of fluidity to allow of suitable agitation [...] particular kind of ore under treatment, and so th[...] chemicals used in the treatment are properly mixed [...] the solution, it is introduced into the treatment vat o[...] in which the operation, which I shall again refer [...] carried out until nearly all the precious metals are ex[...]

rbed by the amalgam at the bottom of the vessel . Although a preliminary mixing of the solution in a tank may be thus implied, there is nothing to prevent ng being carried out in the treatment tank itself. re have, I believe, for the first time, a process and s which effectively combines, in a way that can be ed and worked by a workman of average intelligence, wing: (1) a vat made of a material dielectric in its (2) an agitating apparatus of various specific forms, m calculated to carry out one and the same process— e result of considerable experience—having an agitator, which constitutes the anode in an electrolytic circuit, s carried so that it can by no means make with the bottom or sides of the vat; (3) the of a cathode, which covers the whole of the of the vat, made of a metal (preferably copper), sheet, and suitably contained and fixed so as to it a layer of mercury; (4) the use of a graduated from an electrical generator, having large quantity and ntial; (5) the mixture or sludge under treatment being d of water in given proportions, ore finely pulverised, m cyanide or other solvent of gold and silver, and salt, with the addition as required during the process ies or organic acids as may be required. These are the tures, together with important details of construction I shall refer further on, that constitute the Pelatan-rocess.

e latter half of 1894 J. H. Haycraft, of Adelaide, in stralia (whose invention jointly with Breakell has been mentioned), described an improved process for the t of auriferous and argentiferous ores. He expressly s originality for the apparatus, and for any separate his process, or for any two or more parts together, but s that his invention consists in the entire and particular tion planned by him. In this process we again find wing conditions: one circular vessel for the whole f treatment, having a revolving stirrer with projecting nnected with the positive pole of a dynamo. The nder treatment is a mixture of pulverised ore and nd the precipitation is obtained by the use of a n conjunction with the electric current, the precious ing absorbed (and afterwards recovered) by amalga-n mercury. But, in addition, the process presents wing features: First, the vessel is heated by a furnace steam chamber underneath, and being therefore of e whole of it forms the cathode. The stirrer, which is s, can doubtless be insulated from the vessel without ficulty, and its arms are clad with carbon electrodes at tremities, which in revolving are separated from the by a space of about ¼in. To the charge of ore is added per cent. of its weight of mercury, with about 1 per chloride of sodium or any other salt capable of yielding by electrolysis; but these proportions the inventor cording to the class of ore under treatment.*

little practical experience in working an apparatus of ription given by Haycraft might be expected to fail in t of many difficulties that the construction presents—: (1) in keeping the density of the solution uniform ont; (2) in bringing it under the influence of the current the ¼in. space between the anodes which lie nearest to hode where the path of the greater part of the current lie; and (3) the difficulty of maintaining surface ... between the electrodes.

ptember, 1894, P. Danckwardt patented in the United an improved apparatus for and process of extracting gold and silver from ores. In this we find again the treatment of finely-pulverised ore in a solution containing potassium cyanide—in this case about 10lb. of cyanide to the ton of ore—and agitation. Besides, the inventor adds to the solution 2lb. to 3lb. of ammonium, "or another alkali," sulphide, the object of which is said to be to reduce the consumption of cyanide to a minimum, as a means of preventing "the formation of soluble combinations between any of the raw metal combinations and part of the cyanide of potassium."* In spite of the low tension of the current employed, the difficulty of insulation between the cylinders at their axial bearings must be considerable. I can find no record of this combination having ever been used on a practical scale, and I do not think that the description given is such as to enable an apparatus to be constructed that would produce practical results on a working scale. The actual subjection to electrolysis of the mixture described was, of course, not novel in 1894.

Edward W. Clark filed an application in the United States in November, 1894, describing a process and apparatus, which he calls an "electric chlorinator," for extracting ores by electrolysis. He passes an electric current through a solution containing the crushed ore to be treated and chloride of sodium. He uses an agitator of a particular form, and mercury as his cathode.† With the exception of that part of the combination which is affected by the special form of apparatus, and which is said to prevent the combination of the liberated hydrogen,

* The charge having been introduced into the vessel, the t—about 200 amperes by 3 volts to each ton of ore under nt—having been started, and the temperature raised to maintained a little under the boiling point of water, the n is continued for about one hour, the stirrer revolving all the time. The bullion is afterwards recovered from malgam in the usual way, but in the first instance malgam must be separated from the pulp with which mixed during the treatment. The peculiarities of this which may occur to the electrical engineer are, that the of the vessel slopes towards the centre, and that, using of a description by Prof. Wiedemann, of the University ..., "a large quantity of quicksilver placed in the centre gives the cathode or negative electrode; thus the pans the only suitable leading link between the cathode and he (the professor) attaches great importance to the free of the quicksilver cathode, as at boiling water tempera- quicksilver spreads through the whole pan, thus coming t with the coarser particles of gold, which settle down tom of the pan by their own specific gravity." And is, what is still less easy to understand, seeing that the ween the anode and the cathode is only about ¼in.: ading of the quicksilver brings into action the most then shoes, otherwise the electric current would pass to an electrode, and by its action would prove of no value, would be a continuous deposition and reunion." Again "The electric current by its passage through the liquor r and the ore in suspension decomposes," etc.

* The agitation is effected by the rotation of a cylindrical drum, A, on its axis, and two ways of doing this are described. In one case (Fig. 7) the rotating drum is external to the inner one, and

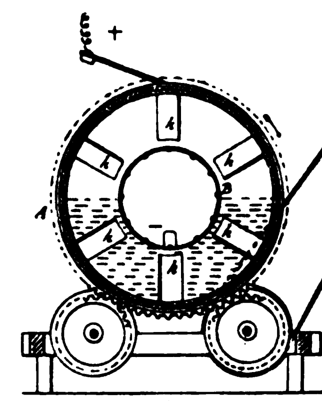


Fig. 7.

the conditions are the other way in the second example (Fig. 8). In each case the cylinder in motion, B, constitutes the anode, the stationary vessel the cathode. In the first case the outer revolving drum carries internally blades, k k, by which the solution is stirred and guided on to the amalgamated surface of the inner fixed cylinder, B, which is made of copper. The second example (Fig. 8)

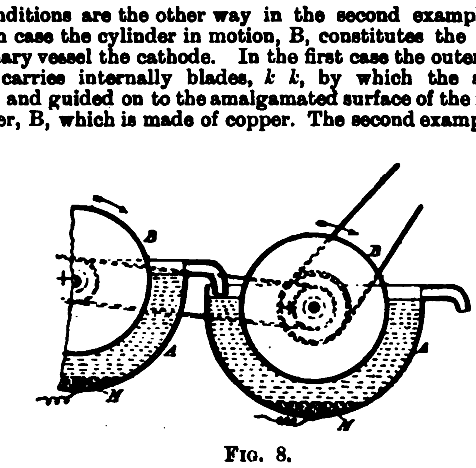


Fig. 8.

of effecting agitation in this way is an auxiliary one, and only resorted to in case the extraction by means of the first form of apparatus is imperfect, when the solution taken from the first, having been filtered, is passed through one or more of the agitating vessels; and in this latter case the outer and stationary tanks, A A, besides being amalgamated on their inner side, contain a little mercury, M M.

† The vessel in which the agitation takes place is a horizontally fixed cylinder, A (Fig. 9), with a shaft, B, carrying spirally fixed stirring arms, C, which revolve inside on its axis. The bearings are gas and water tight. The anode is a fixed carbon lying on the bottom of the cylinder. The mercury cathode lies at the bottom of small boxes, D D, attached in pairs at intervals on each side of the cylinder. The communication between the cylinder and the boxes is by means of openings, E E, at the lower sides of the former, which are covered with a canvas screen or filter. The current has to pass between the electrodes through these screens, in company with the solution on its way for the chloride of gold to deposit the gold in the above named boxes or amalgamating chambers.

oxygen, and chlorine, there is no reason for claiming novelty for the invention.

At the end of 1896 Dr. Keith, who read a paper on "The Electrolysis of Gold," in March, 1895, before this Institution, took out a patent in Canada, in which he makes, amongst others, a claim for a "process of extracting gold and silver from auriferous and argentiferous materials, rocks, or ores, which consists in submitting them to the solvent action of a solution of cyanide of potassium, containing a solution either of cyanide or bromide of mercury, or both, and then depositing the gold, or the silver, or both, and the mercury from the solution so obtained, by means of electricity upon a cathode or an amalgam." I understand that this was reported on by Prof. Silvanus Thompson, but the only encouragement I can find in the published part of his report is that the "process hastens the solution of the gold, in comparison with the use of potassium cyanide only."*

I now propose to go for carefully into the process I have described as that of Messrs. Pelatan-Clerici, which I have had under my observation for more than two years. It claims as its object the treatment of ores containing gold or silver, or both, so as to obtain the precious metal therefrom in a manner more complete, simple, satisfactory, and with greater economy of the agents than hitherto. As an example, I shall refer to the simplest form—of which an illustration is given—namely, the circular vat with the shaft of the anode in a vertical position (see Fig. 10). The improvements are: (1) That the space (unlike some previous proposals) between the revolving anode and cathode is free from all obstructions, the disadvantages of which are that they tend to cause the ore

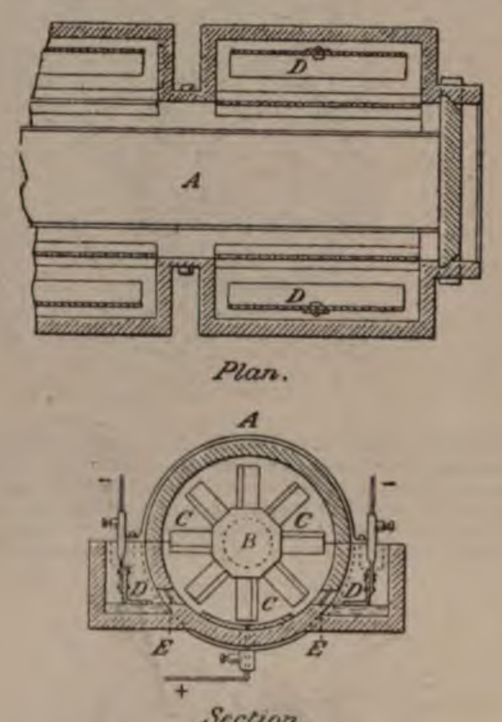


Fig. 9.

under treatment to accumulate upon the cathode, and prevent perfect parallelism between the surface of the mercury cathode and the effective under-surface of the anode—a condition the necessity for which is obvious. (2) That the sludge is constantly and gently swept by the current from over the cathode so as to have no tendency to settle on it, and also so that that portion of the sludge which is above the anode should not acquire such a continuous rotary motion as to cause the heavier particles to be carried outwards by the centrifugal action, and thus to travel round in the same plane, instead of in their turn being subject to the combined action of the electric current and the chemical agents employed.

This leads me to draw attention to the necessity that efficient agitation should, in the first place, maintain the sludge perfectly homogeneous throughout its mass, and, in the second place, should not be such as to disturb or break up the mercury cathode. In the example before us this is secured by regulating the speed at which the anode is driven, according to the size of the vat and the number and length of arms that are attached to the shaft, either for the support of the anode plates, or to act

* Similar means to some of those I have mentioned for doing the same work have been patented by De Neufville September, 1895; Hinman, September, 1896; Becker, August, 1897; but, with the exception of the combination of very minor details, these present no features of originality.

only as stirrers. For instance, subject to the den
sludge, it is found that if the speed of the agitator
lowered 30 per cent. the number of arms should b
As the diameter of a vat is increased in order t
homogeneity in the mixture the rate of motion at the
of the agitator would have to be increased, but to
ment of the surface of the mercury cathode—name
rate of about 8ft. or 10ft. a second. To avoid this t
of arms is increased. Provision is also made to m
circumstances to add arms which vary in length,
form part of the anode or not. The proportion of w
in the sludge is a condition that also affects this dep
the treatment, and it is found that between equal w
proportions the best results are obtained when the w
three-fifths of the ore.*

* The revolving anode is mounted so as to be susp
above in the vat at the lower end of a vertical shaft
and supported in the manner shown in the drawing

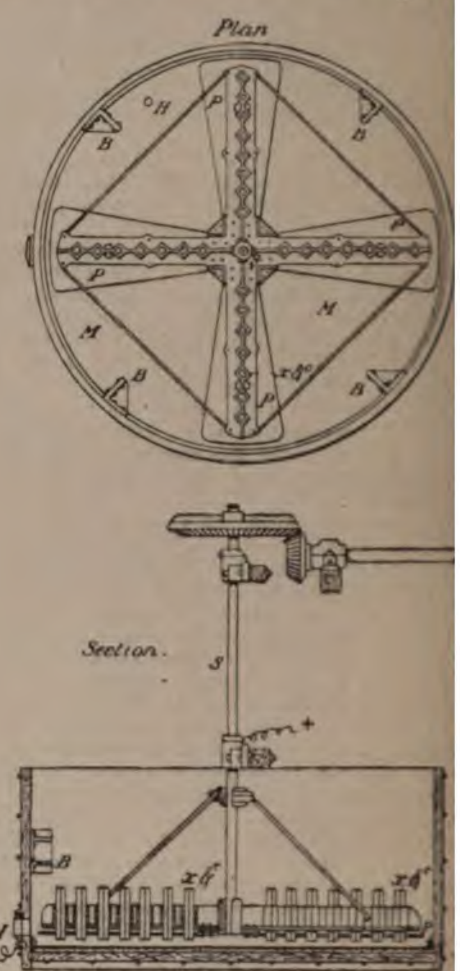


Fig. 10.

The lower surfaces of the iron plates, P P, etc., attach
undersides of the lowest tier of projecting arms are in
horizontal plane, and are carried at a distance of bet
and 6in. from the mercury cathode, M, which is
of regulation according to conditions which are well u
The positive connection from the dynamo is by way of th
shaft and a rubbing contact connected with the conduc
connecting cable from the negative pole of the dynamo
the copper plate of the cathode, M, with which it may
nection at one or more points. In the space between
and the cathode the actions and reactions described f
take place, and the metal which is absorbed or taken
amalgam is there allowed to collect through the conti
the treatment of successive charges until, when it is
a "clean up" takes place. According to the ri
the ore, a "clean up" may be necessary at int
say, two to fifteen days. In order that the agitatio
sludge may be such as to prevent the accumulation
material on the surface of the mercury. the revolv
are provided with pins, x x x, etc., say of wood or
conducting material, placed vertically, and projecting d
to within a short distance, say an inch of the cathode. T
as shown on the drawing, also project upwards, so as
maintain agitation throughout the liquid mass. In order
the tendency to continued centrifugal movement of th
projections, or bafflers, B B, etc., are fixed at intervals to
side of the vat above the arms, either vertically or at an
the vertical. By their influence the revolving current

ards the current, the potential should be capable of erned between 5 and 14 volts, and this must be done nces fixed in the circuit of each vat or group of vats. ance, when using vats of 9ft. interior diameter, each f treating 2½ tons of ore in two shifts—total, five tons— of 24 hours, should a plant to treat 200 tons of ore a orked, 40 vats will be required, and these would pro- governed in eight groups of five vats in a group. The is regulated by the resistance in that part of the circuit which lies between the electrodes. Provision for a minimum quantity of 1½ amperes per square foot, If the sum of the cathode and anode together in square s, if that area is equal to 52 square feet, the current ot be less and not much more than 39 amperes. The claim the use of several other forms of apparatus to e same objects, the details of which are more or less and are wholly original as forming parts of combina- d they also describe conditions of variations of tempera- ng the progress of the treatment, as well as the addition oxidising agents and compounds, and organic acids, ch are matters appertaining to the discoveries they le in experimentally treating samples on a working res from over 200 mines.*

nvestigation of the electro-chemistry of the process, I ine myself to the simplest (or circular) form of appa- ut before doing so, it is well to remind any mining who may be present that the degree of fineness of risation employed is obviously a varying factor in g this part of my subject, both as regards the chemical ncal, and their combined effects, especially when th refractory ores.†

ble you to follow the course of what happens in the tank, the process will be divided into more than one ough the actual order in which they follow one nd the time occupied by each, may vary with the treatment, and it is not always the case that it is le to separate them even for a short time. During time of treatment, "agitation," as distinguished rcolation" or "circulation," is going on. The stages vith or without the accompaniment of an electric uring portions of the time, but in any case the current ring more or less of the time. The liquid may contain loride (NaCl) or potassium cyanide (KCN) alone, or t, as the sodium chloride is directly and in the nce used to "reduce the resistance" or "increase ictivity" of the solution, there is no stage during cept for the purpose of mixing—it is used alone, without being accompanied by the current. The expressions I have used—namely, "reduction of resistance" and "increase of conductivity"—are useful because they are easily understood; but, be it remembered, they are not correct as applied to the solvent—*i.e.*, water. Indeed, these descriptions of the effect of the mixture of sodium chloride in a solution, and then placing that solution between an anode and a cathode, is scientifically inaccurate. What happens to the sodium chloride in solution in the water is that it is disintegrated and re-formed, and thus it becomes the intermediary by which at the instant that chlorine gas and sodium are set free the current is enabled to "communicate" between the electrodes. During the time of electrolysis, when the liquid contains only sodium chloride (NaCl), the primary decomposition will be sodium (Na) and chlorine (Cl). In practice, the quantity by weight of NaCl may be between 0·2 and 1 per cent. of the weight of the ore in the sludge, but this depends upon the nature of the gangue. In any case, the presence and addition as required of sodium chloride is a regulator of the electrical resistance of the solution which at any given moment is situated between the cathode and the anode, and, as the resistance in the conductors count for very little, it practically affords means of governing the current in the external circuit of the electrical generator or dynamo. Of the several compounds which might be used for the same purpose, common salt is doubtless much the cheapest.

Now to consider the action of these products of electrolysis. As the sodium is liberated, in contact with the mercury cathode, a small proportion will no doubt be dissolved in the mercury as an amalgam. If the current ceases, this is converted into sodium hydrate (NaHO), with liberation of hydrogen. But the greater part of the sodium liberated will react at once with the water in the solution, giving NaHO and H, the former to be used as described further on. Most of the chlorine liberated will at first be dissolved in the solution, but, as the liberation will take place at the surface of the anode, a small quantity may be used up in attacking the metal of which the anode is made. While this is going on, the liquid immediately in contact with the cathode will become rich in sodium hydrate (NaHO), and the agitation will cause it to come in contact with the chlorine liberated at the anode, with some of it to re-form sodium chloride (NaCl), and with another portion sodium hypochlorite (NaClO) and water (H_2O).*

This formation of hypochlorite in solution will, subject to the adverse conditions caused by agitation, be directly in proportion to the quantity of NaCl used to regulate the resistance, and with the relations of the areas of the anode and cathode respectively. But this formation of sodium hypochlorite will be limited by the extent to which the sodium hydrate above referred to, when it is liberated at the cathode, rises to lay hold of the chlorine which is rich around the anode. This we may regard as taking place in spite of the agitation of the stirrers, which probably tends to cause temporarily a rapid diffusion of the chlorine and sodium hydrate separately in the solution, although eventually they must come together. Although, when not in excess, it is a useful oxidiser, this formation of sodium hypochlorite has little advantage; and when potassium cyanide is added to the solution, it is, when in excess, even when alkaline, likely to oxidise some of it into potassium cyanate—a decided disadvantage, as it is a salt which is easily decomposed, and much less useful.

Let us now consider what may be effected by the chlorine liberated, but not engaged, as above described. In the first place, one might expect the nascent chlorine to attack some of the baser metallic ores present in a finely-divided state. For instance, sulphides, selenides, arsenides, etc., often attached to particles of gold or silver, would be so attacked; the chlorine uniting with the metallic base iron (Fe) or copper (Cu), and the (S) sulphur, (Se) selenium, or (As) arsenic being oxidised by the combined action of the chlorine and sodium hypochlorite above alluded to, into sulphuric, selenic, or arsenic acids. These changes would be marked by the formation of sodium sulphate, sodium selenate, etc., and the consequent formation of free acids, including hydrochloric acids.†

This probably represents what actually is the cause of disintegration of some of the metallic compounds which are present in refractory ores, as the chlorine attacks these first in preference to the gold. At the same time, it is no doubt the case that, as the process continues, some of the gold is brought into solution by the chlorine diffused through it, as

---

guided inwards and downwards so as to oblige every pass in rapid succession through the space below the be pipe opening at the side of the vat and a little above. n, I. is for drawing off a charge at the expiration of its ; and the hole, H, in the bottom is provided for the f drawing off the mercury at the time of periodical n."

s of some tests on a full-size scale, made at Denver with ores from various mines, pulverised to 40 mesh only:

of	Dwts. to the ton. Assay gold value.	Precipitated direct.	Precipitated from the solution.	Total gold saved. Per cent.
....	10·0	40	50	90
......	13·0	46	31	77
......	4·8	55	25	80
....	8·0	45	30	75
ilings	6·8	23	53	76
....	13·2	64	21	85
....	2·4	75	17	92
....	8·4	57	19	76
....	18·4	80	9	89
....	7·8	60	25	85

the above samples were pulverised also to 60 mesh, and sult from 6 to 10 per cent. better.

dvocates of treatment by simple leaching with chemical dislike fine crushing, say, finer than will pass a mesh of to the lineal inch, because it encourages the formation of " in the presence of which systems of treatment that act of percolation become less effective. In those systems ent in which extreme fineness is not detrimental—rather —crushing so that the powdered ore will pass a mesh of 80 the lineal inch is easily practicable, and makers of milling y have no hesitation in facing the problem. Even then n which the work is done depends on the nature of the he means employed. For instance, with some kinds of nd of milling machinery, the particles in which the etal is intimately attached to a baser metal—say, iron nstead of the result rendering them more pervious to ey may be found to be pressed out in solid, rounded, tons, and in the worst form for separation and sub- ges of the process. These conditions would govern the n, subject to the cost of fine crushing.

* $2NaHO + Cl_2 = NaCl + NaClO + H_2O$.

At a higher temperature say 130deg. F., the NaClO would become sodium chlorate, according to the following equation:

$$3NaClO = NaClO_3 + 2NaCl.$$

† The reaction in this process may be represented in two stages, as follows:

$$FeS + Cl_2 = FeCl_2 + S,$$

or $FeS_2 + Cl_2 = FeCl_2 + S_2$ (iron pyrites);

and $S + NaClO + 4Cl + 3H_2O = NaHSO_4 + 5HCl$,

chlorid of gold ($AuCl_3$), which is readily deposited by electrolysis on the mercury. We all know that the solution of gold by chlorine is in common use, but I think that in the example given it is effected under novel conditions, the chlorine being added electrolytically instead of mechanically. During the first two or three hours of treatment by agitation with the electric current, there is no doubt that the free gold which is not dissolved will be precipitated, the heavy particles at a very early stage of the process. In all such mixtures there is also more or less of what is called "float" gold, which in the processes using "percolation," and even "circulation," is lost in the "slimes." These particles, if they escape solution, will be so well mixed up in, and diffused through, the solution by agitation, that they should all in their turn be brought into close neighbourhood of the mercury surface of the cathode. The advantage of mechanically adding small quantities of sodium to mercury employed in gold extraction to assist amalgamation has long been recognised, but in this case the sodium so used is provided electrolytically. There is little doubt that the heavier particles of gold and silver which reach the bottom by subsidence will, owing to the surface being strongly polarised both by the current and by the slight amount of sodium amalgam formed by the current, be more readily amalgamated, and the same conditions also will promote the seizure by the mercury of the minute particles of float gold and silver when they approach its surface. The reason for this is probably not merely that it is thereby "kept clean"—*i.e.*, free from oxide in the well-known sense—but that the difference of electrical potential set up between the mercury and the liquid alters the surface tension at the liquid junction, and helps the metallic particles to come in actual contact with the mercury. This is, I believe, a new way of defining what occurs when what is called "prevention of flouring" and the establishment of metallic contact with the mercury takes place. The presence of the excess of an acid such as hydrochloric acid has to be provided for by the addition, say, of lime, to make the solution neutral; but this will not get rid of any excess of hypochlorite previously mentioned, if present. Lime, to remove free chlorine, will not be added until any metals in the solution, such as copper sulphides, or arsenides, have been formed into electrolysed salts through conversion into chlorides. These, which cause waste of cyanide of potassium, would to a certain extent go into solution, and, by electrolytic action, become deposited in the mercury, and their values saved. It will be understood, therefore, that all this preliminary work not only amalgamates a large proportion of the free gold and silver, but also prepares for the more effective action of potassium cyanide, both as a solvent and as an auxiliary in producing the condition of increased conductivity in the solution.

Thus, everything that chlorine can do to help the disintegration of the metallic ores which are found accompanying gold facilitates the action of potassium cyanide when it is added. This preliminary disintegration would be helped, not hindered, by temporary increased acidity of the liquid, when bodies like sulphides are oxidised at the expense of the chlorine, showing that the best time for neutralising the solution is at the end of this preliminary stage, and just before the potassium cyanide is introduced.

In all this preliminary stage it will be seen that the eventual economy of potassium cyanide (or other solvent) should be aimed at, because, although with "percolation" processes the "leaching" can be effected with even ½lb. of it, as much as 2lb. of it to the ton of ore under treatment may be here required. Obviously, the greater part of it is wasted, as, in treating a low-grade ore containing, say, 15 grm. of gold and, say, 30 grm. of silver, 60 per cent. of the gold and 40 per cent. of the silver may be separated and amalgamated in the first two or three hours, and before the potassium cyanide is added. Clearly, it does not require 2lb. to treat 6 grm. of gold and 18 grm. of silver, even if all the values that remains in the sludge could be dissolved. The addition of potassium cyanide (KCN) to an ordinary agitating vat causes the solution of some of the finely-divided gold; and a further solution will ensue when, by the passage of an electric current, a decomposition yielding free cyanogen at the anode and caustic potash and hydrogen at the cathode will ensue. So far the reactions are common to all arrangements which combine agitation with electro-cyanide processes.*

The addition of potassium cyanide in excess in the Pelatan-Clerici process has been doubtless due to the necessity of allowing for the oxidisation of it by any excess of hypochlorite previously mentioned.† It is also desirable to have some cyanide to spare, because the cyanogen (C_2N_2) formed at the anode and dissolved in the readily unite with the minutest and lightest parti to form with some of the said excess of it the do of gold [$AuK(CN)_2$], which is a salt that is easily readily electrolysed.* These conditions point to t of getting rid of any excess of hypochlorite and neutralisation before the cyanide (KCN) is added; excessive oxidisation of it when, if an insuffici ensue and tests were neglected, it is possible that

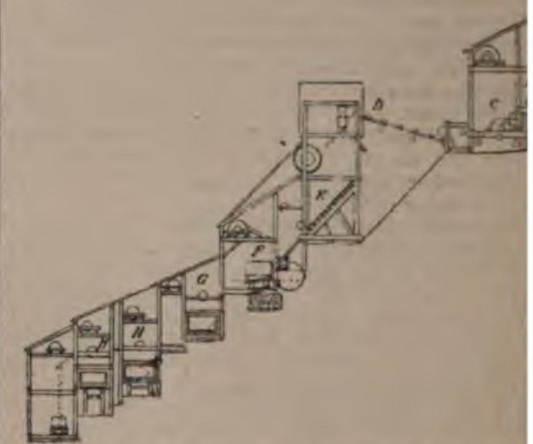


FIG. 11.—Rough Section of Mill at Rossland (B. C.) for the T Low-grade Ores by the Pelatan-Clerici Process.

be formed and remain insoluble, and hence escap and pass away in the tailings. There is an adva the simultaneous electrolysis of both sodium potassium cyanide, though the duty of the former to facilitate the conductivity of the electrolyte. cyanogen are both yielded at the anode, and wo lead to the production of cyanogen chloride, which

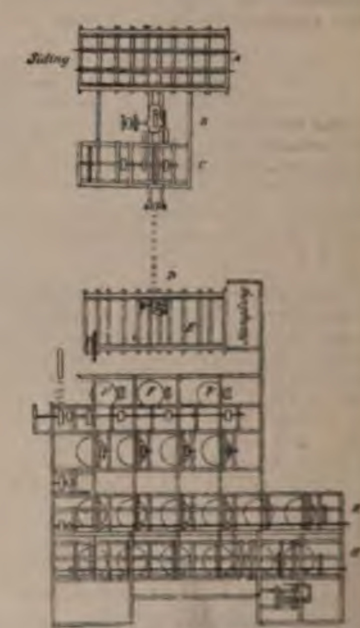


FIG. 12.—Rossland Mill in Plan.

with cyanogen bromide) would be in the presence cyanide as effective in attacking gold, if not more so, itself. The difference between this and what is k Sulman-Teed process is, that in it cyanogen chloride is added mechanically to a solution containing potas

* They are: With dissolved oxygen alone available,

$$4KCN + Au_2 + H_2O + O = 2KAu(CN)_2 + 2KHO;$$

with nascent cyanogen,

$$KCN + Au + CN = KAu(CN)_2.$$

† $NaClO + KCN = NaCl + KCNO.$

* Observation to ascertain the continued presen (KCN) is made from time to time with the nitrate of a drop in a test-tube of the solution. If too much sodium is present, the effect would be masked by the chloride of silver, when it would be difficult to di cloudiness of the liquid caused by the one from that other. In such a case iodide of starch, which is potassium cyanide, and not by chloride, is useful for nitrate of silver.

silver ore,* whereas in this process the conditions rresponding reaction are produced electrolytically.

F. Herroun, of King's College, I owe every thanks me to prepare the above investigation of some of of the process. When some members of the British visited Rossland, in British Columbia, last Prof. Armstrong is reported to have said: "One has struck me most forcibly is that some better ı smelting should be applied to your low-grade ore. me that some of the recent discoveries in elec- :ment might be applied to such ores." Nearly a :hese remarks are said to have been made, I was l in submitting samples of some of the Rossland ores, ; scale, to the electrolytic treatment of the General :ting Company by the Pelatan-Clerici process at ; works in Denver, Colorado; and the following ll give some idea of the arrangement of a mill ore by that process, which, in consequence of the ose trials, and others of a more recent date, is now erection between the Red Mountain Railway and heep Creek, about three miles from the city of At A, in Figs. 11 and 12, is shown a railway siding ›ver and an ore bin under it. At B and C are onebreakers and rollers. D is where an elevator e crushed ore over a sampler into a second ore bin, E, drawn into the Chilian mills, F F F. Thence the asses the screens is taken to the mixing tanks, G, :n mixed in due proportion the liquid is passed :ment tanks, or vats, 12 of which are shown . The motive power is situated to the left, the same level as D; and with about 750 b.h.p. use at one time, about 50 tons of ore can aily on 300 days of 24 hours in the year. By Chilian mills, three mixing, and 10 treatment 55 b.h.p., 100 tons a day can be treated. The ich do not show the power-house, the sampling, ting, and other subordinate departments of such a ended as an examples of how ore carried straight the "dump" can be pulverised and treated for thout any handling. The designs were made and out, under my own supervision, by Mr. Fisher, of has been engineer and millwright to many well- ing works and extracting mills in the Western nerica, but who had had no previous experience s of treatment plant. Below is a simple means, r Mr. Pelatan, of testing quantitatively for the gold and silver in the solutions with potassium solvent at each stage of treatment, which can be y the assayer in charge.†

Discussion.

n, who was called on to speak first, said he did not :hey wanted him to tell them. He did not speak enough to make a speech, but if any gentleman would on any point he would be glad to answer them.

aid it was very difficult to discuss a paper like this, d only read while he was there that evening. The Halske process and the Molloy process were used for gold from a solvent, but Mr. Pelatan's seemed to be ıg it into a solvent. There was one part of the paper t understand. He gathered from p. 6 that the arried on in one tank only, and at least part of the osited in the mercury in the electrolysis vat, but on to be gathered from the table that the solution after it left the vat. He thought that to treat a itic ore and obtain the best possible result, it was at it should be first "roasted" even with the process He would also like to ask as to the waste of cyanide ı. It was expensive stuff, and if 2lb. were used to each ton of ore it meant a loss of 3s. per ton. Better results (4oz. to 5oz. per ton) than that could be obtained by the ordinary cyanide processes, which did not require the extra expense of agitation and electricity. Turning to another part of the paper, he considered that the author's statements as to the formation of sodium hypochlorite and of sulphuric, selenic, and arsenic acid to be a condemnation of the Pelatan-Clerici process. As regards the splitting up of refractory compounds, such as copper pyrites in the electrolytic process, it was well known that the gold would be deposited on such pyrites in the cyanide solution, as they were actually used for this in certain processes. Dr. Teed also found fault with the description given by Major-General Webber of the process with which his name was associated—*i.e.*, the Sulman-Teed.

Mr. E. F. Herroun was then asked to speak, but as he was to a certain extent responsible for the chemical equations in the paper, he preferred to reserve his remarks till direct questions were asked.

Mr. Sulman, the next speaker, said that what the author claimed to be able to do by the Pelatan-Clerici process was what several had been trying to do for years past. Prof. Crookes some time ago took out a patent for extracting gold from ore by electricity. With regard to the Pielsticker process mentioned, it was a curious thing that electricity was thrown over by the Pielsticker people. Mr. Sulman then humorously described an interesting and historical trial made on some Broomhill tailings with the Haycraft process. Some 60 per cent. of the gold was recovered from a large sample, but the queer point was that the refuse still contained the same amount of gold as the tailing. In other words, 160 per cent. of the gold was then available. By an oversight, mercury which had been used before and contained gold had been employed. As regards the agitation of the solution, wherever it had been tried with the cyanide process it had proved a failure. In the Transvaal, at Johannesburg, and other places, it was a common sight to see sets of tanks replaced by a single tank holding, say, 600 tons, and giving better results. He held that the percolation process was much better than those requiring agitation. It had been proved by the early attempt to use cyanide of potassium in revolving amalgamating barrels that the cyanide was wasted by agitation. As regards the number of vats required by the Pelatan-Clerici process, he pointed out it would take some 40 vats to hold 200 tons of ore. Also with pyritic ores, where the gold was between the scales of the pyrites, the process could hardly be successful.

Prof. Barmen said he was pleased to see so many of the younger men interested in this business, and to hear that the process had been used successfully in British Columbia. He himself had lived in British Columbia before there was any gold-mining there, even before it was British Columbia. As far as he could see, the revolving blades in the process was their old friend the "Hungarian mill," working with the help of electricity. He would ask those responsible for the design how much power was required, as with only 65 per cent. of water it much resembled a mortar mill.

Mr. Jenkins said he must follow Dr. Teed in asking for further information on some points. Was there not some difficulty when the sludge was cleaned up? He would like to ask Mr. Pelatan if he could give any further particulars as to the working at the De la Mar mine. Was he always able to keep the surface of the mercury clean? A great many ores contained enough sulphides to cloud over the surface of the mercury, but perhaps not enough to prevent the action of it. The process would, he thought, be limited to only rich ores. The speaker then gave instances of the cost of treatment of ore at other mines, and gave as a representative case one where they were treating their slimes at about 3s. 9d. per ton, or altogether about 6s. with the milling. He asked for comparative figures.

Mr. Pelatan explained that the misapprehension with respect to the mixing vats arose from the fact that the crushed ore could not be passed straight into the electrolysing vats. The crushed ores simply passed into a containing box until there was sufficient to fill the vats. As to the question of the two columns in the table, which when added up gave the total gold saved, the first column of gold precipitated direct gave the gold obtained during the first two hours during which the chlorine process was in action. The cyanide of potassium was then added, and the additional gold listed under the head "precipitated from solution" was then obtained. The stirrers in the vats took ½ h.p. per five tons of ore. About 70 amperes at seven volts was required for the 9ft. vats, representing 490 watts per vat. The reactions which occurred were difficult to ascertain exactly, and doubtless some were of a partial nature only. The 2lb. of cyanide per ton was an outside figure. The average was more nearly 1lb., and in one Russian mine only ½lb. per ton was used.

As the discussion was not finished the **President** adjourned the meeting until Wednesday, the 9th inst., and particularly reminded the members that it would not be on a Thursday, as usual.

Free Power.—It seems that the City Fathers at Cleveland, U.S.A., have had trouble with the street railway people serving their town. A lead from the trolley wire in a certain place was said to be used for the sale of power. After a lot of argument, the public works warden was ordered to cut the offending wire. This being done, an electric swingbridge belonging to the corporation refused to work, and it transpired that the electricity for the purpose had been stolen from the street railway company

---

$CNBr + 3KCN + Au_2 = 2KAu(CN)_2 + KBr.$

n no doubt represents what happens so far as the h actually combines with the gold is concerned, but of the cyanide is not converted into $KAu(CN)_2$: e largest proportion will be decomposed by the omide, giving potassium bromide, potassium cyanate, anic acid. The following two equations represent are taking place together in the solution, but which tant ratio to one another:

.) $CNBr + 3KCN + Au_2 = 2KAu(CN)_2 + KBr.$

.) $CNBr + 2KCN + H_2O = KBr + KCNO + 2HCN.$

00 cubic centimetres of solution. Heat nearly to t. Add 2 grm. sulphate of copper (bluestone) and dium sulphide. Add hydrochloric acid so as to have dity. Heat to boiling point. Filtrate the black pre- which all the gold and silver are retained. Scorify tate with 50 grm. litharge. The precious metals are from the lead by cupellation. The sodium sulphide test is made in a very simple way, by fusing in a part of carbonate of soda and one part of sulphur. must be well covered.

THE

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REFUSE DESTRUCTORS.

The character of the audience which a
at the sewage works of the Leyton Urban
Council on Thursday of last week to ins
refuse destructors after twelve months' wo
have been a surprise to many. It is co
that sanitary engineers, town councillors, m
engineers, and the like should take great in
the economic and sanitary disposal of hou
and sewage sludge; but why so many e
engineers at such an inspection? The
is not far to seek, and we congratula
in their endeavours to learn all they ca
by-product obtained when destructors a
The by-product is waste heat—at least, th
only one which concerns electrical engine
this only to the extent of "how much."
palities *must* get rid of house refuse and
and if by a system of cremation they ca
waste heat, it will assist them in determ
become undertakers for the supply of e
energy. If they can utilise the wast
from their refuse destructors, that will re
cost of generation of electricity. Munic
however, are not compelled to have
destructors, though such apparatus is b
more and more common, and in our opin
be extended with great rapidity in the near
They have to consider, first, the most s
perfect way to dispose of these troubles of
tion; and, secondly, which is the cheaper
or more equally good ways of disposal.
not be too readily assumed that crem
the answer to both the first and second p
In our opinion—which must be taken for w
worth, and not as having had the fact proved
doubt—cremation is the only satisfactory
sanitarily dealing with the refuse of large
We cannot accept any other method of
as approaching it in sanitary perfection.
the authorities were to accept this view
would be no necessity to discuss which
cheaper of two methods. The question of
disposal is not on all-fours with that o
disposal, and as this phase of the subje
incidentally concerns our readers, we n
dilate upon it. A well-established fact is th
house refuse will, in general, not only cremat
but have a surplus of waste heat over.
portion of the waste heat can be used for in
purposes, and it is of this portion we would
If, besides house refuse, sewage sludge has al
cremated, then a portion at least of the ot
available heat from the refuse cremation n
used up, for sewage sludge does not possess
value sufficient to cremate itself, and the a
portion is lessened by the amount so used.
statements are axiomatic, but we have also
in support—if support be needed to a
axiomatic. At Leyton the destructors are
Beaman and Deas type, the house refuse is
a moderately well-to-do class of residential
and the sewage to be treated comes from a
tion of about ninety thousand. Messrs. Sir
and Mr. Francis Fox in their report give the

ıed during a twelve hours' trial run. These that the water in the sludge to be cremated ged 64·86 per cent. The amount of combustible n was about 6·50 per cent., a figure which quite es us in saying the sludge would not cremate

One paragraph in the report is very instruc- and we give it verbatim:

m-*Raising Value of the Refuse and Sewage Cake.*—Dura- f trial, 10 a.m. to 10 p.m., March 30, 1897—12 hours; r of cells of destructor in use, four.

DETAILED RESULTS OF TRIAL.

	Tons.	Cwts.	Qrs.		Lbs.
t of house refuse consumed	22	5	0	=	49,840
t of sewage cake consumed	11	4	1	=	25,116
reight of material burnt	33	9	1	=	74,956
tion of house refuse to sewage cake...	100 : 50·4			=	2 : 1 (nearly)
e weight of material burnt per cell per hour					1,561
reight of clinker produced	9	16	2	=	22,008
tion of clinker produced to material burnt					29·4 %
e steam pressure in boilers.....					105lb.
e temperature of feed water					65deg. F.
t of water evaporated....................	3,192 gal.			=	31,920lb.
t of water evaporated per hour					2,660lb.
t of water evaporated per pound of material burnt...					0·426lb.
rresponding with					
t of water evaporated per pound of material burnt and at 212deg. F..					0·507lb.
e pressure of air in ashpit					...2in. of water

tremely low quality of the material consumed (poor refuse and wet sewage cake) is indicated by the small y of water evaporated per pound of fuel (0·426lb.). te of this the total power produced was consider- Taking the total weight of the water evaporated 920lb., and assuming an average consumption of f water per indicated horse-power, the horse-power le would be 133 i.h.p.; the equivalent amount of coal which would be required to obtain this result is , representing a cost of £1. 11s. 6d., assuming the price to be 18s. per ton delivered at the works. The total ailable was more than sufficient to heat the boilers, and their turn supplied more steam than was required for ds of the works, which was served by a 45-h.p. engine sewage works, and by a 12-h.p. engine in the portion d by the destructors. A smaller engine drove two fans ng air to the ashpits of the cells, a dynamo lighting the and a steam hoist for raising the sewage to the charging nd a feed-water pumping engine was also provided with rom the boilers. The larger engine drove a pump lifting from low to high level, an air compressor for the filter nd all minor plant in the sewage works.

ly speaking, we may take it that out of the 6lb. of sewage cake consumed, some 16,000lb. consisted of water to be evaporated. This, to the 31,920lb. of water evaporated in s, gives a total evaporation of nearly 48,000lb. ter (20lb. water per indicated horse-power gh twelve hours, hence $\frac{48,000}{20 \times 12} = 200$, so it be seen that the available horse-power l be increased in this case by about 50 per had not the refuse to cremate the sludge. pause; the ruling figures will be those ned when the calorific value of the refuse west, not when it is an average or a maxi- . The state of the weather, the time of the and a number of factors assist in increas- or decreasing the calorific value; hence the ntages to be derived by the utilisation of such e heat must be discounted down to this mum. How much the minimum is below the ge it is impossible to say, but in calculations ssistance in designing stations to be partly ed by destructors, we should have a factor of y very large—say 50—for the average calorific . In designing, then, a central station to work n adjunct to a refuse destructor, the greatest must be taken in the testing of the waste heat during the worst weather and under the worst conditions, as it will be that amount which will have to be supplemented by the station.

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week:

FRIDAY, FEB. 4.

Royal Institution, Albemarle-street.—At 9 p.m., "Some New Studies in Cathode and Röntgen Radiations," by Alan A. Campbell Swinton.

North-East Coast Institution, Westgate Assembly Rooms, Newcastle-on-Tyne.—At 7 p.m., annual dinner.

Institution of Junior Engineers.—At the Westminster Palace Hotel, at 8 p.m. "Electromagnetic Brakes and their Capabilities," by Louis H. Walter, A.I.E.E.

SATURDAY, FEB. 5.

Institution of Electrical Engineers.—Students' visit to the works of Messrs. Siemens Bros. and Co., Woolwich; train from Fenchurch-street, 10.5 a.m.

Chesterfield and Midland Institute of Engineers.—Joint meeting at Sheffield, at 2.30 p.m. For numerous papers to be read and discussed see "Notes."

General Electric Company's annual dinner at the Trocadero Restaurant.

MONDAY, FEB. 7.

Society of Engineers.—At 8 p.m., presidential address, by Mr. Worby Beaumont.

TUESDAY, FEB. 8.

Institution of Civil Engineers.—At 8 p.m., "The Security of Locomotive Fire Boxes," by Mr. William Thow, M.I.C.E.; "Friction of Locomotive Slide Valves," by Mr. John A. F. Aspinall, M.I.C.E.

Royal Institution, Albemarle-street.—At 3 p.m., Prof. E. Ray Lankester, M.A., LL.D., F.R.S., on "The Simplest Living Things."

WEDNESDAY, FEB. 9.

Society of Arts.—At 8 p.m., "Compensation to Workmen," by A. D. Provand, M.P.

Institution of Electrical Engineers.—At the Institution of Civil Engineers, at 8 p.m., conclusion of discussion on "Notes on the Electro-Chemical Treatment of Ores containing the Precious Metals," by Major-General Webber. Also a paper on "An Electrolytic Process for the Manufacture of Parabolic Reflectors," by Sherard Cowper-Coles (member).

THURSDAY, FEB. 10.

Institution of Mechanical Engineers.—At the Civil Engineers, at 7.30 p.m., resumed discussion on "Mechanical Features of Electric Traction," by Mr. Philip Dawson. The following paper will be read if time permits: "First Report to the Gas-Engine Research Committee," by Prof. Frederic W. Burstall, of Birmingham.

FRIDAY, FEB. 11.

Physical Society. Burlington House.—At 5 p.m., annual general meeting, with presidential address. At an ordinary meeting afterwards a paper on "Electromagnetic Induction in Plane, Cylindrical, and Spherical Current Sheets, and its Representation by Moving Trails of Images," by G. H. Byran, M.A., F.R.S.

Institution of Mechanical Engineers.—At the Civil Engineers, at 7.30 p.m., continuation of the papers and discussion left over from Thursday; and "Steam Laundry Machinery," by Mr. Sidney Tebbutt, of Leamington.

Royal Institution, Albemarle-street.—At 9 p.m., "The Metals used by the Great Nations of Antiquity," by Dr. J. H. Gladstone.

INSTITUTION OF JUNIOR ENGINEERS.

The Institution of Junior Engineers held their thirteenth anniversary dinner on Saturday evening at the Westminster Palace Hotel. Among those present were Mr. R. Harrison (L. and N.W.R.), Mr. Alex. Siemens, Prof. S. P. Thompson, F.R.S., Prof. J. Perry, F.R.S., Mr. Hiram S. Maxim, Mr. J. Swan, F.R.S., Prof. D. A. Low, Mr. H. B. Vorley, Mr. S. H. Wells, Mr. T. E. Gatehouse, Mr. E. King, Mr. K. Gray, Mr. E. Berry, Mr. H. Young, Mr. W. J. Tennant, etc.

After the loyal toasts had been honoured, Mr. ALEXANDER SIEMENS gave the toast, "British Railways." He could not, he said, help thinking that the management and development of English railways had a very direct bearing on

the question which gave rise to the late engineering dispute. Those present would, perhaps, be interested to know that they were in the same room in which the conference was held. That day was the happy one on which the lock-out notices had been withdrawn, and for that reason he had ventured to speak of one of the greatest labour disputes of the century. The trades unions went on the socialistic fallacy that there was a certain amount of work to be done, and the less work each man did, the more hands would be employed. This was right up to a certain point, but there was also a large amount of work which was purely optional. If an article could be bought for 1s. 6d. it would be had, but if it cost 3s. people might not buy it. The unionists should have sense enough to know that the more work done by each man (without overworking), the cheaper the production, and the greater the demand. Looking back to the "dark ages" of railways, the directors used to go on the principle of extorting as much money as possible from the passenger. A man had to go a journey, and the companies would charge as much as they could and make it as uncomfortable for him as possible. Now all that was changed, and one could travel very comfortably by third-class. In France, when the trains were full, no more passengers were taken, but in England there was always plenty of room.

Mr. R. HARRISON, general manager L. and N.W.R., in replying, said that in the "dark ages" great opposition had been met with in constructing railways, but now these were helped in every possible way. He thought the locomotive could not be improved very much, and he was looking to the electrical engineers to bring out something to replace it. He congratulated Mr. Siemens and his fellow-workers on the settlement which had been brought about in the engineers' dispute. It was a settlement, he thought, which would not only benefit the employers—who did not regard it as a victory—but also the workmen themselves, and not least of all, the railway companies and those who had to transport the manufactured articles and the materials necessary for their manufacture.

Mr. J. A. F. ASPINALL, chairman, also responded, and said that he thought it was fortunate that Mr. Harrison had touched on the subject of improving locomotives, because he felt sure that the electrical engineers would be able to show the way to what was wanted. He had compared the cost of locomotive and the cheapest electric railway, and found that the locomotive was the cheaper method. But the difference was so small that it might easily be overcome. There were points with regard to railway working that were apt to be overlooked. A fast non-stopping train did not do anything like the work a fast stopping train did. If electricians could devise a means of overcoming the inertia of the train at the start, and enable it to get up speed more quickly, it would be a very good thing. The railways also wanted to overcome the difficulty of making up for lost time on high-speed trains. If a train running at 60 miles per hour lost a minute, it had to run 13 miles at 65 miles per hour to make it up.

Prof. PERRY proposed the toast of "A Realised Teaching University for London." He said he would have liked to have talked about railways and all that, but he didn't know anything about it. There was one thing he would like to know, however, and that was when were they going to take cycles at a cheap rate. The London University had done a great deal of good work. It had provided for a lot of young men the education they required. It had also done some harm in giving people the idea that the universities were an examining body. Ireland had the intermediate system of education, and when it came to granting degrees we were very much behind. He sympathised with the efforts to bring the London University more under the control of the teaching bodies of London.

Prof. S. P. THOMPSON, in responding, said a great change was coming over the teaching of science. It used to be thought that science could only be learnt from books, but now it was coming to be understood that the only way to learn it was by working in the laboratory. The movement for the reconstruction of the London University was to enable young men who attended colleges, etc., to obtain a degree. In Paris and Berlin the universities had been greatly enlarged, and it was so in all parts of France. He thought the teacher should have some part in the examination of the students, though of course he not wholly examine them. That was essentially a question, but he was sorry to see the apathy with Londoners took up the matter.

Mr. R. NEWMAN, in proposing the toast of "Su the Lancashire Meeting," said he had read a pa Lord Rosebery on the "advantages of staying at but he thought if Lord Rosebery had been with th their excursion he would not think it so much of an tage to stay at home. The excursion was the m increasing their membership.

Mr. G. FARREN, in reply, said the strike h increased wages by one penny piece. He recomm Dr. Perry's book to young students. He had so blast furnaces he would like to show the member they came up to the North.

Mr. J. W. SWAN, president of the Institution o trical Engineers, in proposing "The Institution of Engineers," said he had not realised before that even value of the institution. It had grown till now larger than it had ever been before. He sympathise the object of it. It was to the younger engineers th must look to keep up the prestige of engineering future. They could not reinvent the locomotive an important things [Prof. PERRY: "Incandescent la but there were still conquests to be made in electri mechanical engineering. He had reason to hope th institution would be largely influential in promoting national discovery.

Mr. BLOOMFIELD VORLEY, in replying, said th been greatly helped by the members. The instituti rapidly developed, and was in a flourishing condition dangers must be guarded against. If the members to be successful they must work as one, and there m be apathy on their part.

Mr. HIRAM S. MAXIM said only one or two mi hour more than 60 miles per hour could now be of an ordinary locomotive whatever improvemen effected. He thought that if electricity were introd any of the lines now in use, they might possibly to 100 miles per hour. The finest coal had to be express locomotives, but with electricity they coul coal costing half the price. Electricity had been so much into use in the United States that it had the price of horses one-half; in fact, it was said tha place horses were being killed and potted to France. His firm's losses over the strike had bee £200 per day, but he thought it was worth all it ha

Mr. KING, in proposing "The President," sa besides being chief engineer of the Lancashire an shire Railway, he had been heard of in other thing boats which ran between Fleetwood and Belfas engined by him. He had also helped to judge the cars in the *Engineer* competition.

Mr. ASPINALL, in replying, said he thought An worked harder, and turned out more work than men. The English had very carefully-constructed tools, but the men did not get half as much wor them as they might.

After the toast of "The Press" had been give was a cinematographic display, and the proceeding with the "National Anthem" and "Auld Lang Sy

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GUTTAPERCHA.*

BY DR. EUGENE F. A. OBACH, F.I.C., F.C.S., M.I

(Continued from page 22.)

At this time the genera of Sapotads indigenous to th were not sufficiently differentiated to produce those p species which supply a latex yielding guttapercha. W later period the subsidence proceeded further, so as t any direct communication with the mainland, th rentiation had taken place, and the guttapercha trees imprisoned on the islands, where they now exist quite probable that in addition to the gradual su of the intervening portions of the continent, volcan may also have assisted in the further disintegration of t a belt of volcanic mountains existing all along Sum

* Cantor Lectures delivered before the Society of Arts.

ava, as shown on the map, and we know from the recent ruption of Krakatoa, in the Straits of Sunda, what havoc such catastrophe can play.

Besides the general climatic conditions, such as the variations f temperature, degree of moisture, prevailing wind, etc., the ocal conditions—*e.g.*, the composition of the soil, elevation above sea-level, distance from the coast, etc.—also play an important part in the development of special features of the fauna and flora in a particular locality, and account for the fact that the guttapercha trees are very irregularly distributed over the different islands, and may even be entirely absent from some parts of them.

About six years ago the directors of the German New Guinea Company asked me whether I thought it likely that guttapercha trees would be found in Kaiser-Wilhelmsland, which they considered probable, the northern portion of their territory having the same latitude as the southern part of Borneo and Sumatra (see map), but for the reasons which I have just tried to explain to you, I ventured to predict that genuine gutta trees would not be found there. However, in order to test the matter, the directors instructed their botanists to keep a sharp lookout for such trees during their exploring expeditions, and I furnished them with all necessary particulars to facilitate their recognition. Since then I have received, from time to time, specimens of various kinds of gums which have been collected there, but as yet not one of them bore any resemblance to true guttapercha, though several—for instance, Getah Susu, Marau, and Natu—are derived from sapotaceous plants, and some even from the same genera—viz., Palaquium and Payena. It was, therefore, somewhat premature to describe the trees as guttapercha trees in the *Bulletin* of the Royal Botanical Gardens of Berlin.

The various gums from New Guinea which have hitherto been submitted to me are on the table. Only one of them contains a small percentage of caoutchouc-like substance or pseudo-gutta.

Expeditions in Search of Gutta Trees.

Let me now say a few words about the various expeditions in search of gutta trees. You have heard how eagerly the search for Taban trees had been pursued by the natives, already at the very beginning, and how successful they were in discovering them almost everywhere in the Malayan Archipelago. In Europe naturally only little attention was paid to the matter, till rumours spread about that in consequence of the ruthless destruction of the trees by the Malays it might possibly occur that the further supply of guttapercha would suddenly cease if measures were not taken to remedy this state of things, either by regulating the collection of the gutta by law, or, if this was not possible, by cultivating the guttapercha trees in the same way as is done with the cacao tree, coffee shrub, and others. With this purpose in view the French Minister of Posts and Telegraphs, M. Cochery, in 1881, instructed M. Séligmann-Lui to proceed first to Malaysia to study the guttapercha trees and then to French Cochin-China to search for them there, and if not found indigenous, to investigate if they could not be cultivated in that locality. M. Séligmann accordingly went to Singapore, and from there started on an exploring expedition, first to Penang, then across the Straits of Malacca to Deli on the east coast of Sumatra. From Deli he followed the coast to Assahan, here penetrating into the interior by the river Ajer Siloh, as far as the village Pasir-Manogeh, where he found various kinds of gutta trees, including the Mayang ..., or true Taban. Returning to Assahan, he again followed the coast to Siak, went up the river of that name as far as Pakan Baru, where he came across the Balam sundek, which he had already found lower down the river; but the Taban he was in search of was still six days' journey higher up the ... He returned to Siak and thence to Singapore. From the latter place he set out for Saigon, to which place he had previously despatched some young gutta plants, proceeding further ... through Gambodia and part of Siam.

Although Séligmann does not appear to have been very successful in his mission, and had to inform the Minister that guttapercha trees could neither be found in Cochin-China nor Cambodia, and, moreover, could probably not be cultivated there, yet he was able to collect a good deal of information from the ... people with whom he came in contact during his journey in Malaysia, and this he embodied in a valuable report.

The second expedition was an English one, arising, it appears, from an enquiry addressed to the Government of the Straits ... for information respecting the propagation of ..., by the French Consul at Singapore. The British ... at Perak thereupon instructed the curator of the ... Thaipeng, Mr. Leonard Wray, jun., to explore the ... and report to him on the various trees from which ...percha of commerce is obtained. Mr. Wray, who ... his expedition early in 1883, was able to collect a ... specimens of plants producing guttapercha and ..., and these he sent to the botanical gardens at ... Ceylon, and Kew for examination and identification; ... presented a set of them to the Society of Telegraph ... in London. By the kindness of the Kew authorities and of the Council of the Institution of Electrical Engineers, I am able to show you to-night a complete series of the specimens collected by Mr. Wray in Perak. You see here the bunches of leaves and fruit, the wood and bark, and last, but not least, the coagulated latex or getah itself, from seven different trees. I shall have something more to say about the getahs later on, but with regard to the other specimens, I can only invite you to inspect this unique collection after the lecture, and to identify the localities whence they are derived by means of the special map on the wall, showing the State of Perak on a large scale.

Unfortunately time does not allow me to give you any details about Mr. Wray's expedition, but I must not omit to state that this gentleman sent a most interesting report on it to Sir Hugh Low in September, 1883, in which he gives a great deal of information about gutta trees, the quantity of guttapercha obtained from them by the Malays, and other useful data. He also comments upon the wasteful manner in which the gum is collected by the natives, and suggests that the bark—which in the dried state contains over 11 per cent. of guttapercha, and is now thrown away—should also be utilised for the extraction of the gum.

(To be continued.)

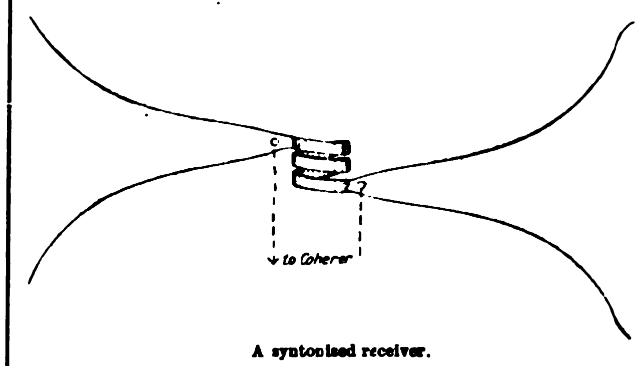
PHYSICAL SOCIETY.

[The illustrations given herewith were made from sketches kindly lent us by Dr. Oliver Lodge, and are explained by their footnotes. They are not referred to in the text of the official report.—Ed. *E. E.*]

At the ordinary meeting held on Jan. 21, 1898, Mr. Shelford Bidwell, president, in the chair,

Prof. Fitzgerald exhibited some photographs by Mr. Preston in illustration of the Zeeman effect for various cases, including those of iron, cadmium, zinc, and sodium. These photographs and the method of obtaining them have already been described. The cause of doubling is now attributed by Prof. Fitzgerald to absorption by the surrounding vapour. In a particular case he examined a double line that exists in one of the photographs. Under the polariser the two lines are at first distinctly seen, but when the polariser is turned, a thin line appears in the middle, and this central line is therefore circularly polarised in a direction opposite to that of the outer pair of lines. The reason for the appearance of doubling in the first position of the polariser is that the central line is there completely absorbed out by the surrounding vapour.

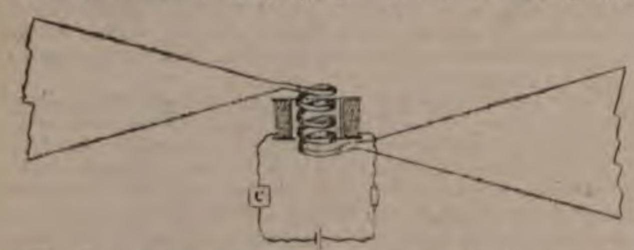
Prof. Oliver J. Lodge then gave a communication concerning his work on "**Electric Signalling without Connecting Wires.**" From the nature of the oscillatory disturbances emanating from any of the customary forms of Hertz vibrator, syntony has hitherto been only very partially available as a means for discriminating between receivers. There is, in fact, so rapid a decrease in the amplitude of the vibrations that almost any receiver can respond to some extent. Discrimination by syntony is possible with magnetic systems of space telegraphy where the



A syntonised receiver.

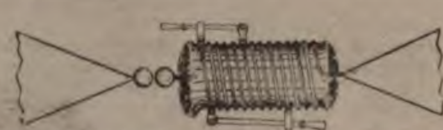
magnetic energy much exceeds the electric—*i.e.*, as between two separated inductive coils—and by the use of such coils, appropriately applied, the author has been able to attain fair syntony even with true Hertz waves—*i.e.*, he has constructed spark-gap oscillators, with sufficient persistence of vibration, and syntonised resonators. The "coherer" principle can be applied to either a purely magnetic or to the Hertzian system. It was first used by Prof. Lodge in devising lightning guards, and afterwards in his magnetic system of telegraphy by inductive circuits, each in series with a Leyden jar, a pair of knobs in near contact, or other overflow gap, being provided in the receiving apparatus. This was the first meaning of a "coherer" in the electrical sense as used by Prof. Lodge: it referred to a single contact between two metal knobs. The term has since been extended by others to the filings tube of M. Branly, and some confusion has arisen, for M. Branly does not consider that simple coherence and break explains fully the behaviour of his instrument. Prof. Lodge is disposed to agree, for he finds that the resistance of almost any form of coherer varies in rough proportion to the received impulses, and that there are other peculiarities (to be mentioned later); he is therefore inclined to think that the action cannot,

after all, be entirely explained as due to mere "welding," but that there is something more to be learnt about it. The sensitiveness of a coherer depends upon the number of loose contacts; it is a maximum for a single contact—*i.e.*, for a needle point lightly touching a steel spring. With this sensitive coherer, hardly any "tapping back" is required for decoherence, but it wants delicate treatment when properly adjusted, and the greatest



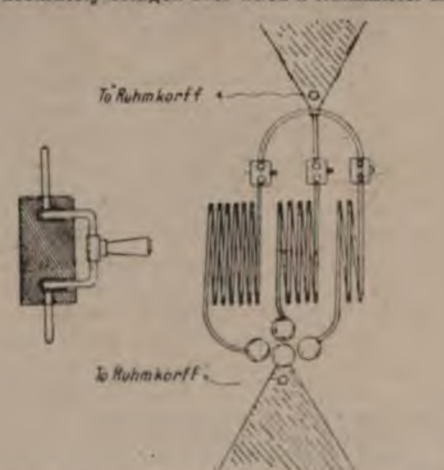
A syntonised receiver. Sketch showing a mode of stimulating coherer by means of currents induced in an outer coil with the simplest connections to coherer.

current through it should not approach a milliampere. On the other hand, a Branly tube rather improves under rough treatment. In such a tube the author prefers to use iron filings in the best possible vacuum; brass, too, is very good, but rather less easy to manage. Aluminium is thoroughly bad, and gold, for an opposite reason, will not work—its surface is too clean. Points, or small surfaces for making contact with the filings, are better than large surfaces. The usual method of connecting the coherer across the gap of an ordinary Hertz receiver, in parallel with the telegraph instrument and battery, has the unavoidable objection that they shunt away part of the received oscillations. With the syntonic receiver of



A method of tuning a receiver by means of a Hedgehog choking coil.

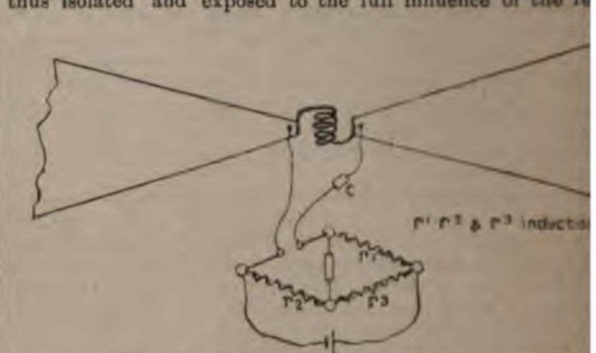
Prof. Lodge, which contains no gap but a closed wire coil instead, the difficulty no longer exists, for the coherer can now be in series with the detecting instrument, and in so far as these obstruct the oscillations they may be shunted out in various ways, as the author describes. The main feature of his new syntonised vibrators is this self-inductance coil, whose function it is to prolong the duration of the oscillations, and thereby to render syntony possible. Although such a coil acts disadvantageously in so far as it possesses resistance, the resistance does not increase so fast as the self-induction. The coil should consist of thick copper of highest conductivity, and it should have maximum inductance for given resistance. For similar reasons the capacity areas should also be of highest conductivity; their dimensions should increase outwards from the spark-gap, as triangles. The receiver must have no gap; it should be accurately bridged over when a transmitter is used as



Emitter for three different receiving stations. The connections A, B, or C are plugged up according to station required.

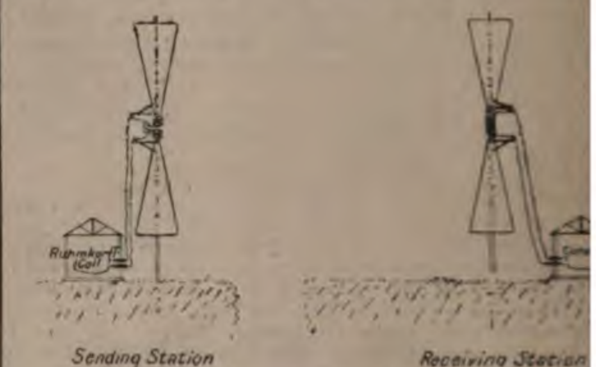
receiver. The limit of speed of response depends upon the telegraphic instrument. Dr. Muirhead adapted a siphon recorder to the purpose, because it is one of the quickest responders. He arranged it so that it could be used with intermittent currents direct. Under these intermittent impulses the siphon trembles, and instead of the ordinary siphon signals the slip is marked with dots and dashes. Constant mechanical tremor is usually employed by decoherence, but the author finds that decoherence can be brought about by electrical means, without any mechanical tremor, by connecting the coherer momentarily to a circuit less effective as a collector than that of the proper capacity areas of the syntonised receiver. The battery and galvanometer detector circuit may be used for this purpose; the coherer being momentarily connected to it, and while so connected, letting it experience an impulse from a distance. Prof. Lodge has designed a revolving commutator, by

means of which the coherer can be rapidly changed over fr
resonating circuit to the instrument circuit, and finally
"tapping-back" apparatus. A coherer is more sensitive
thus isolated and exposed to the full influence of the re



A syntonised receiver with Wheatstone bridge connections.

oscillations. The subsequent detection of the effect by a
connections is very convenient for laboratory measuremen
diagram of a series of plotted measurements showed th
resistance of an undisturbed filings tube is approximately a
function of the intensity of the received stimulus, wheth
cessive stimuli increased or decreased in strength. This ele



General appearance of one form of a pair of long-distance signalling
with syntonised emitter and receiver. The coils connecting the
areas are diagrammatically shown.

process of "tapping back" is to be depended upon, but the
long continued fatigues the tube until a mechanical sl
employed to restore it. Large-size apparatus made by Dr.
head for actual distant syntonic work was exhibited, and
were shown for protecting and isolating the coherer w
receiving areas were being used as emitters; also a switc
for changing at one moment all the connections from "se
to "receiving."

A long-distance sending and receiving station. The insulated metal ro
as the capacity area, with all its parts well connected up to discharg

Prof. Threlfall said he had come to the same conclu
Prof. Lodge as to the advisability of diminishing the nu
contact points in the coherer. He had endeavoured to
longer and more persistent waves, and thus to set afield
effective energy. It was desirable to keep the waves as
as possible. He thought there was some probability t
wave fronts could be altered and rendered more conformab
process of diffraction.

Mr. Rutherford also had found it best to work with long
He fully appreciated the advantage of increasing the cap
the oscillator by extending the surface of the metallic plate

Mr. Campbell-Swinton asked whether experiments ha
made to verify Hertz results as to the influence of re
behind oscillators and receivers. He had found them di
tageous. A single wire behind either apparatus seemed p

l the effect. He also asked whether Prof. Lodge had l the extraordinary sensitiveness of coherers to small of current in neighbouring circuits.

Lodge, in reply, said he had observed the sensitiveness to adden variations of current referred to by Mr. Campbell- —for instance, when electric lamps were switched on or e effect of mirrors had been studied by Prof. Fitzgerald. equired to be of large dimensions as compared to the r and receiver, otherwise the true reflections were not d.

ilvanus Thompson afterwards exhibited a Tesla oscillator. paratus is intended to replace the two induction coils and ap arrangements used by Mr. Tesla for high-frequency nents. It consists of an induction coil with a separate self- nce coil in the primary circuit. This self-inductance coil is ed as an electromagnet for the separate interrupter of the y circuit. A condenser is connected between one end of imary coil and one terminal of the interrupter, so as to both of them between its terminals. The primary is a turn of copper strip, 6in. wide. The secondary is one of thick wire; each turn separated from the next by an ce. The supply current, about half an ampere, may be from the electric light mains at almost any voltage from 00, direct or alternating.

Lodge said it would work quite well at 10 volts. He d out also that if the straight discharge rods at the spark re free to slide, the discharge drove them back into their .

Fitzgerald said it was stated at Toronto that the spark oken at the interrupter when the condenser was charged, at by the time the condenser was ready to discharge the at the interrupter had been made again. It seemed to at the condenser discharges and surgings must take place te far higher than the period of the mechanical movement interrupter. The condenser charges and discharges were apid. It was not what is ordinarily called the "time t" that was involved for that only referred to constant . Here the voltage was changing very rapidly indeed.

Herschel asked if such an apparatus was suitable for ith Röntgen rays.

Thompson, in reply, congratulated Mr. Tesla upon the working and compactness of his invention. The present as not suited for Röntgen-ray experiments with the y focussing tubes, but Mr. Tesla had designed a special ich gave most excellent results with the coil.

President proposed votes of thanks, and the meeting was ed until Feb. 11.

QUESTIONS AND ANSWERS.

er this heading we insert questions and answers ractical character relating to central-station work, ay work, or construction work; and for each suit- uestion offer *one shilling*, and for the best solu- f any question we offer *ten shillings*. We also o *shillings and sixpence* for every other answer we The answers to any question should be sent 10 days after the question has appeared, and be written on one side of the paper only. Questions sent at any time.

QUESTIONS.

uld it be false economy to use galvanised iron-wire rope tead of copper tape for a lightning conductor?—J. C. R.

lead-covered high-tension cable is to be used on a wing-in system. Discuss the advantages and dis- antages of the use of earthenware conduits, wrought or t iron pipes, respectively. Should the lead be braided compounded, or not?—P. T.

ANSWERS.

. 29.—Compare the advantages and disadvantages of phase *versus* continuous-current motors for distribution ower in factories.

Answer to No. 29 (*awarded* 10*s*.).—The relative ity of each of these two systems can be divided under r of heads, among the principal of which are: (1) superiority of motors; (2) the question of line ring work, switch-gear, etc.; (3) prime cost of ance.

e of the great arguments in favour of polyphase asynchronous) is the absence of commutators, and edly under such conditions as exist in dangerous, d out-of-the-way places, this is a question of some , as commutators require attention, and where this rthcoming there is eventually trouble from destruc- king and other evils. But in the larger sizes of nous motors some form of starting resistance is and this has generally been most satisfactorily placed in the motor circuit. To do this, ordinary alter- nating-current slip rings or collectors are used, but these are not so objectionable as direct-current commutators, and also are only in use at starting. The torque at starting of the direct-current motor is superior to that of the asynchronous type, and for some classes of work this is a material advantage. The speed of the direct-current motor at all loads is more constant than that of the others, but this advantage is somewhat nullified by the fact that where perfectly uniform speed is required a polyphase synchronous motor can be used, which of course will run in step with the generator; if this latter plan is adopted, then the motor will only start light, which is not always feasible. The range of speed through which it is possible to work is also greater with direct-current motors, the speed of poly- phase motors simply decreasing slightly as the load comes on. The greatest disadvantage of this latter type is their low power factor, which varies in different machines from ·65 to ·85, while that of the direct-current motor, of course, is unity. The synchronous machine is better than the induction type in this respect, its power factor approaching unity at full load. This low power factor means that the size of both generators and motors has to be much increased to get the same amount of work from them as would be obtained if their power factor were unity. The efficiency of the two types is just about the same for similar sizes, varying from 80 to 95 per cent. As far as length of life and upkeep are concerned, the induction motor takes the lead, the winding of its short-circuited squirrel-cage arma- ture being more mechanical with its buried conductors than the great run of direct-current armatures, numbers of which have only smooth cores. The starting gear with the larger sizes of induction motors is more complicated and expen- sive than that of the direct-current type; with the smaller sizes the starting resistances are dispensed with, with the result that the torque at starting suffers slightly.

2. With polyphase work there are always the inseparable disadvantages attached to alternate currents, such as the arc light trouble, and if it is intended (as is most probable) to combine the lighting and power plant, then auxiliary machinery, such as rectifiers, converters, etc., have to be used to obtain anything like satisfactory results. The question of frequency is also rather a difficult one to settle, the frequency most suitable for motor driving being too low for lighting purposes, so that an average has to be struck which may be somewhat prejudicial to both. For the same voltage the insulation difficulties are greater with alternating currents, the maximum voltage being $\sqrt{2}$ the mean, not, perhaps, that there would have to be much difference in the cables and installation work, but the restrictions with alternate currents are always more stringent than with direct. The actual weight of copper in the polyphase systems is from 85 per cent. for two-phase to 75 per cent. for three-phase of that required for direct currents. In a combination of lighting power loads by three-phase distribution there is the difficulty of balancing the lighting load on the three circuits, which at times involves complications.

3. In prime cost there will be no great difference, direct-current distribution perhaps being a little the cheaper, but in maintenance polyphase work will have the advantage. Attendance is more with this latter system as a rule. It may be fairly correctly stated that for moderately small works the direct-current system will be most suitable, being simpler and cheaper. The full advantage of the polyphase system is not realised until the line losses become appreciable, though under certain conditions, such as apply in mines, dangerous trades, etc., the polyphase motor offers many advantages from the very fact of its construction; but for large powers and long-distance distribution the polyphase system is the best.—H. BELL.

Answer to Question 29 (*awarded* 2*s*. 6*d*.).—Very few firms in this country have gone in for polyphase motors to any extent. It is in the United States and Switzerland where most work has been done in this way. This is chiefly owing to their unequalled water powers. In England, the absence of considerable water powers and the satisfactory running of continuous-current motors have undoubtedly been the principal causes which have prevented us having a more

practical acquaintance with polyphase work. Polyphase motors require starting arrangements which are rather complicated—more so in the larger sizes. The Oerlikon Company use a special starting device for motors over 36 h.p., called an auto-transformer. It is a very neat device, but it all adds to the expense of the motor. The simplicity of design which is often claimed for the polyphase motor is considerably departed from, and the cost of the necessary adjuncts and resistances may counterbalance the cost of commutator of a continuous-current motor. The constancy of speed of an asynchronous motor is about equal to a shunt-wound con tinuous-current motor of the same power, the total drop in speed averaging 5 per cent. In the continuous-current machine the drop in speed can be remedied by merely putting on a series winding. In the other, the drop in speed, termed the "magnetic slip," is an absolute necessity of running. To remedy this, it is necessary to vary the speed of rotation between the field and armature. When a good starting torque is needed, efficiency and speed regulation must be sacrificed. The series continuous-current motor has the highest initial torque, sometimes as high as six or seven times the running torque. The initial torque of a polyphase motor may amount to three times the running torque by sacrificing efficiency and speed regulation. It will therefore be seen that a polyphase motor needs to be relatively about twice the capacity for similar starting power, and another difficulty steps in, for when running on the load, such a motor would only be doing half the work it was capable of doing. This would mean a still lower efficiency, perhaps not more than 60 per cent. On this point there appears to be a great advantage with continuous-current motors. It does not do to overload an alternate-current motor, for a sudden overload is liable to pull them up. The regulating resistances for continuous currents are more simple than for a polyphase motor. The impedance coil used as a resistance or damping action in certain alternate-current apparatus is no use for motor work, as its self-induction causes a lag in current, so

ADVANTAGES AND DISADVANTAGES OF CONTINUOUS AND ALTERNATE CURRENTS.

—	Continuous.	Alternating.
Pressure limit.	About 2,500 volts.	About 15,000 volts.
Generators. ...	Dynamos of two, four, six, or eight poles, with expensive commutator.	Alternator with 12 or more poles; no commutator.
Parallel running.	No difficulty, however dissimilar the units. Series working possible.	Difficulties, if too high or too low, an amount of self-induction, and, at high frequencies, synchronism becomes increasingly difficult the higher the number of phases. Series working impossible.
Self-induction.	Not affected.	Necessary to have concentric cables. There is also a difficulty in regulating pressure of supply.
Insulation.......	Stress of insulation a minimum.	Stress about 50 per cent. more than with direct currents for any voltage.
Transformers .	Rotate. Consist of dynamo and motor coupled. Expensive.	Stationary. Very cheap in construction. Large size require air blast to cool them.
Motors.	Extensively used. Very efficient, but require commutator and brushes.	Not many used. Only efficient at full load; special clutch or rings; starting resistance required.
Starting torque maximum.	Series wound. Six times running torque. High efficiency.	About three times running torque. Low efficiency.
Arc lighting ...	Most suitable crater in positive carbon; no noise in working.	Can be used; does not give such good results as continuous currents; noisy.
Electric welding.	Suitable especially for small welds.	Suitable especially for large welds.
Electrolytic work.	Suitable.	Unsuitable.
Charging accumulators.	Suitable. Most useful for storing power and steadying pressure.	Unsuitable.

increasing rather than diminishing the startin
The efficiency of polyphase motors is about t
that of direct-current motors. The following
give some idea of the efficiency which ma
guarantee for various sizes:

1½ h.p.	....	76 efficiency
4 ,,	....	80 ,,
5 ,,	....	80 ,,
12 ,,	....	84 ,,
15 ,,	....	88 ,,
50 ,,	....	91 ,,
110 ,,	....	92 ,,

The preceding table is a summary of adva
disadvantages of continuous and alternate cur
sidered from the point of view of the local dist
power in factories, and the general conclusion
continuous-current motor is the best all round.
neering shops, especially, where lighting, pow
electric welding, electric traction, and chargin
lators may all be employed, the advantage of
type of generating plant is obvious.—F. BRUTO

Question No. 30.—Discuss, from the consumer's
the Brighton system of charging for electrical
the reduced rate comes into force after one, tw
hours' average use per day respectively. Also
case when a charge of 8d. per unit for the fir
2d. per unit after is introduced to replace a uni
of 6d. per unit.

Best Answer to No. 30 (*awarded* 10*s.*).—Th
system of charging from the consumer's poin
It is to be assumed that the price charged at a
is not greater than the uniform charge previous
otherwise there will be discontent. In the first
will be some difficulty in grasping the system
consumers will not see the object of departin
"discount on quantity" system. When the pub
educated they will expect the discounts, and the
consumers will consider it an excellent arrang
many cases it will make the light cheaper tha
these consumers will increase their lamp c
There are, however, many disadvantages in t
from the ordinary consumer's point of view
private house, where there are lights in all th
an example. The householder uses two or t
from dusk till 11 p.m., and should get a good di
any accidental or careless leaving on of, say, th
lights will make the maximum demand indicat
deprive the consumer of the discount not for that
but the half-year. This is a very good excuse for
and is most certain to be taken advantage of.
party is to be held, there is always the bother
round to the supply station to have the instrum
circuited. Very often this will be overlooked in
preceding the event, and the discount will be lost
I consider, a very weak point in the system
popular point of view—there is too much fuss an
required in order to get cheap electricity.
sumers have to be very careful to turn off li
room before or soon after turning on lights
Now, although a consumer may do this hims
find it very difficult to make his servants do the
these objections are popular, and will apply to th
of the consumers. To those who understand
about electricity supply and the conditions of
will be at once apparent that the system fail
important particular—viz., that it takes no acco
time of maximum demand. The consumer is d
from using electric cooking apparatus in the d
requires too much current, and will increase
light bill. The same will apply to motors.
will charge him just as much whether his
switched on in the day as in the evening. Th
has no preference over the night load, and this
and rightly so, as unjust. It may be argued
consumer requires his discount he must compl
conditions, and should not expect it if he does
he does expect it. It annoys him to see his
enjoying cheap electricity while his is dear, and
a better consumer, but has made a mistake on p
night. The three hours' average use is too long

ıpting reward which almost no one can attain. It prize competition—the conditions are so onerous care for the trouble. The "two hours" is more e, and will be appreciated, but still, it is rather few will obtain the reward. The "one hour" ourse, meet with great approval, and Mr. Wright n that consumers above one hour have paid, or aid, their standing charges, and are therefore o the discount. Taking the case where 8d. and harged, instead of an uniform 6d. (previously used), raise such opposition that the unfortunate engi- soon be only be too pleased to make it 6d. and ı not fair to those consumers, bad ones, perhaps, probably big shopkeepers who close early, but dly have done a great deal of advertising for ·icity supply. It will increase their bill by one- ey will not use the light, and there will be an n amongst intending consumers that the price is . They will know little and care less about ı demands, and will not use the light. A scare nd does a large amount of damage. There is little ay, except that the system has worked fairly well, the central-station engineer's point of view it is ıccess. However, we are not concerned with this *system* which would give great satisfaction is a *ystem*, in which the *maximum price* is fixed for, *ours* when the station is heavily loaded. There m in use at Norwich on these lines, except that num price is charged for a longer time. It is a t mistake if in these matters timidity makes the hard to obtain. In your issue of the 21st ult. St. Pancras as an "awful example" of this policy.— ELL.

to No. 30 (*awarded* 2s. 6d.).—Speaking from the s point of view, the case is one of the ratio naximum demand in amperes and total demand -hours per day. The lower this ratio, the more ı would be the Wright system to the consumer. set of conditions as to the all-round price of ıe time during which the high rate is charged, and charged then and at the low rate, there is one ıbove at which the systems balance, while any io would favour the all-round rate, and a lower ld render the Brighton system the cheaper. In ıuoted, all-round price is 6d. per unit; Brighton l. for one hour, 2d. afterwards. This ratio works

$\frac{\text{ax.}}{\text{tal}} = \frac{2}{3}$—that is, if he burns his maximum number

$\frac{1}{2}$ hours per day, or if he burns lamps during the day ıximum current is two-thirds total ampere-hours, ıterial to the consumer whether he pay one way or If, however, the ratio be one-half, he would gain by ton system, while if it rose to five-sixths he would ied more cheaply on the all-round system. , therefore, a consumer who has many lamps once, and burning only short hours, would not ed by the Brighton system, while one who had ning few in number or many, but for long hours, l his bills greatly decreased.

take, in the first place, a case of a large shop ıy, 200 32-c.p. 220-volt lamps taking ·6 ampere ese would probably be alight all at once, and the ght would average, say, $1\frac{1}{2}$ hours per day, or n winter and half-hour in summer in case shop about 6 p.m. :

d rate of 6d. per unit, say, for 310 days per year, the cost would be: 10,230 units at 6d.... = £255 15 0
ton system in *winter* we have—$2\frac{1}{2}$ hours :

units at 8d. =	£0	14	8
units at 2d. =	0	5	6
for one day =	1	0	2
, at 6d. per unit, 55 at 6d. =	1	7	6
per day	0	7	4

er, average half-hour daily for four months = 1,133 units,

at 8d. =	£37	15	4
, 1,133 units at 6d. =	28	6	6
on four months	9	8	10

On the whole year's working we have, therefore,

At old rate, 10,230 units at 6d. =				£255	15	0
At new rate—						
Summer consumption, no rebate—1,133 units at 8d. =	£37	15	4			
Winter - 22 units *every day* for eight months, no rebate = 5,346 units at 8d. =	178	4	0			
Remainder, 3,651 units at 2d. =	30	8	6			
Total				246	17	10
Saving by new system				£8	17	2

This case probably is too good for new system owing to summer average being taken too low and winter too high. In practice the balance would likely be against new system.

For the second illustration take a large hotel or private house where lights are burned steadily until late at night. In this case the maximum demand may be taken as 60 16 c.p, the average at 40, and average time per day as six hours :

Then 60 lamps = 18 A. one hour at 8d. per unit— = four units at 8d. =		2	8
(40 lamps = 12 A. for six hours = 16 units) − 4 = 12 units at 2d.		2	0
Cost per day new system		4	8
Cost old system, 16 units at 6d.		8	0
Saving per day		3	4
For year = 365 × 16 × 6d. =	£146	0	0
New system = {365 × 4 × 8d. = £48 13 4; 365 × 12 × 2d. = 36 10 0} =	84	13	4
Total saving	£61	6	8

In these two cases the ratio $\frac{\text{maximum}}{\text{total ampere-hours}}$ was in Case 1: winter, $\frac{2}{5}$ gain on new system; summer, $\frac{2}{1}$ loss on new system; ratio at which prices balance, $\frac{2}{3}$.

In Case 2 average ratio is $\frac{1}{4}$, showing a gain on new system all the year round.

It may be noted that frequent meter inspections favour the consumer on this system very considerably.—W. H. I.

[N.B.—We have received a very large number of excellent answers to this question, but several of those replying have considered the subject from the station engineer's point of view. The consumer wants the reduction, and as a rule does not care for calculations or reasons.—Ed. *E. E.*]

LEGAL INTELLIGENCE.

IMPROVED ELECTRIC INCANDESCENT LAMP.

Action against the Edison-Swan Company.

In the Queen's Bench Division this week the case of the Improved Electric Glow Lamp Company, Limited, *v.* the Edison-Swan United Electric Light Company, Limited, came before Mr. Justice Mathew. This was an action for damages for breach of contract for the supply of electric lamps. Counsel representing plaintiffs were Mr. W. R. Bousfield, Q.C., Mr. Roger Wallace, Q.C., and Mr. A. J. Walter; for defendants, Mr. J. Fletcher Moulton, Q.C., and Mr. J. C. Graham.

In opening the case, **Mr. Bousfield** said the plaintiffs were a new company, while the defendants were old-established and well known. The new company had brought out a new lamp, called the "Glow" lamp, and had negotiated with the defendants as regards the manufacture of that lamp. Evidence was called to show that the plaintiff company had suffered damage by reason of the non-delivery of the lamps contracted for.

Ultimately an arrangement was come to by which the defendant company agreed to pay the plaintiffs £750 as compensation for delay, with costs. Judgment accordingly.—*Financial Times.*

ACTION BY MESSRS. SALMONY.

In the Westminster County Court on Tuesday, his Honour Judge Lumley Smith, Q.C., had before him the case of Salmony *v.* Thierman, in which the plaintiffs, Messrs. Salmony and Co., electrical engineers, carrying on business at Charing Cross-road, sued the defendant, who carries on business at Liverpool, to recover payment of an account of £10 odd in respect of an electrical resistance made to his order and other sundries supplied.

The plaintiffs called evidence to prove the order and delivery of the goods, and that they were in strict accordance with the defendant's instructions. In cross-examination, the plaintiffs' witness admitted that galvanised iron wire was used in the making of the resistance, and contended that it was the proper material to use, although in some cases German silver and other metals were employed.

The defendant's contention was that the resistance was about four times as large as it need have been, and that it was consequently useless for the purpose for which he wished to use it. He further contended that it was altogether different from the resistance shown in the plaintiffs' catalogue, and from which he gave the order. He had offered to pay the plaintiffs a reduced price for it in the hope that he might be able to make use of it in connection with another contract, but they refused his offer.

After hearing other evidence his **Honour** gave judgment for the plaintiffs for the amount claimed, less £1 in respect of one of the items. Costs were allowed.

COMPANIES' MEETINGS AND REPORTS.

CITY AND SOUTH LONDON RAILWAY COMPANY.

The twenty-seventh ordinary general half-yearly meeting of the City and South London Railway Company was held on the 28th ult., at Winchester House, Old Broad-street, the chairman of the Company (Mr. C. Grey Mott) presiding.

In moving the adoption of the report and accounts (published in our issue of the 21st ult.), the **Chairman** said he was sorry the directors were not able to propose an increase on the dividend of the past year, although they were enabled to give the same return to the shareholders. He was glad to say that the extensions were going on very satisfactorily. Considerable progress had been made at Finsbury-pavement, where the station tunnel was complete, and the other would soon be finished. Both tunnels were nearly finished for the whole length of Moorgate-street. The tunnels on the south side were nearly completed. One of the tunnels coming from that station northwards towards the City was nearly a third of the way under the river. There was likely to be delay in consequence of the necessity of supporting the structure of the church of St. Mary Woolnoth, but the expense thus occasioned would be paid by the church authorities. In their Bill power was sought whereby, if the opening of the new line should be delayed, and any extra expenditure should be incurred in the shape of dividend on the preference shares, they should be enabled to pay the necessary sum out of capital, the question whether this should not be taken as a part of the claim against the church having to be determined by an arbitrator. The Board had also bought property in connection with the Clapham extension. They were now negotiating with the contractors on the subject of the extension. The Company was, of course, providing for the increased generating power at the existing station. The directors were in negotiation with parties who were willing to carry out an extension of the piece of line between the Borough Station and King William-street, and who had deposited a Bill, with the approval of the Board of the City and South London Company, for the construction of a railway, to be known as the City and Brixton Railway, which would run from the Borough, *viâ* St. George's-circus and Kennington-road, to Brixton-hill, but taking a direction not very far from Waterloo Station to Westminster and Lambeth Bridges, thence turning up the Kennington-road, and so on to Brixton-hill. It was proposed that that new line should be leased to the City and South London Company, who would work it by means of the increased power they were providing in connection with their generating station, on terms which the directors believed would be mutually profitable. Beyond this the Board had arranged with the Central London Company, whose line was now being constructed from the Mansion House, up Holborn and Oxford-street, to Shepherd's Bush, that their two stations should be connected by a short subway, thereby creating, it was hoped and believed, a large interchange of traffic. The City and South London Company's station at Finsbury-pavement was opposite the booking office of the Metropolitan Railway, and their passengers would be landed within a few yards of each other place. Another interchange of traffic would take place at London Bridge with the South-Eastern and London and Brighton Railways, and provision had been made for platform accommodation between those two companies and the City and South London.

The motion was seconded by **Mr. S. Hanbury**, and agreed to.

A further motion declaring a dividend of $1\frac{1}{2}$ per cent. was also adopted, and, the chairman having been re-elected as a retiring director, the proceedings terminated.

CENTRAL LONDON RAILWAY COMPANY.

The report states that three-fourths of the main-line tunnel and one-half of the station tunnels are ready, and nearly the whole of the lift and staircase shafts have been constructed. At the Bank Station the subway for pipes is complete, and the public subways are well forward. The total amount expended to date is £1,606,948. The estimated expenditure for the current half-year is £700,000, leaving a further outlay in subsequent half-years of £1,200,000. The balance due to the Electric Traction Company on engineers' certificates is £224,447. The debit to capital account is £199,906. The total capital authorised consists of £2,850,000 shares and stock and £900,000 in loans, making together a total of £3,800,000. The amount of capital created £2,800,000, and amount received thereon £1,407,042, leaving the amount uncalled, less the payment in advance, £760,498. The amount unissued is £682,000, with respect to which a note to the account states "the shares have been subscribed under a binding contract with the Electric Traction Company, Limited, and their successors, for the payment of the sums subscribed." The amount received on capit[…]
during the half-year was £8,724. The interest of 3 pe[…]
the paid-up capital is £21,050. The total mileage aut[…]
6 miles and 35 chains.

The half-yearly general meeting of this Company was[…]
the 2nd inst., under the presidency of **Mr. H. Tenn[…]**
moved: "That the reports and accounts be adopted, and
payment of interest at the rate of 3 per cent. per annu[…]
paid-up capital of the Company be approved." **Lord C[…]**
Culross seconded the motion, which was adopted.

EDINBURGH STREET TRAMWAYS COMPAN[…]

The report of the directors of the Edinburgh Street T[…]
Company for the half-year ended Dec. 1 last, to be sub[…]
the ordinary meeting to be held in Edinburgh on the 7[…]
according to the *Financial Times*, states that the tota[…]
have been £18,837, and the total ordinary expenditure
showing a net profit of £2,563, to which has to be a[…]
balance from last half year, £592, making a total of £3[…]
interest on mortgages £362, leaving a balance of £2,7[…]
directors propose a dividend at the rate of 1s. 4d. per s[…]
of income tax, leaving £793 to be carried forward. T[…]
traffic receipts from cars and omnibuses show an in[…]
£2,350, earned for the most part during the autumn, w[…]
and open weather generally prevailed. The net revenue
working of the traffic as a whole shows a satisfactory
The directors have been in negotiations with the Corpor[…]
Leith and Edinburgh for the sale of the tramway lines
regard their negotiations as now concluded, subjected […]
the approval of the shareholders. It will be necessary t[…]
special meeting at an early date in order to submit th[…]
agreements, which are in course of preparation, to t[…]
holders. Full details will be given to that meeting.
directors content themselves at present by announc[…]
visionally that the price for the Leith line is £75,000 an[…]
Portobello line £40,000.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT CO[…] LIMITED.

Directors: Eustace J. A. Balfour, Esq., chairman; […]
Clark, Esq., F.R.S., vice-chairman; Sir John H. Morris, […]
Bennett Fitch, Esq., M.I.C.E.; Walter Leaf, Esq. […]
manager and secretary: Frederic J. Walker. Chief […]
S. T. Dobson, A.M.I.C.E., M.I.E.E.

Report of the directors, with abstract of accounts for[…]
Dec. 31, 1897, to be presented to the shareholders at t[…]
general meeting to be held at the offices of the Company, […]
street Central Station, Golden-square, W., on Tuesday, […]
12 noon:

The extension of Carnaby-street station is on the poin[…]
pletion, and will soon be equipped with a full plant of […]
It has been working satisfactorily throughout the year i[…]
tion with the station at Mason's-yard. Steady progress […]
made in the increase of the Company's supply to pri[…]
sumers, and the principal streets of the district are now li[…]
electricity. An agreement, dated Dec. 16, 1897, has be[…]
with the holders of founders' shares by which, subject to […]
tion by the shareholders, they will receive an allotmen[…]
ordinary shares at par in exchange for each founder's sh[…]
exchange to take effect as and from Jan. 1, 1898. In […]
carry out this agreement steps are being taken to inc[…]
capital of the Company to £300,000 by the creation of 2[…]
ordinary shares of £5 each, of which 12,000 £5 shares […]
issued at par to the holders of the founders' shares. […]
give the Company £60,000 additional capital at once, an[…]
effect, extinguish the founders' shares. A notice of a m[…]
deal with the matter after the general meeting is over is […]
the report. The net earnings of the Company during […]
year have amounted to £29,093. 17s. 7d. Of this sum £6[…]
was distributed in August last in payment of an interim […]
at the rate of 7 per cent. per annum for the half-yea[…]
June 30, 1897, on the ordinary shares, and of 7 per […]
annum on the preference shares. The balance, £22,097.[…]
together with the undivided profit of £327. 15s. 9d. […]
year's account, leaves £22,425. 3s. 4d. now to be dealt wi[…]
directors propose to divide the amount as follows:

(A) By payment of a dividend at the rate of 7 per cent. per annum on the preference shares for the second half of the year	£3,5[…]
(B) By payment of a dividend on the ordinary shares for the second half-year of 11s. per share, making, with the interim dividend paid on Aug. 2 last, a total distribution of $14\frac{1}{2}$ per cent. for the year	10,[…]
(C) By payment of a dividend of £75. 10s. 4d. per share on the founders' shares	7,[…]
(D) Amount to be carried forward to ordinary shareholders' undivided profit account	[…]
	£22,[…]

Sir John H. Morris, K.C.S.I., and Mr. Bennett Fitch, […]
are the directors who retire by rotation under Clause 7[…]
articles of association, and, being eligible, offer thems[…]
re-election. The auditors, Messrs. Deloitte, Dever, Grif[…]
Co., also retire, and, being eligible, offer themselves for re-

REVENUE ACCOUNT YEAR ENDING DEC. 31, 1897.

	£	s.	d.	£	s.	d.
To Generation and Distribution of Electricity.				£	s.	d.
ıcluding dues, carriage, etc.	£6 514	1	2			
ıte, water, engine-room stores	921	19	2			
of engineers and officers......	1,494	12	4			
ıt generating and distributing ns	3,642	18	6			
and maintenance, as follows: ings (including alterations), 0s. 6d.; engines and boilers, 3. 0s. 8d.; dynamos, 16s.; other machinery, ıments, and tools, £367. 1.; accumulators, £82. 2s. 2d.; ı (at stations), £64. 3s.; main ıst and chimney shaft, £1,200	3,773	5	2			
ng and repairing public ı	373	1	0			
and maintenance of mains ...	1,145	4	4			
ıneous expenses	112	9	6			
				17,977	11	2
To Rents, Rates, and Taxes.						
ayable	245	0	0			
nd taxes	2,456	8	6			
				2,701	8	6
To Management Expenses.						
rs' remuneration......	2,500	0	0			
of manager and secretary, eer, clerks, canvasser, etc. ...	3,463	9	5			
ıry, printing, and advertising	216	19	3			
establishment charges.........	394	0	9			
s of Company...........	78	15	0			
for debenture stock-holders..	52	10	0			
				6,705	14	5
ıenses				124	9	2
To Special Charges.						
ıe	485	14	7			
testing meters	24	3	10			
Trade audit	60	0	0			
				569	18	5
To Depreciation.						
tion on buildings..............	419	3	6			
plant, machinery, etc.	8,850	16	6			
				9,270	0	0
				37,349	1	8
of sales on old plant..............................				386	1	1
carried to net revenue account				30,534	2	6
				£68,269	5	3

	£	s.	d.
urrent, after deducting provision for bad ıbtful debts (at 6d. per unit, less rebate)	63,668	14	11
der contract...........	1,210	4	10
ghting	1,497	3	2
	66 376	2	11
f meters on consumers' premises	1,528	11	5
ceivable	128	16	9
fees	40	7	6
ts on purchases	106	13	6
old materials, stores, etc.	4	1	8
fees, shareholders' lists sold, etc.	4	5	3
ıtes m......	80	6	3
	£68,269	5	3

GENERAL BALANCE-SHEET, DEC. 31, 1897.

	£	s.	d.
account—amount received	250,000	0	0
Bank, Limited, temporary loan	50,000	0	0
tradesmen and others, due on construction ınt and machinery, fuel stores, etc............	3,197	16	9
creditors on open accounts	2,815	3	4
ture stock-holders, for interest accrued, less payable Jan. 1, 1898	996	13	4
med dividends	28	8	11
l reserve fund...	15,000	0	0
venue account—balance at credit thereof, 421. 13s. 4d.; less interim dividends paid on rence and ordinary shares, £6 996. 10s.	22,425	3	4
	344,433	5	8

	£	s.	d.
account- -amount expended for works, less ciation to date	254,077	2	5
liture on freehold site etc.	37,450	13	10
on hand—coal, £226. 13s. 6d.; lamps, 5s. 6d.; meters and switches, £1,629. ld.; general, including oil, waste, etc.,). 17s. 8d.	3,436	5	7
debtors for current supplied, £16,906 .; other debtors, £536 13s. 9d.	17,443	3	1
bankers (Lloyd's Bank, Limited), £16,942. l.; cash in hand, £83. 5s. 3d...........	17,026	0	9
eserve fund investments, cost of Canada ent., Cape 3½ per cent., and India 3 per tock	15,000	0	0
	£344,433	5	8

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC., YEAR ENDING DEC. 31, 1897.

Board of Trade units generated..		3,386,944
Quantity utilised—		
Sold to consumers	3,028,242	3,077,186
Used on works....................................	48,944	
Quantity expended in distribution—		
In batteries	8,730	248,794
In feeder	240,064	
Quantity accounted for.. ...		3,325,980
Quantity unaccounted for..		60,964
Number of lamps on circuit, Dec. 31, 1897..................		126,827

WATERLOO AND CITY RAILWAY COMPANY.

The report states that the final call on the shares has now been received, and that the shares will be converted into general capital stock, with all the rights and privileges of the holders of existing shares. The total expenditure to date is £473,776, £113,170 of which was received during the half year. The estimated expenditure on capital account for the current half-year is £62,000, and in subsequent half-years £41,200, making a total of £103,000. The following is a copy of the engineers' report: "All the tunnels are finished except a portion of the white glazed tiling in the up City station tunnel, and in the inclined approach to the Central London Company's subways at the Mansion House. In the down or southern tunnel the permanent way has been laid from Waterloo to the cross-over road at the western end of the City station, and in the up or northern tunnel the permanent way has been laid from Waterloo to the river shaft, and the remaining length of road-laying is in hand. The low-level station at Waterloo is finished, and all the three communications between the high and low level stations will be completed early next month. The yard for the terminal sidings at Waterloo is finished and ballasted, and more than half of the sidings have been laid. The whole of the permanent-way materials for the sidings are on the ground. In the generating stations the first portion of the engine and boiler houses is ready for the reception of the machinery. All the boilers have been delivered, and these have been fixed. Two engines have been delivered and are being fixed, and it is expected that current for experimental purposes will be available about the middle of February. In addition to the engines mentioned above, the remaining four machines and the whole of the dynamos are nearly ready, and the switch-board work and other apparatus for the station is far advanced. The travelling crane is delivered and in use. The electrical work in both tunnels is now complete as far as the river shaft. Beyond the shaft the contractors for the electrical work are following on towards the City as quickly as possible, and will reach the cross-over road in the down tunnel in about a month. The rolling-stock has been delivered to the London and South-Western Railway Company, and is now being erected at their Eastleigh Carriage Works. One train is practically complete, and the others are far advanced. The signalling arrangements have been approved by the Board of Trade. The contract for the same has been let, the work is in hand, and fixing will very shortly be commenced. The works now remaining to be completed are: (1) the permanent way in the up tunnel between the shaft in the River Thames and the City station; (2) portions of the platforms and tiling in the City station and inclined approach tunnel, and the short staircase and landing connecting the inclined tunnel with the up and down platforms; (3) the remainder of the buildings at the generating station at Waterloo. All the above will, we believe, be ready by the middle of March. The large lift for lowering the rolling-stock is making good progress, and is expected to be in working order on or before Feb. 20. Of the two temporary exits for passengers at the Mansion House (pending the completion of the Central London subways), one is well advanced, and it is hoped will be ready simultaneously with the completion of the Waterloo and City Railway. The other is progressing, but its completion depends upon the levels of the gas and water mains at the eastern end of Queen Victoria-street, the exact position of which have not yet been definitely ascertained by the Central London Railway Company, by whom these outlets are being constructed."

METROPOLITAN RAILWAY COMPANY.

After the conclusion of the ordinary general meeting held on Friday at the Cannon-street Hotel, the meeting was constituted a special one for the consideration of a Bill conferring further powers on the Company for the ventilation of their railway and the working of it by electrical power. The Chairman, Mr. John Bell, said the Bill was an omnibus Bill, intended for the improvement of the Company's undertaking. They would have power to make additional openings in the streets in order to improve the ventilation. The directors had for the past 10 years been considering the question of electricity; 25 years' practice assured him that electric traction was the solution of their ventilation difficulty. They thought they were now on the way to secure it, but there were great difficulties in the way. They would require entirely new stock. There was no difficulty about pulling trains of 200, 250, or 300 tons. The question to be solved was having a sufficient reserve of energy on the circle in the event of two, three, four, or more trains wanting to start at the same time for them to do so. That was the problem. A resolution granting the directors the necessary powers was agreed to.

YORKSHIRE HOUSE-TO-HOUSE ELECTRICITY COMPANY.

The ordinary general meeting of the members of the Yorkshire House-to-House Electricity Company, Limited, was held on the 1st inst. at the Great Northern Hotel, Leeds, Mr. Grosvenor Talbot presiding. The report and accounts as published in our issue of 21st ult. were passed. Mr. A. G. Lupton and Mr. J. T. Pearson were re-elected directors, and Mr. John Gordon, jun., was reappointed auditor.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Leon (Spain).—Tenders are invited for electric lighting of the town of Valderas for 17 years. Specifications are to be obtained from, and tenders addressed to, Municipal Authorities of the above town. Tenders by Feb. 11.

St. Chamond (France).—Tenders are invited for lighting the town by electricity or otherwise. Particulars are to be obtained from, and tenders addressed to, Municipal Authorities at above place (Department Loire) by March 31.

Braila (Roumania).—Tenders are invited for the electric lighting of the town. The deposit required is £600. Specifications are to be obtained from, and tenders addressed to, the Municipal Authorities at Braila by Feb. 20 (March 4), at 4 p.m.

Novorossisk (Russia).—Tenders are invited for the construction, etc., of an electric lighting installation for the town. The deposit is 5,000 roubles. Specifications may be obtained from, and tenders addressed to, the Municipal Authorities of the town by March 1 (13).

Madras.—The Secretary of State for India in Council announces that the time allowed for the receipt of tenders by the Chief Engineer for Irrigation, Madras, for the utilisation of water power of the Periyar Lake has been extended from Oct. 31, 1897, to July 1, 1898.

Brussels.—Tenders are invited for electric lighting of the Government offices, rue de Chêne, Brussels. The estimated cost is 8,860·72fr., and the deposit required is 900fr. Specifications are to be obtained from, and tenders addressed to, Provincial Government Offices, Brussels.

Jordesillas (Spain).—Tenders are invited for electric lighting of the town for 20 years. The estimated cost is 2,500 pesetas per annum, and the deposit required is 1,385 pesetas. Specifications are to be obtained from, and tenders addressed to, Municipal Authorities of the above town. Tenders by Feb. 6.

Tipperary.—The Guardians of Tipperary Union invite tenders for the erection of electric bells in the workhouse and a speaking-tube connecting the Board-room with the porter's office. Full particulars can be had on application to the Master. No charge to be made for preparing plans. Tenders by 12 noon on 8th inst.

Novorossisk (Russia).—Tenders are invited for the construction, etc., of an electric tramway. The deposit required is 5,000 roubles. Specifications, etc. (in French), are to be obtained from, and tenders addressed to, the Municipal Authorities, Novorossisk (Russia), by March 1 (13). The time has been extended from November 15.

Edinburgh.—The Lord Provost and Magistrates and Council invite tenders for the wiring of the police station, Abbeyhill. Specification, form of tender, and plans of building can be obtained at the office of the Resident Electrical Engineer, 5, Dewar-place, Edinburgh, on deposit of £2. 2s., which deposit will be returned on receipt of a bona fide tender. Tenders must be sent to Mr. Thomas Hunter, W.S., town clerk, City Chambers, Edinburgh, by to-morrow.

Madrid.—The Secretary of State for Foreign Affairs has received a despatch from her Majesty's Chargé d'Affaires at Madrid, enclosing copy of a Royal decree announcing that a public auction for the contract for repairing the national submarine telegraph cables during the next five years will be held at Madrid on Feb. 22. Further particulars as to the cables in question may be inspected at the Commercial Department of the Foreign Office any time between 11 and 5.

Rochdale.—The Corporation invite tenders for the following: (Contract No. 1) steam dynamos, balancer and boosters, etc. Specifications, conditions of contract, and form of tender may be obtained at the offices of the engineers, Messrs. Lacey, Clirehugh, and Sillar, 10, Delahay-street, Westminster, on payment of £5. 5s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed and endorsed "Electricity Works," must be delivered at the office of Mr. Jas. Leach, town clerk, Town Hall, Rochdale, by Feb. 19.

Wolverhampton.—The Public Works Committee invite designs and tenders for motor-vans for street scavenging and the conveyance of road materials. Outline specification and form of tender can be obtained on application to Mr. J. W. Bradley, C.E., borough engineer and surveyor, Town Hall, Wolverhampton. Firms tendering do so at their own cost in every respect. Drawings and a full description of the motive power, capacity, and other particulars, addressed to the Chairman of the Public Works Committee, to be delivered by February 7.

London, S.W.—The Secretary of State for War is prepared to receive offers, in writing, accompanied by competitive designs and specifications, for the supply of portable electric search-light apparatus. General particulars as to requirements can be obtained on application, either by letter or personally, to A. Major, director of army contracts, War Office, Pall-mall, S.W. The offers and designs must be delivered at the War Office, Pall-mall, London, S.W., by April 27, addressed to the Director of Army Contracts, and marked on the outside "Designs for Search-Light Apparatus."

Guipuzcoa (Spain).—The Secretary of State for Foreign Affairs has received a despatch from her Majesty's Consul at Bilbao, reporting that the Provisional Board appointed in connection with the electric tramway which it is proposed to lay from Zumarraga to Zumaya, in the province of Guipuzcoa, invite plans and tenders, to be received by February 28, for the construction and equipment of the line. Further particulars of the conditions of the tender for the above-named tramline and branch, which together measure 30 miles, may be inspected at the Commercial Department of the Foreign Office between 11 and 6.

Wimbledon.—The Urban District Council invite tenders for the erection of an electric lighting station and chimney shaft near the pumping station at Wimbledon. Plans and specification may be inspected at the offices of the Council's engineer, Mr. A. H. P[illegible], A.M.I.C.E., 39, Victoria-street, Westminster, London, S.W., and bills of quantities can be obtained from him on payment of the sum of £2. 2s., which will be returned on the receipt of a bona fide tender. Tenders, on the printed forms, are to be delivered to Mr. W. H. Whitfield, clerk, Broadway, Wimbledon, by 5 p.m. on Feb. 9. The tender to be accompanied by the priced bills of quantities, in sealed envelopes, which will be returned unopened to the unsuccessful competitors.

Redditch.—The Urban District Council are prepared to receive tenders for the following: (Contract 1) central-station buildings, foundations for plant, etc.; (2) gas-producing plant for 230 h.p.; (3) three double-cylinder gas-engines, total 350 h.p.; (4) three alternators, total 235 kw.; (5) concentric lead-covered armoured cables; (6) alternating-current transformers, for 200 kw.; (7) switchboard and instruments; (8) countershaft, pulleys, ropes, and belts. Sealed tenders, marked "Electric Lighting," must be sent in to Messrs. Browning and Hobson, clerks to the Council, Redditch, by Feb 14. Any of the specifications can be obtained from Mr. J. A. McMullen, M.I.E.E., Hornchurch, Essex, consulting engineer to the Council, on payment of a deposit of £2. 2s., which will be returned on receipt of a bona fide tender.

St. Helens.—The Corporation invite tenders for the following work in connection with the supply of electricity for electric traction: engines, condensers, dynamos, switchboards, batteries, overhead conductors, poles, and other appurtenances. Copies of the specification may be obtained from Mr. W. J. Jeeves, town clerk, on payment of £25 (to be returned on receipt by the Corporation of a bona fide tender). Specifications and drawings can be seen at the temporary offices of Dr. J. Hopkinson, F.R.S., 34, Victoria-street, London, and at 29, Princess-street, Manchester, and at the Town Hall, St. Helens. The Corporation will also be prepared to consider any tenders providing for any alterations or other arrangement or system that a contractor may desire to specify. Tenders, on the prescribed form, must be delivered at the office of the Town Clerk not later than Feb. [illegible] 1898.

Sophia (Bulgaria), March 5-17.—Her Majesty's Secretary of State for Foreign Affairs has received a despatch from her Majesty's Agent and Consul-General at Sophia to the effect that the Municipality of Sophia have issued a notice inviting tenders (*a*) for electric lighting of the town, town hall, and fire brigade barracks; (*b*) for an electric tramway for the town and surroundings. Only bona fide electrical firms are allowed to tender. Tenders must be in by March 5-17, at 11 a.m. A deposit certificate of the National Bank of Bulgaria of £6,000 must accompany each tender; also documents showing that the contracting firm has already successfully carried out similar work. If up to the 10th-22nd of March, at 10.30 a.m., a proposal of reduction of at least 5 per cent. per kilowatt-hour of the lowest tender is received, a new adjudication will take place on the same day at 11 a.m. Specifications are to be obtained from the Mayor of the above town (8s. prepaid), where tenders are to be addressed. Further particulars may be obtained, and a copy of the specification and other papers may be inspected, on application at the Commercial Department of the Foreign Office, between the hours of 11 and 5.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one-fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to

approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to July 1, 1898.

RESULTS OF TENDERS.

Bedford.—The Town Council have accepted the tender of Messrs. Rootham and Jeakings, Bedford, at £309, for building offices and storerooms at the electricity works.

Hammersmith.—The tender of Messrs. Robey and Co., at £3,210, has been accepted for the supply of two steam-engines and other plant to drive electric lighting alternators.

West Hartlepool.—The tenders of Messrs. Anderson and Co., for boilers, etc., at £1,530; Messrs. Crompton and Co., for dynamos, etc., at £1,630; and the same firm for lamps, at £239, have been accepted.

Bedford.—The tender of W. T. Henley's Telegraph Works Company, Limited, at £1,683. 3s., has been accepted by the Town Council for the supply and delivery at the Bedford railway station of vulcanised rubber cables.

Bedford.—The Electric Light Committee have accepted the following tenders: W. H. Allen, Son, and Co., Bedford, one 400-b.h.p. double-acting compound enclosed engine, £1,375; Easton, Anderson, and Goolden, Erith, one 250-unit alternator with stationary armature, £1,075.

Leith.—The Special Committee on Electric Lighting have accepted the following tenders for the electric light station buildings: mason work, Kinnear, Moodie, and Co., £7,693; joiner work, Kinnear, Moodie, and Co., £994; plumber work, Patrick Knox and Sons, £269; ironwork, A. Mather and Son, £1,972; glazier work, Robert Graham, £307; slater work, M'Lean and Reid, £99; plaster work, Stuart's Granolithic Stone Company, Limited, £69.

BUSINESS NOTES.

Gateshead.—We hear that the tramway company propose to adopt the overhead system.

Patrington.—A telegraphic system is to be arranged between Patrington and Ottringham.

Exeter.—The number of lamps has increased from 7,400 to 9,000 during the year 1897.

London Electrical Cab Company, Limited.—Letters of allotment to applicants for shares have been posted.

Southampton.—The Corporation have practically offered £40,000 to the tramway company for their undertaking.

Worthing.—A definite electric lighting scheme has been promised for the next meeting of the Town Council.

Castleford.—The Council are in favour of applying for powers to supply electricity for lighting and other purposes.

Fulham.—The electric lighting of Argyll-mansions, Addison Bridge, is under the immediate consideration of the Vestry.

Dewsbury.—At the last meeting of the Dewsbury Corporation an increase in the use of gas and of electricity was reported.

Burnley.—An unopposed Local Government Board enquiry was held last week into the Council's application to borrow £25,000 for electric lighting extensions.

Hastings.—A strong committee has been formed, and steps are to be at once taken to oppose the proposed tramway. A fund has been opened to guarantee the necessary expenses.

Shoreham.—The Southern Cross Shipyard and Engineering Company, Shoreham, are submitting to the Council estimates and specifications for the electric lighting of the town.

Wigan.—With reference to the proposed electric lighting, a resolution that the ratepayers be asked to express their views upon the project has been confirmed by the Town Council.

Canterbury.—The Council have granted several amounts to tenants in compensation for their giving up the land at once for the purpose of the erection of the electric light station.

Cuba Submarine Telegraph Company, Limited.—The directors recommend a dividend on the ordinary shares at the rate of 6 per cent. per annum, tax free, for the half-year ended Dec. 31.

Sheffield.—The minutes of the Finance and General Purposes Committee, which recommended that the electric light should be installed at the Union Offices, Westbar, has been confirmed by the Guardians.

Camberwell.—At the last meeting of the Vestry, the Clerk said he had received a letter from the promoters announcing that the proposed New Cross and Waterloo Electric Railway Bill would not be proceeded with.

Edmonton.—The Board of Guardians have instructed their Committee to consider and report on the advisability of applying electric lighting to the workhouse and to the Chase Schools at Enfield.

Saddleworth.—Notice of motion having been given that a provisional order for power to light the township by the electric light should be obtained by the Council, a special meeting is announced for March 4, to pass the resolution.

Belfast.—The Estates Committee's report contained a statement that they have thoroughly considered the question of lighting the stalls on the Market-hills by electricity, and recommended that the work be not carried out.

Whitehaven.—A deputation from Motherwell, Scotland, visited Whitehaven last week to inspect the system of public and private lighting by electric incandescent lamps. The visitors were received and entertained by several members of the Town Council.

Newark.—The committee appointed to consider the Bill of the General Power Distributing Company have recommended that communication be opened up with other local authorities, with a view of considering the question of opposition to the Bill.

Blackpool and Fleetwood Tramroad Company.—The ordinary half-yearly meeting of the shareholders of the Blackpool and Fleetwood Tramroad Company will be held in the Accountants' Hall, 65, King-street, Manchester, on Friday, 18th inst., at 12 noon.

Otterbourne.—The National Telephone Company's offer to connect the waterworks at Otterbourne with the audit house and the waterworks engineer's residence for a rental of £50 per annum (for earth circuit), on a five years' agreement, has been accepted.

Waterloo and City Railway.—The engineers' report, appearing in another column, states that the work will be completed by the middle of next month. The large lift for the lowering of the rolling-stock is expected to be in working order on the 20th inst.

Norwich.—In connection with the proposal for a municipal telephone exchange for the city, to be established either by the Corporation or by a company approved by it, a deputation of the Council is to wait upon the Postmaster-General to present a petition.

Almanac.—We beg to acknowledge the receipt of an almanac from Messrs. Nalder Bros. and Thompson, makers of the N. C. S. ammeters and voltmeters, Ayrton-Mather patent electrostatic voltmeters, and permanent magnet moving coil instruments for power transmission work.

London County Council.—By way of forcing the Postmaster-General to grant an enquiry into the telephone service of London, the Highways Committee are recommending the Council to apply for a licence to provide a municipal service, but the proposal was not reached at the last sitting.

St. George's, S.E.—With regard to the New Cross and Waterloo and the City and Brixton Railway Bills, the Vestry require certain clauses to be inserted in the Bills for the protection of the Vestry. Messrs. Hargreaves and Co. are to be employed as the Vestry's parliamentary agents in relation to these Bills.

Finchley.—At the last meeting of the Urban Council it was decided, with reference to an enquiry as to supplying electric light in the district, to reply that up to the present the Council had not been able to see its way to support any scheme, but they would give careful consideration to any proposal.

Birmingham.—Mr. H. H. Law, Local Government Board inspector, sat in the Council-chamber last week to enquire into the application by the City Council for sanction to borrow £10,000 for lunatic asylum purposes, and £12,510 for the erection of a refuse destructor at the Montgomery-street wharf.

Sheffield.—The Brush Electrical Engineering Company, Limited, has received an extension order from the Sheffield Electric Light and Power Company for a 600-kw. steam alternator for next winter's load, the plant to consist of an inductor pattern alternator coupled direct to an Universal steam-engine.

Bolton.—Mr. Walter A. Ducat, Local Government Board inspector, held an enquiry recently into an application by the Corporation for sanction to borrow an additional sum of £10,255 to defray the cost of completing the Back-o'-th'-Bank refuse destructor works, and for £3,000 for technical instruction purposes.

North Riding.—The Highways Committee have reported that the laying of the tramway rails in connection with the electric tramway from Thornaby to Middlesbrough had been completed, and that the sum of £1,200 had been voted to the Imperial Tramways Company for wayleave. The Council have confirmed the grant.

Buenos Ayres and Belgrano Tramways Company.—A meeting of this Company was held on the 1st inst. for the purpose of considering a draft agreement with the Buenos Ayres and Belgrano Electric Tramways Company, Limited, for amalgamation with the latter in order to substitute electric for horse traction. The proposal was carried.

Norwich Electric Tramways Company.—A special meeting of the proprietors of the Norwich Electric Tramways Company will be held at 4, Bank-buildings, London, E.C., on Wednesday, the 16th inst., at 2 p.m., for the purpose of considering a Bill to authorise the Norwich Electric Tramways Company to construct additional tramways and for other purposes.

Cardiff.—A Local Government Board enquiry was held on the 28th ult. by Mr. Herbert H. Law in connection with an application for sanction to borrow £29,500 for the purposes of electric lighting; £2,809 for street improvement; £520 for the purchase of land for a branch library at Grangetown; and £180 for the purposes of sanitary conveniences at the town hall.

Appointments Vacant.—In another column appear advertisements of several vacancies, amongst which we note that the Corporation of Birkenhead require a resident electrical engineer; a switch-room attendant is required at the electric lighting works of the St. Mary, Islington, Vestry; an improver is wanted at the Dundee electric light station, and several other vacancies occur.

Leeds.—At the last meeting of the City Council it was resolved that the Electric Lighting Committee should oppose the General Power Distributing Company's Bill, and that the chairman and

the clerk should confer with the Nottingham, Derby, and Newark authorities as to concerted action. The Finance Committee were authorised to issue Corporation stock to raise £10,000 for electric lighting contracts.

Houghton-le-Spring.—At the last meeting of the Guardians a recommendation appeared in the Visiting Committee's report that incandescent lights be fixed in the Board-room. It was thought rather than fix incandescent lights as suggested it would be better to go in for an electric light installation for the lighting of the whole workhouse establishment. The matter was referred to the Visiting Committee.

Anglo-American Telegraph Company.—The total receipts from July 1 to Dec. 31, including £8,507 brought forward, amounted to £187,832. The traffic receipts show an increase of £6 540. The total expenses amounted to £58,372, being an increase of £371. The directors have, before declaring the net profits, set apart the sum of £12,000 to the renewal fund, leaving a balance of £117,459. The dividends have already been announced.

Flixton.—A meeting of ratepayers, called under the auspices of the Flixton Parish Council, was held last week to consider and test the feeling of the township with respect to publicly lighting the main roads, and also to decide whether application should be made to the Lancashire County Council for urban powers for the district. A resolution "That the Council should proceed with the lighting" was carried, but a poll was demanded.

Charing Cross and Strand Electricity Supply Corporation, Limited.—The directors have decided to recommend a dividend for the half-year ended Dec. 31 last at the rate of 8 per cent. per annum, making, with the interim dividend distributed for the half-year ended June 30, at the rate of 6 per cent. per annum, a dividend payable for the year 1897 of 7 per cent. on the ordinary share capital. A dividend of 6 per cent. was paid for the year 1896.

National Telephone Company, Limited.—The directors recommend a dividend for the half-year ended Dec. 31 at the rate of 6 per cent. per annum, tax free, on the amounts paid up on the ordinary shares, carrying £40,000 to reserve and about £9,000 forward. The transfer books in respect of the preference and ordinary shares will be closed from 4th to 17th inst., both days inclusive, preparatory to the payment of the half-year's dividend.

Chelmsford.—At the last meeting of the Town Council the desirability of periodical testings of the illuminating power of gas and electric light was again urged. The Mayor said that when a test was last made both lights were above normal power. A councillor suggested that the lighting companies knew of the inspector's coming. The question of appointing a gas and electric lighting inspector was referred to the Lighting Committee for consideration.

Electric Metal Working.—We are informed that Messrs. Scott, Anderson, and Beit, of Royal Insurance-buildings, Sheffield, have been appointed sole agents for the Voltex process of electric welding, brazing, etc., for the following counties: Yorkshire (south of a line through Whitby, Northallerton, and Richmond to Kirkby Stephen), together with the entire counties of Lancashire, Nottingham, Derbyshire, Staffordshire, Cheshire, Worcestershire, and Warwickshire.

Dudley.—At the last meeting of the Town Council the Mayor said that the Dudley Corporation had spent a considerable sum of money and had expended much time in obtaining a provisional order for electric lighting, and if the Midland Electric Power Distribution Company would approach the Council with definite terms, it was probable that satisfactory terms might be arranged. The executive powers of the Electric Lighting Committee were extended for two months.

Leamington.—The Midland Electric Lighting Company, of Birmingham, have abandoned the provisional order promoted in Parliament for powers to light the borough of Leamington by electricity. This decision has been arrived at in consequence of the Leamington Corporation having applied for a similar provisional order. The company are already supplying a large portion of the borough with electricity, and possess plant in the town which cost £34,000.

Limavady.—The directors of the Limavady Gas Company at their last meeting had under consideration the future progress of the consumption of gas and its rival, the electric light. It appears that some time ago Mr. J. E. Ritter, who advertised his intention to apply for a provisional order for the purpose of supplying electric light in the district, has not yet made this application. A deputation was appointed to lay the matter before Mr. B. H. Lane, S.C.S., with instructions to proceed according to law.

Hull.—The electrical engineer, Mr. Barnard, has submitted the following estimate of the income and expenditure of the committee during 1898: Expenditure—generation of current, £3,100; distribution of current, £350; repairs, renewals, and maintenance, £1,100; management expenses, £1,175; insurances, £150; rents, rates, and taxes, £950; interest on capital, £1,985; payments to sinking fund, £1,470; balance, being profit, £970—total, £11,250. Income: sale of electricity, £10,830; meter rates, £420—total, £11 250.

Derby.—The following report of the Electric Lighting Committee has been adopted by the Town Council: "Prices are being obtained for low-tension cable for use in extensions during the ensuing year. The committee are pleased to report that the Highways Committee have accepted the offer made to them for lighting Uttoxeter New-road and Sudbury-street with incandescent electric light. The Plant and Stores Committee are recommending the Council to grant the necessary money for lighting Ford-street yard and the buildings and offices with electric light."

All-British West India Cable.—An all-British cable
West Indies was opened on the 31st ult. The last link
nished by a cable from Bermuda to Jamaica, connecting
already in operation between Halifax and Bermuda.
from England to Jamaica, instead of going to Nova Sc
thence *viâ* Galveston, Texas, to Jamaica, will now
viâ Nova Scotia to Bermuda and Jamaica, and so on to
islands by the existing cables.

St Albans.—A clause in the Parliamentary Com
report with reference to the St. Albans Electric Lighting
1898, recommending that the necessary steps should be
behalf of the Council to oppose the order asked for by
Albans Corporation, and that the seal of the Council sh
affixed to the necessary petition to Parliament against
which might be introduced to confirm the order should th
of Trade decline to insert the provisions asked for by the
Council, has been agreed to by the Hertfordshire County

Bromley (Kent) Electric Light and Power Company, L
The works of this Company are now in full swing. The C
was registered on Sept. 23 last, and the Board of Trade
visionally consented to the transfer of the order from the
Council for the supply of electric energy in the district. It
that the only contract entered into by the Company is on
Dec. 3, 1897, and made between the Bromley (Kent) Electr
and Power Company, Limited, of the one part, and
Edmundsons' Electricity Corporation, Limited, of the oth

London Telephones.—At the last meeting of the Corpor
the Guildhall it was decided that a letter should be addre
the town clerk to all vestries and district boards of
informing them that application was made to the Treasury
late Commission of Sewers for an enquiry into the
efficiency of the telephone service in London, and all
relating thereto, and asking their co-operation by making
application to the Treasury. A conference of local autho
London will be held at the Guildhall with regard to the t
service of the City.

Edinburgh.—At the last meeting of the City Council t
Provost's Committee recommended the Council to purch
the Edinburgh Street Tramways Company the Portobello
of the tramway system at the price of £40,000, conditional
Corporation of Leith purchasing the section in that burg
report was adopted. The Lord Provost's Committee are c
ing an application from the directors of the Edinburgh and
Tramways Company, Limited, for an extension of their
21 years. Plans of proposed public baths at Portobel
probable cost of £18,000, will be discussed at the next me
the Corporation.

Brighton.—A Bill will be introduced into Parliame
session to incorporate a company with powers to const
underground electric railway from a point near the statio
London, Brighton, and South Coast Railway Company to
under King's-road, but with openings under the parad
municating with the beach. The total length of this rail
be 5 furlongs 7·25 chains, and the capital proposed to be
for its construction is £120,000, with power to borrow a
sum of £40,000 for equipment purposes. The maxim
proposed to be charged on the railway is 2d. for th
distance. The promoters named in the Bill are Mr. S. H. Do
Mr. C. F. Webber, and Mr. J. W. Kersley.

Mansfield.—At a meeting which took place last Frid
where Mr. Devonshire and Mr. Mills explained the pro
the Electrical Power Distributing Company, the Mayor,
posing a vote of thanks to Mr. Mills and Mr. Devonsh
they would not expect him as mayor of the borough to
himself in any way. He felt sure that the town and distri
rally would give such support to the scheme as they co
did not know whether it would not be better for the town
control of such a matter as that, should it come, beca
would see how extremely undesirable it would be to have
three authorities each having power to take up roads,
behalf of the town of Mansfield he thanked the gentleme
for their courtesy in explaining the scheme to them.

Horfield (Bristol).—A conference on the electric tramw
place last week at the Church Schools, Bishopston. The f
resolutions were carried: (1) "That this meeting of repre
residents of Bishopston and Horfield considers the t
company's proposals entitled to the strongest support
resident in this vicinity, and (whilst not objecting to
ratepayers in Stokes-croft expressing their own opinions)
disclaims those opinions as at all representing the wishe
important districts," and (2) "That those present at this
feeling the importance of making strenuous efforts to en
this district the advantage of the adoption of the t
company's proposals, do resolve themselves into a comm
that purpose, with power to add to their number."
arranged that an early meeting should be held to orga
district.

Annual Dinner.—The eighth annual dinner in connect
the L. and N.W.R. Electrical Works was held at the
Bulkeley Hotel, Stockport, on Saturday. Mr G. E.
assistant telegraphic engineer and superintendent, preside
following toasts were honoured: "The Queen," propose
Chairman; "The L. and N.W.," coupled with the nam
superintendent and assistant superintendent of the tel
department, to which Mr. G. E. Fletcher replied; "M
Neele and Inspectors," proposed by Mr. Sturgess, and s
by Mr. Norris, responded to by Messrs. Neele and Dan
Michod and Workshops," proposed by Mr. Giles, supp

and replied to by Mr. Michod. Mr. Fletcher proposed of "The Men": this toast was replied to by Mr. Several selections, vocal and instrumental, were rendered evening.

r.—At the last meeting of the Town Council the salary M. Johnstone, electrical engineer, was increased £20 per The committee is considering their present and future its on capital account, with a view to an application e to the Local Government Board for the necessary powers. A report of the engineer on the capacity and ide upon the dynamos and machinery at the electricity referred to a sub-committee. In moving the adoption ctricity Committee's minutes, Mr. Alderman Kitchen estion of a further increase of engines and machinery eferred to a sub-committee, but it was noteworthy that nption had again increased, and as the whole of the had been used during the month, it was possible they to ask for increased powers to extend the machinery rovide for increased consumption. The minutes were

am.—At the last meeting of the District Council a read from Messrs. Norman and Stigant suggesting the d not really had occasion to consider the points of the hey submitted with reference to electric tramways. o opportunity of meeting the Council to point out the to the ratepayers and the public of a scheme under the Act as compared with that under the Light Railways advantages were very great. They trusted the Council nge to reconsider the matter to enable them to go into ly. At the suggestion of the Chairman, the clerk was to reply that the Council saw no necessity to reopen the A communication was read from the electric lighting forming the Council that the electric light would be streets within four weeks, and asking permission to onal standards. The Chairman said the Council had lined to grant this request. Eventually it was decided matter to committee.

, **Islington.**—An ordinary meeting of the Vestry will day, at which the following report from the Electric mmittee is to be considered: "That in consequence demand in the district for electrical energy the new s rapidly becoming loaded, and that in order to satisfy nents of intending consumers it is necessary that achinery should be placed on order without delay, able that even if ordered at once, it will only just be t the increased demand during the coming winter; ending that the additional plant referred to in the timate be placed on order, and that the cost be raised eretofore." The engineer's estimate is for two boilers, gine, 1,300-kw. alternator, £7,180; steam and exhaust pipes, heater, pump and injector, £818; foundations, oring, excavations, etc., and contingencies, £1,282; truments, regulators, boosters, exciter board, cable, £2,720—total, £12,000.

-The fourth annual dinner of the Lincoln Chamber of as held at the Saracen's Head Hotel last week, and tended. Alderman Maltby, the president, was sup- Ir. C H. Seely, M.P., Mr. Emerson Bainbridge, M.P., Mr. H. Wyatt), and others, and Mr. T. Bell occupied air. Councillor Pennell proposed "The City and mbers." Mr. Emerson Bainbridge, in proposing "The Commerce," said he would like to mention that he had ard there was a scheme in progress which he believed to be applied both in that part of the country, and also hbourhood of Staffordshire, to bring into the district d very important centre for electrical power. It was s suggested on so large a scale that the company were o supply enough for working the whole of the traffic on ed new line between Lincoln and the coast at Sutton, proposed also to supply all kinds of work with electrical one-sixth the present cost of electrical power. An enter- at kind was certain to have a very important effect upon like Lincoln.

pool.—The General Purposes Committee of the Blackpool on the 28th ult. sanctioned the expenditure of upon the extension of the electricity works. It was stated necessary machinery had been provisionally secured, that ing firms would not undertake to fulfil further orders in two years, and that without more plant the demand for could not be met. At the last monthly meeting of the uncil a long discussion took place as to the advisability of the members of the Electric Lighting and Tram- mittee visiting Hanover, Berlin, Dresden, and Paris in inspect various systems of electric traction. Exception to the deputation on the ground that it would be a of public money, and that for the £300 that would be would be little or no return. In the end the deputa- sanctioned. On a recommendation to spend £40,000 nt for the electricity works, it was remarked that it ght to rush the matter through the Council, and as had not been adequately considered, it had better be . The recommendation was adopted.

—At the meeting of the Shoreditch Vestry on the chairman of the Electric Lighting Committee, Mr. w, said that, in consequence of the unprecedented Vestry's efforts in the combined scheme of the electricity from the steam supplied by the dust des- committee recommend the Vestry to reduce the charge for electricity from 6d. per unit for the first two hours and 4d. per unit for the surplus) to 6d. per unit for the first hour and a half and 2d. per unit afterwards. Consumers of electricity using the light for three hours per day will pay 4d. per unit; four hours per day, 3½d. per unit; six hours per day, 3d.; and so on, reducing the cost in proportion to the number of hours the light was in use. This, he believed, was a record in municipal electric light undertakings. After existing for six months only they were supplying electricity, within a little, as cheaply as any municipal installation in the country. During the past quarter they had sold 95,000 units of electricity, and the engineer's estimate for the current quarter was 150,000 units. The report will come up for decision in March.

Glasgow.—A lengthy discussion took place at a meeting of the Tramway Committee of the Corporation on Monday in regard to the announcement recently made that the German firm who contracted for the supply of tramway rails had withdrawn their offer, with the result that the members decided to adhere to their acceptance of the estimate of the Leeds firm, which was made through Messrs. P. and W. MacLellan. The amount of estimate is about £18,000, and it is said to be about £1,700 higher than the German offer. The German firm (the Bochum Steelworks) had wired to the effect that their London agents withdrew their offer without authorisation and against their wish and will, telling them that the Glasgow magistrates insisted on British material. The firm desired to maintain their offer for rails and fishplates as tendered, and wished their agents to officially put this proposal before the Glasgow magistrates. It was agreed to enquire into the circumstances attending the withdrawal of the offer, and to send all the documents to the Bochum Company for their information. The subject will probably come up for discussion again at next meeting of the Corporation.

Bristol.—Colonel C. H. Luard, R.E., Local Government Board inspector, held an enquiry on the 1st inst. relative to the proposals of the Corporation to acquire property and leases at Temple-back, for the purposes of street improvement, and to borrow £23,000 to extend the electric lighting. At a meeting of the Bristol Trades Council Labour Electoral Association's executive, held on Monday, the following resolution was passed: "That, seeing that the corporations of so many large towns are taking over and working their trams, to the great convenience and profit of all the citizens, instead of in the interest of a few shareholders, we regret that the tramways company have refused to negotiate with the Council's committee to secure reasonable terms of purchase for themselves, proper conditions of employment for the employés, and the complete control of its own streets to the city. We therefore urge the members of the Council to disregard all factious opposition and seek powers of compulsory purchase, on no account surrendering the practical monopoly of electric power possessed by them in the interest of the whole city, lest a new and most burdensome private monopoly be created in our city, to the great disadvantage of the working-class and other ratepayers."

Beckenham.—The Council have passed the following resolutions with reference to competitive telephone service: "That, in the interests of trade, industry, and social convenience, it is essential that the fullest possible development of the telephone service in this country should be promoted." "That, in order to effect such development, it is necessary that only a moderate rental should be charged." "That the best and cheapest service can only be secured by competition." "That as the Treasury minute, dated May 23, 1892, provides as a matter of general policy 'that competition shall not be prevented,' this Council earnestly requests the Postmaster-General to grant licenses without enquiry as to the charges or efficiency of the present service to any municipalities or companies which comply with the requirements of the Treasury minute, such enquiries being inconsistent with the spirit of the Treasury minute and involving unnecessary expense and delay." With reference to the proposed visit of the Electric Lighting Committee to Oldham, the surveyor has informed the Council that there were only two combined electric lighting and dust destructor works in England—viz., at Shoreditch and Oldham. Of the six tenders sent in, that for an apparatus as used at Oldham was £600 or £700 less than the one constructed upon the system adopted in Shoreditch, therefore it was of importance that they should go to Oldham.

Liverpool.—A very important meeting of the Liverpool Tramways Committee was held in the Municipal Offices on the 27th ult., under the presidency of the Right Hon. Sir Arthur Forwood, Bart., M.P., principally for the purpose of considering the tramway fares of the future. In the course of the discussion it was mentioned that the construction of the new electrical tramline from St. George's Church to the Dingle would be commenced either in the first or second week in February, and would be completed and opened about May 1. The rails, it is expected, will be delivered a few days hence, and the cars, which are quite different to those used at present, are being made. The Council will be recommended to adopt the establishment of electric traction throughout the city, and the penny fare is to be adopted from one end of the city to the other. An additional penny will be charged in the covered-in portion of the cars. This will probably be found a mistake, as the smoking (open) part will be overcrowded while the rest will often remain empty, passengers preferring in fine weather to wait for the next car than to have to pay double fare for the privilege of being deprived of the fresh air, and their smoke as well. At least, such has been the experience everywhere when open dummy cars and closed-in trailers are run on cable lines. The extension of the electrical traction system to other routes is also under consideration.—The widening of Scotland-road is proposed in a report of Mr. Turton, the deputy-manager of the tramways

[illegible] consideration [illegible]

[illegible] Town Council the [illegible] Jan. 24 [illegible] subject of [illegible] Electric Lighting [illegible] to transmit to [illegible] to offer [illegible] in which the [illegible] applications for [illegible] a proper and [illegible] to state that [illegible] volts, appli- [illegible] approval of an [illegible] Section 3 [illegible] Description of [illegible] purposes—a [illegible] pressure, and the [illegible] insulated [illegible] conduits, and partly [illegible] concrete conduits." [illegible] they had great [illegible] Clerk submitted [illegible] to the Board [illegible] Peterborough Electric [illegible] order, which was [illegible] These minutes were confirmed [illegible]

Ealing.—[illegible] London United Tramways, [illegible] Council to its proposal to [illegible] the district, was discussed [illegible] Thursday week, when Sir [illegible] K.C.M.G., chairman of the Council, presided. [illegible] the Council represented the rate-payers of Ealing, and it was necessary that the members [illegible] be said on both sides of the question. [illegible] they had consistently opposed pro- [illegible] in Ealing, and until recently there [illegible] consensus of opinion that this was the right [illegible] his own opinion was altered, but [illegible] there was any reason why the Council [illegible] the present proposals, the Council would, of course, be ready to do so. He proposed that Mr. Robinson, the manager of the company, should be admitted. [illegible] Mr. Robinson, Mr. White (the secretary [illegible] and Mr. Godfrey (the solicitor) then entered the [illegible] of the Chairman, Mr. Robinson proceeded [illegible] of the company. Mr. Hutchings then, on [illegible] of ratepayers present in support of the [illegible] presented a petition in their favour, signed, [illegible] ratepayers and inhabitants of the district. [illegible] the Council on behalf of a number of [illegible] who appeared to oppose the scheme. The [illegible] a resolution to the effect that the deputations [illegible] Council would continue in its opposition to [illegible] which was declared carried.

[illegible] Board.—At the last meeting of this [illegible] Hospital Committee reported that Messrs. [illegible] had reported on the question of lighting [illegible] and had given estimates of establishing [illegible] The committee reporting on this stated: [illegible] into the whole question, we are of [illegible] of lighting proposed by Messrs. Burstall [illegible] as we can judge, satisfactory, and their [illegible] These estimates, increased by sums [illegible] in respect of engineer's fees, erection of [illegible] proposed to be adapted to the purposes [illegible] are as follows: total cost of installing [illegible] cost of working and maintaining ditto, [illegible] the Board can obtain loans at interest [illegible] per annum, and we are informed by [illegible] that 2½ per cent. per annum on [illegible] installation is an ample allowance to make [illegible] plant proposed by them; therefore we think [illegible] electric lighting may be fairly estimated [illegible] for interest at 2¾ per cent., and depreciation [illegible] per cent. in all) on capital expenditure of [illegible] £317. 10s. per annum; cost of working [illegible] £884 per annum—total £1,401. 10s. per annum; [illegible] We may add that in these estimates the [illegible] buildings (nurses' home and isolation [illegible] of erection, is provided for; also that we [illegible] make full allowance in them for every item of [illegible] can be foreseen in connection with the proposed [illegible] reports dated respectively June 11 and Nov. 12 [illegible] the costliness, and inadequacy, and the [illegible] of the system of gas lighting existing at [illegible] informed the Board that Mr. F. Livesey, [illegible] sanction, engaged to investigate and report [illegible] had failed to suggest any method of reducing [illegible] but had on the other hand advised the [illegible] etc., a course which would entail a [illegible] For the purposes of this report we have [illegible] into the question of the cost of gas, and we [illegible] the information we have had before us, that to [illegible] hospital, with the addition of the new [illegible] mentioned, will cost not less than £1,500 per [illegible] it will be necessary, in order to provide a sufficient gas supply for those buildings, to carry ou[t] [...]tions, etc., suggested by Mr. Livesey, or some simi[lar] [...] in other words, to expend a considerable sum of [...] estimates we have quoted of the cost of gas an[d] [...] respectively—viz., £1,500 per annum for the forme[r] [...] for the latter—show a balance of £100 per annum [...] electricity. In view of that fact and the many adva[ntages] [...] as greater cleanliness and convenience, non-pollution o[f] [...] etc.—which electricity possesses over gas, we are [...] opinion that steps should be taken to substitute th[e] [...] the latter." The committee concluded by recommen[ding] [...] the principle of lighting the Northern Hospital by [...] the general lines indicated in Messrs. Burstall and [...] report be adopted; and that the Works Committee [...] to recommend to the Board an engineer, or firm of en[gineers] [...] engaged (a) to prepare a scheme for lighting the hos[pital] [...] lines, and (b) to prepare the necessary drawings and [...] for the work, and to supervise its execution." This w[...]

Bradford.—The following are the principal conditi[ons] [...] motors and arc lamps can be hired from the Corp[oration] [...] tricity department: The rent per annum for motors, d[...] on Jan. 1 and July 1 in each year, will include the c[...] the motor from the Corporation stores to the premises [...] if such premises are upon the ground floor. If, howev[er] [...] is required in a basement or upon a higher level, th[...] pay the cost of raising or lowering the motor to such [...] follows: for ½-h.p. and 1-h.p. motors, 10s.; for 2-h.p. [...] motors, 20s.; for 4½-h.p. and 6-h.p. motors, 30s. Th[...] also provide suitable foundations (timber being usua[lly] [...] upon which the motor will be secured by the Corpo[ration] [...] rent per annum includes supplying and fixing the nece[ssary] [...] switch, and also the fortnightly inspection by a[n] [...] inspector, who will be in uniform. All other access[ories] [...] oil, carbon tips, special pulleys, etc., must be paid for [...] and obtained from the Corporation stores. The nec[essary] [...] from the Corporation terminal box to the motor, in[...] outs, main switches, etc., must be provided by th[...] will be subject to the same conditions and tests [...] wiring for the electric light. The meter must, in [...] fixed adjacent to the service terminal boxes. The d[...] motors and the charges are as follows:

Horse-power.	Speed.	Diameter of pulleys.	Volts.	Am[...]
½ b.h.p.	1,700	4in.	230	[illegible]
1 ,,	1,450	4in.	230	[illegible]
2 ,,	1,200	5in.	230	[illegible]
3 ,,	1 100	5in.	230	1[...]
4½ ,,	1,000	6in.	230	1[...]
6 ,,	800	7in.	230	2[...]

As regards arc lamps, the above regulations as t[o] [...] wiring hold. We note that the lamps will be suppli[ed] [...] with globes and resistances, and will be left in satisfac[tory] [...] order. In the event of any globe being broken, or [...] or portion of the lamp becoming burnt, the hirer m[...] cost of replacing the defective part. These defects a[...] must be remedied with the least possible delay. Als[o] [...] meter must be placed in the arc light circuit in the ev[ent] [...] being also incandescent lamps in the same instal[lation] [...] following table gives the rent and particulars of arc l[amps]:

Type.	No. in series.	Amps.	Approxi-mate c.p. each lam[p]
Enclosed arc (single carbon)	2	5 to 6	500
Open arc (double carbon)	2	5 to 6	500
Open arc (double carbon)	2	10 to 12	1,000
Open arc (single carbon)	4	5 to 6	500
Open arc (single carbon)	4	10 to 12	1,000

The prices and sizes of carbons for the above are [...] 12mm. and 12mm. (for enclosed arcs), 3d. per pair; [...] 11mm., 1⅝d. per pair; 12mm. and 7mm., 1d. per pair. [...] of heating and cooking apparatus is also given on the s[...] and it is worthy of note that the charge for power f[...] for heating or cooking, is 2½d. per unit, while 5d. per u[nit] [...] for the power supplied to arc lamps.—Messrs. A. J. [...] Co., electrical engineers, working under the direction [...] F. Priestman, as chairman of the Friends' Provident [...] owners of the property, have just completed a s[...] electric lighting station to supply the illuminant [...] tenants occupying the shops and warehouses compris[ing] [...] Mills, Manchester-road. This installation is quite [...] of the Corporation system. Provision is made f[or] [...] thousand 16-c.p. incandescent lamps by means of d[...] accumulators working alternately during day and n[ight] [...] consumer has taken a share in the company, whic[h] [...] formed for the purpose of obtaining electric light ap[art] [...] monopoly held by the Corporation, and by the comb[...] formed the tenants are able to realise at a very cheap ra[te] [...] tages of electricity over gas as an illuminant. Messrs. H[...] have utilised the surplus motive power available on the [...] the current is generated by two dynamos, each with a [...] 350 lamps, connected with a set of 55 Epstein cells [...] maintaining 400 lamps. The dynamos, coupled in p[...] an output of 170 amperes each at a pressure of 110 v[olts] [...] machines are compound wound, with ring armature[s] [...] three bearings, each driven by 1in. ropes. The main [...] thrown in and out of gear to the dynamos by two frict[ion] [...] capable of transmiting 35 h.p. each. The cells [...] through a motor-transformer during the day, simulta[neously] [...] the current being supplied from the dynamos. Th[...]

on the motor side of the transformer at 25 amperes at s, and this is converted on the dynamo side to 70 amperes he voltage. By this addition the cells are charged at a of 145 volts. The cells, which are fixed on insulators in estimated to discharge at the rate of 160 amperes per hour. tchboard, from which the supply can be controlled by a of devices, is 7ft. 6in. by 4ft. in dimensions.

ester.—The question of providing a site was again con by the Electricity Supply Committee on Dec. 31, and lars as to various sites were laid before the City Council ek. It was resolved, with three dissentients, that the be recommended to provide dust destructor works upon the ite as and in conjunction with the proposed electricity The Town Clerk reported on Jan. 7 that he had com ted with Messrs. Hannam-Clark and Co. with reference to posed purchase of the old gasworks site, but had received : intimating that the expense of obtaining immediate on must be added to the purchase-money. After consider matter and further discussing the general question of site, k was instructed to inform Messrs. Hannam-Clark and Co. ving regard to the terms of their letter, the committee ot proceed further with the negotiations. On Jan. 19 the rk reported that since the last meeting Messrs. Hannam nd Co. had intimated that Mr. Andrews found he could to give early possession of the portion of the old gasworks . It was resolved with three dissentients: "That it be ended that, subject to the approval of the Local Govern ard, the Council do purchase from Mr. F. Andrews the referred to in his letter at the price of £2,500, with the f taking the other properties referred to within the time the terms named in the foregoing letters. subject to a ontract containing such provisions as the town clerk may cessary: and that the necessary contract be sealed with mon seal." The Town Clerk reported that about 60 for the electricity works had been received, and that ld be at once opened and forwarded to Mr. Hammond. n Clerk observed that the recommendation to purchase practically cancelled. Mr. Hammond, the electrical engi he had, at the suggestion of the mayor, inspected the sites d been pointed out to him. With regard to the site near , the property which was at present available was not of e shape to enable them to put up electrical works properly, a very different block were chosen, the site at that place unsuitable. The objection to the Barton-street site would supposed, apply to the baths site—viz., the presence of a tructor in the centre of the city. In fact, he might say t it seemed to him the moment they came in from the from any distant part of Bristol-road or near the canal, e confronted by the question as to the advisability of g the two projects. At the present time they had made minds that they should be worked together, but it was for him to go on viewing sites which were condemned ecision of the Council was adhered to. If he might to say a word on a point already settled, he would nd them to avoid going past the best site, or what roximately the best site, for the electricity works, ake of the dust destructor, and, although, as he had pointed out, there were advantages in the combination, might run that combination too far. Personally, he would t have the dust destructor next door to his electricity or the one reason that the dirt and dust made it more to carry the electricity works on with a dust destructor immediate vicinity. Besides, they could not keep the ry and building so smart and tidy as they could if destructor was half a mile away. He visited Moffatt's underneath which, he understood, the River Twyver It did not appear to be a large river, though there to be a good flow in the winter. The site was an t one, with plenty of frontage and depth, and, no doubt, e in the matter of foundations. It was, however, new to he was only able to speak of it as a question of position. ituated opposite Councillor King's house. The question, , came in again with regard to the dust destructor. Then the Mitre-street site, and there was no question about g a most suitable place—an excellent site, and coming to tion of pulling down a lot of old property that ought not in the immediate neighbourhood. it would be a very t site—but there, again, the difficulty of the dust destructor . As to the gasworks site, the reasons which led him to it were the favourable borings that had been made, and him ask the Council to allow him to give a second opinion ubject, after the statement by Councillor King. Of course, desirous in fulfilling his duty to the Council not to take ricity works to a place where they would incur a heavy foundations, which Councillor King prognosticated. ld like to carry the question a little further if they allow him. Councillor King said the ground was exceed cherous, and, of course, he brought his knowledge of ict to bear upon the matter, and the experience he had in carrying out work in the neighbourhood, and he warned inst putting down large works which would involve them g to pay compensation to adjoining owners, and, generally, heavy expenditure. He should like very much to thrash on out, and he would come down again in a week or time and give them an opinion that should be justified investigation and consideration. In reply to the whether the presence of the dust destructor would be Mr. Hammond replied that at Shoreditch the dust con terfered with the machinery. The works there were , and if he were asked to draw up a scheme of combination he should take care that the dust destructor portion was entirely closed up from the electricity works, instead of being connected by windows and doors as at Shoreditch. Of course he would rather not run the risk of having his smart machinery interfered with, but still he believed those difficulties might be got over, and the saving undoubtedly would be what had been stated. The nearest approach to the works not being interfered with was at Cheltenham. There the destructor was separated from the electric works by a promenade. They had plenty of room there, more than they wanted to take in Gloucester. He knew of no place where a certain amount of dust did not come in. When he recommended the combination he had, of course, considered the *pros* and *cons* and if they had it they must put up with the disadvantage of some amount of dust, and that would require greater care in cleaning the machinery, because there was nothing so dangerous to electrical machinery as dust. At Shoreditch some of the machinery was disabled from that cause, but as to whether he could keep it out he would be able to tell them better when he had erected the Gloucester works. Councillor Clutterbuck, as chairman of the committee, withdrew the recommendation that the gasworks site be purchased after hearing Mr. Hammond's wish to further investigate the question as to the safety of the foundations. The committee dare not ask the Council to arrive at any decision in view of those statements. A special meeting of the Council could easily be called when Mr. Hammond had completed his further investigation.

PROVISIONAL PATENTS, 1898.

JANUARY 24.

1833. **Improvements in the brakes of electric arc lamps.** Joseph Edmondson, Penny Bank-chambers, Halifax.

1855. **An improved telegraph cable grip.** Andrew Gray, Carisbrook, Helensburgh, co. Dumbarton.

1869. **Improvements in insulators.** Edward Renault, 111, Hatton-garden, London. (Complete specification.)

1872. **Curve tracer of electrical measurements.** William Oliver Smith, 101, St. Martin's-lane, London. (Edward Ross, United States.) (Complete specification.)

1880. **Improvements in electric pendulum indicators.** Frederick Jones, 64, Grant-road, Clapham Junction, London.

1912. **Improvements in telephones.** Joseph Devonport Finney Andrews, 45, Fulham Park-gardens, Fulham, London.

1921. **Improvements in telephones.** Josef Exner and Carl Kraft, 322, High Holborn, London. (Complete specification.)

1923. **Improvements in dynamo-electric machinery.** Joseph Slater Lewis and Felix John Howitt, 322, High Holborn, London.

JANUARY 25.

1970. **An improved electric switch or contact-maker.** John George Dixon, 70, Palace-chambers, Westminster, London.

1994. **Improvements in safety fuses for electrical conductors.** Louis Aloysius Ferguson, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

2007. **Improvements in or relating to transmitting electrical impulses and signals.** Ernest Wilson and Charles John Evans, 64, St. John's-park, Blackheath, London.

2024. **Improvements in and relating to primary batteries.** Carl Koenig, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

2025. **Improvements in rheostats for regulating the current used in electroplating and other processes.** William Phillips Thompson, 6, Lord-street, Liverpool. (The Zucker and Levett and Loeb Company, United States.)

2030. **Improvements in primary batteries.** Edgar Giglio, 6, Lord-street, Liverpool.

JANUARY 26.

2039. **An improved relay switch.** Tom Bousquet Browne and John Melville James, 39, Victoria-street, Westminster, London.

2040. **An electrical fire-call telegraph.** William Blenheim, Egham, Surrey.

2063. **Improvements in switches for electric light service.** Albert Edgar Tanner, 70, Market-street, Manchester.

2106. **An improvement in and connected with electric arc lamps.** John Owen Girdlestone and Carl Frederik Grimur Thorkelin, 16, Davis-street, Berkeley-square, London.

JANUARY 27.

2171. **An electric bell piano.** Stanley John Godwin, 6, Wynne-road, Brixton, London.

2172. **Improvements in attachments to electric incandescence lamps.** Charles Henry Stearn, 4, Branstone-road, Kew Gardens, Surrey.

2215. **Improvements in and connected with the generating of electricity through the motion of rolling-stock and the like.** Mateo Clarke and Joseph Baxeres de Atzugaray, 9, Dashwood House, New Broad-street, London.

JANUARY 28.

2292. **Improved insulator for telegraph wires and the like.** Heinrich Peters, 40 Passage, Cologne, Germany.

2284. **A new application of the electric incandescent lamp.** James Richard Payne, 23, Southampton-buildings, Chancery-lane, London.

2299. **Improvements in joints between the glass globes of electric arc lamps and the supports by which they are carried.** Paul Henry Guérin, 65, Chancery-lane, London.

JANUARY 29.

2375. **A teletypograph for transmitting receiving and recording messages through a telegraph wire electrically.** John Campbell, 57, Comelybank-avenue, Edinburgh.

2382. **Improvements in or relating to electric telegraphy.** Pierre Picard, 111, Hatton-garden, London.

2389. **Improvements in secondary batteries.** John Vaughan Sherrin, 77, Chancery-lane, London.

2415. **Improvements in methods or processes for electro-thermally treating materials and particularly with reference to the manufacture of calcium carbide and apparatus therefor.** Hudson Maxim and William Henry Graham, 377, Norwood-road, London.

2417. **Automatic electric circuit-breakers.** Maurice Bouchet, 53, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, July 2, 1897, being date of application in France.)

2420. **Improved means for controlling the working of lifts, motors, and other appliances operated by electric energy.** William Arthur Ker, 191, Fleet-street, London.

2423. **Improvements in the manufacture of filaments for incandescent electric lamps.** Robert Mullard, 45, Southampton-buildings, Chancery-lane, London.

2426. **An improved method of and means for facilitating the starting of single or polyphase alternating-current motors and like apparatus.** Max Deri, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

2427. **Improvements in variable electric resistances or rheostats.** R. Waygood and Co., Limited, and Philip Ibotson Unwin, 24, Southampton-buildings, Chancery-lane, London.

2428. **An improved electrical transformer for currents of high potential and variable frequency.** Alfred Wydts and Octave Maximilien Rochefort, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1897.

43. **Electric motors and apparatus for propelling cars, carriages, cycles, and boats.** Joel.
246. **Means for adjusting electric light carbons.** Gibbings.
265. **Electrical indicating railroad signalling.** Griffith.
2721. **Electric motors.** Obelt.
2801. **Electrical transformers.** Berry.
2904. **Perforators for use in connection with automatic telegraph transmitters.** Muirhead.
3488. **Secondary batteries.** Schattner.
5040. **Telegraph relay suitable for long submarine cables.** Rymer-Jones.
5430. **Speed-regulating governors specially suitable for electric light and other high-speed engines.** Marshall.
6178. **Device for deadening the noise in telephone conductors and the like.** Messing.
6181. **Electric cables and their manufacture.** Smith and Granville.
6292. **Electric incandescent lamps.** Stowell.
10994. **Electric arc lamps.** Worsley.
10995. **Carbon-holders for electric arc lamps.** Worsley.
14247. **Electric furnaces.** Thompson. (La Société Italiani dei Forni Elettrici.)
19745. **Electromagnetic picking mechanism for looms.** Fairweather. (Klein.)
20996. **Electrical cut-outs.** Dorman and Smith.
21818. **Electric arc lamps.** Adams.
22250. **Controllers for electric motors.** Thompson. (Von Zweigbergk.)
25703. **Electrical batteries.** Hanscom and Hough.
27495. **Starting devices for alternating-current motors.** The British Thomson-Houston Company, Limited. (Foster.)
27496. **Dynamo-electric machines of the inductor type.** The British Thomson-Houston Company, Limited. (Steinmetz.)
27765. **Electric arc lamps.** Spencer.
28246. **Safety electric fuses.** Gover and Müller.
28268. **Current collectors for electric railways with overhead wires.** Timar.
28895. **Insulating supports for the third rail or electric conductor of elecric railways.** Anderson.
28956. **Electric cables.** Kelman.
29024. **Reflectors and supports for electric glow lamps.** Webster and Reynolds.

TRAFFIC RECEIPTS.

Dover Tramways.—The traffic receipts for the week January 29 were £103. 9s. 9d. The total receipts for t 1898 are £437. 0s. 3d. The mileage open at present is 2½

Bristol Tramways.—The traffic returns for the week January 28 were £2,344. 7s. 11d., compared with £1,738 for the corresponding period of last year, being an inc £606. 4s. 5d.

Birmingham Tramways.—The traffic receipts for th ending January 29 were £3,584. 7s. 9d., as compar £2,900 3s. 2d. in the corresponding week in 1897, b increase of £684. 4s. 7d.

Liverpool Overhead Railway.—The traffic receipts railway for the week ended January 30 amounted to £ compared with £1,227 in the corresponding week of the year, being an increase of £110.

City and South London Railway.—The returns for t ended January 30 were £1,059, compared with £1,101 for th sponding period of last year, being a decrease of £42. T receipts for the half-year amount to £5,393, compar £5,488 for the corresponding period last year, being a of £95.

South Staffordshire Tramways.—The traffic returns week ending January 28 were £568. 12s. 11d., as compar £496. 2s. 0d. in the corresponding week of the previo The aggregate receipts for the year are £2,353 16s. against £2,206. 14s. 4d. in the corresponding period previous year.

S.D. United Tramways.—The traffic receipts for th ending January 28 were £436. 18s. 10d., as compare £360. 12s. 10d. in the corresponding week in the previo being an increase of £76. 6s. 9d. The number of pa carried was 73,523 in 1898 and 60,025 in 1897. The ag returns up to date are £1,720. 0s. 10d., as compar £1,640. 2s. 11d. last year, being an increase of £79. 17s. 11 mileage open is the same as last year—viz., 8 miles.

COMPANIES' STOCK AND SHARE LIST

Name.	Paid.
Birmingham Electric Supply Company	5
Brush Company, Ordinary	2
—— Non. Cum., 6 per cent. Pref.	2
—— 4½ per cent. Debenture Stock	100
—— 4½ per cent. 2nd Debenture Stock	100
Callender's Cable Company, Debentures	100
—— Ordinary	5
Central London Railway, Ordinary	10
——	6
—— Pref. Half-Shares	1
—— " "	5
Charing Cross and Strand	5
—— 4½ per cent. Cum. Pref.	5
Chelsea Electricity Company	5
—— 4½ per cent. Debentures	100
City of London, Ordinary	10
—— Prov. Cert.	10
—— 6 per cent. Cumulative Pref.	10
—— 5 per cent. Debenture Stock	100
City and South London Railway, Consolidated Ordinary	100
—— 4 per cent. Debenture Stock	100
—— 5 per cent. Pref. Shares	10
—— " " " '96	10
County of London and Brush Provincial Co., Ordinary	10
—— 6 per cent. Cum. Pref.	10
Crompton and Co., 7 per cent. Cum. Pref. Shares	5
—— 5 per cent. Debentures	—
Edison and Swan United Ordinary	3
—— 5 per cent. Debentures	5
Electric Construction, Limited	2
—— 7 per cent. Cumulative Pref.	2
Elmore's Copper Depositing	1
Elmore's Wire Company	2
W. T. Henley's Telegraph Works, Ordinary	10
—— 7 per cent. Preference	10
—— 4½ per cent. Debentures	100
House-to-House Company, Ordinary	5
—— 7 per cent. Preference	5
India Rubber and Gutta Percha Works	10
—— 4½ per cent. Debentures	100
Kensington and Knightsbridge Ordinary	5
—— 6 per cent. Pref.	5
London Electric Supply, Ordinary	5
Metropolitan Electric Supply, Limited, Ord. No. 101-50,000	10
—— " " " 50,001-82,500	10
—— 4½ per cent. First Mortgage Debenture Stock	100
National Telephone, Ordinary	5
—— 6 per cent. Cum. First Pref.	10
—— 6 per cent. Cum. Second Pref.	10
—— 5 per cent. Non. Cum. Third Pref., No. 1-119,234	5
—— " " " 119,235-250,000	4
—— 3½ per cent. Deb. Stock, Red.	100
Notting Hill Company	10
Oriental, Limited, £1 shares	1
—— £5 Shares	5
—— £4½ shares	4½
Oriental Telephone and Electric Company	1
Royal Electrical Company of Montreal	—
—— 4½ per cent. First Shares Mortgage Debentures	100
South London Electric Supply, Ordinary	2
St. James's and Pall Mall, Limited, Ordinary	5
—— 7 per cent. Pref.	5
—— 4 per cent. Deb. Stock, Red.	100
Telegraph Construction and Maintenance	12
—— 5 per cent. Bonds	100
Waterloo and City Railway, Ordinary	5
Westminster Electric Supply, Ordinary	5
Yorkshire House-to-House	5

NOTES.

ris Exhibition.—Offices for the Royal Com- the Paris International Exhibition of 1900 have at 23, Great George-street, Westminster.

: Traction in Spain.—We understand that 'ndicate has been formed to acquire a number s in the North of Spain with a view to replacing traction by electric traction. The line from Catarroja is amongst them.

Institute of Architecture, Science, and drawings submitted in the local competitions of e for this session are being exhibited this week oria Art Galleries of the Albert Institute at statement of the awards is also exhibited.

ium.—The output of aluminium in 1897 by States has nearly quadrupled the returns for ording to the figures given by the *Engineering Journal*, last year's production is estimated at ., as against 1,300,000lb. in 1896, and 188,000lb.

'estimonial.—The Executive Committee are to contributors resident in the United Kingdom invitations to the presentation reception which d at 9.30 on Monday, the 21st inst., at the Rooms of the Hotel Metropole, immediately ıner already announced.

k Institution.—We have received an invita- tudents' conversazione of the above institution, be held on Saturday next, at 7 p.m. The are a concert, a dramatic entertainment, of various scientific apparatus. These exhibits course, the usual X-ray demonstrations, ıotographs, and colour-photographic apparatus.

t in Kind.—At a meeting of the Markets of the Leeds Corporation the other day, a letter om the National Telephone Company in regard silent cabinets for the use of members of the nge. This concession is in return for the given to the company to carry their trunk lines building. It was decided to accept the offer, he payment by the company of a certain small owledgment.

azione.—The students of Finsbury Technical hold their annual conversazione at the above the 18th inst. Dr. Thompson has promised to "Wireless Telegraphy," Mr. Ives will give an of colour photography, and incandescent lamp l be demonstrated by Mr. Robertson. We are d that the college will be specially decorated ly illuminated by electric fairy lamps and arc that there will be dancing in the great hall.

sgow Technical College.—Owing to the Mr. George Weir, late of the Holm Foundry, who resigned his directorship of the technical n he went to Australia, the electrical laboratory he college has recently been presented with a livan's universal galvanometer for the measure- ltages, currents, and resistances. This galvano- sses several novel qualities, and is equally well se on board a telegraph ship and a laboratory

tained Works.—The larger a manufacturing the more scope for growth there appears to works find it pay to produce or treat by special much of the raw material required by them. e of this comes before us from the States, where it is announced that the General Electric Company is about to erect one of the largest iron foundries ever constructed in that country, in connection with their works in Schenectady, New York. The foundry will be 500ft. long and 130ft. wide.

Telephones in the States.—We note that an attempt is being made in the United States of America to induce the Government to fix the price to be charged for telephone service in the district of Columbia. The proposed charges in the Bill now before the House of Representatives for this purpose are as follows: £5 per annum for telephones in private houses, £7 for those in business houses or commercial offices, and £10 per annum for hotel telephones. It is proposed also to inflict a fine of £50 on any contract made at higher figures than the above.

The Institution "Journal."—We have received from the Institution of Electrical Engineers Part 131 of the *Journal*, which concludes vol. xxvi., and the *Proceedings* for the year 1897. We are informed that after the issue of this part no abstracts or classified lists of articles appearing in the technical periodicals and *Proceedings* will be published in the *Journal* of the Institution; but in each month there will be issued to all members (subject to the provisions of No. 33 of the articles of association) a series of abstracts prepared under the direction of a joint committee of the Institution and the Physical Society.

Water Power in Ireland.—We understand that a company has been formed to utilise the water power of the Shannon electrically. The company, or rather syndicate, has an influential board of control, and proposes to construct a canal from a point above Castleconnell to the outlet below Doonas, to provide for storage a certain volume of water in Lough Derg during the summer, and the company are in communication with the Limerick Fishery Board so that fishery rights on the river may not be interfered with by the intended scheme. We do not, however, hear for what purpose the electric power so obtained is to be utilised.

Scientific Toys.—Mr. James Swinburne contributes to the current number of *Good Words* an interesting and illustrated article on the scientific principles underlying many of the most familiar mechanical toys. Steamboats, jumping beans, spinning tops, and ballet dancers all come in for a share of attention, while flying machines and cheap living picture apparatus are also described. The article is concluded by an illustration of some magnetic dancers. These consist of paper figures attached to pieces of iron wire of different geometrical shapes. The magnetised spindle of a top projecting through a smooth lid of a metal box attracts these wires, and by its revolution causes them to impart graceful motions to the figure attached.

Direct Cable from Spain to Cuba.—The Spanish Government is still considering the advisability of constructing a direct cable to Cuba. At the same time, they are negotiating with a French company which has a capital of £4,000,000. This company has offered to lay a cable from Hayti to Cuba within three months of signing an agreement, at an expenditure of £200,000. The company do not ask for any money subsidy, but demand the right to work the cable for 25 years. The charge is to be fixed at one peseta (about 10d.) per word, providing that the Government will guarantee them an average of 1,000 words per diem. The company undertake not to make any claims for compensation or otherwise in the case of direct cables being established within the limits of this proposed time.

The Glasgow Cars.—We gather from the discussion at the last meeting of the Glasgow Corporation that the

electric tramcars to be used in the town are of somewhat novel type. It seems that the entrance to and exit from the cars is to be effected by doors placed in the centre of the sides of the car. This some of the members object to on the score of space wasted, and also of safety. The first plea seems to be a valid one, but the second hardly does. The end entrances are more liable to run passengers into danger, as they cannot on alighting see any vehicles travelling in the opposite direction to that of the tramcar. One half of the car, if constructed as proposed, will be devoted to non-smokers, and the other half to smokers. The matter is referred to the Tramway Committee to report on.

Electricity in the Catacombs.—The Rome correspondent of the *Pall Mall Gazette* announces the fact that on the feast of St. Cecilia the catacombs of St. Callixtus, where the Roman virgin was buried in 177 A.D., were for the first time all glowing and glaring with thousands of electric globes illuminating even the most remote corners, and giving to the whole a mundane rather than a mystic air. Bones and skeletons of the ancient martyrs are found all along the walls of these catacombs, in three rows, one above the other. The lower room of the three, which together extend about five miles, is the more disturbed, as almost everyone tries to take something away as a sacred relic. But the electric light on these bones turns the catacombs into a museum, and tends to keep the present contents safe.

The Chemical Society.—The vexed question of voting by proxy or through the post at the annual general meeting is still before the council of the Chemical Society. The present arrangement of allowing only those present to vote disenfranchises the large proportion of the country members. Counsel's opinion has been taken on the question, and is to the effect that under the present charter voting by proxy would be invalid, and that the council has not power to amend their by-laws to allow such voting; also it would probably be necessary to obtain a supplementary charter allowing members not actually present at meetings to vote by means of balloting papers. We trust that the change may be made, as it will unite more closely the town and country members. The Institution of Civil Engineers introduced a similar change quite recently, and with considerable benefit to all concerned.

Electricity on the Underground.—We had hoped to hear some particulars as to the proposed adoption of electric traction on the Metropolitan District Railway at the annual meeting held on Monday last. The only reference to it, however, in the course of Mr. J. Staats Forbes's remarks was to the effect that the company had spent £14,000 during the past year in connection with the promotion of several new suburban lines, and the not less important principle of converting the present lines into electric ones. The proposed deep-level line to relieve the congested portion of the Metropolitan District's present system would, of course, also be electric. As regards the question of carriage lighting, the chairman said that the best and most efficient system had yet to be decided upon. Here, again, electricity is one of the rival competitors. The fact that the trains on these lines are not split up, but always run as a whole, is greatly in favour of an electric system.

An Electric Traction Engine.—Our New York namesake contains a description of an electric road wagon for traction engines to be used on the public roads which would derive its power from a pair of trolley wires placed on one side of the roadway. This is the device of Mr. W. G. Caffrey, of Reno, Nevada. The vehicle actually constructed is more of the light-wagon type, and was equipped with a 2-h.p. motor of the Westinghouse The double trolley wire and collecting gears essential system like this, where the running wheels cannot return circuit, are fully described and illustrated. collecting trolley is pulled along the wires by a twin lated conductor. This cable is of sufficient length to the wagon to run some 200ft. away from the pole line the necessary extra length is wound on a drum when required. In a heavier vehicle of the traction-engine the author proposes to use rear driving wheels diameter with smooth steel tyres 26in. wide. Two would be used, each of 50 h.p. This engine would be it is estimated, to haul 30 tons at a speed of six miles hour.

Water-Tube Boilers.—Mr. E. Duchesne contri to the Société des Ingenieurs Civils de France, on 21 a paper on some results of trials of multitubular boilers. He said that two essentials in such boilers (1) that they should produce dry steam for the and (2) that their construction should afford every for ease of repair. He then described the Niclausse as installed in the cruiser ss. "Friant" and other and claimed that on one trial a boiler had burnt 95lb. of coal per square foot of grate surface for six without developing any faults in the tubes. The and water evaporating tests are not given in the pamphlet containing the discussion. This part of the ceedings were lively, as the author's conclusions controverted by Mr. L. de Chausseloup-Laubat. gentleman touched on the question of circulation, that he had calculated that the maximum out-put tube through which there was circulation was when the volume of the steam bubbles and the of the water in the tube were equal. This calculation been verified practically.

The Municipal Electrical Association.—W informed that at a meeting of the council of the Mu Electrical Association held at the Westminster Hotel on Friday, 28th ult., Mr. A. H. Gibbings was president for the year 1898. It was decided to hol convention in London on June 8, 9, and 10. For papers have been arranged upon the following subj "Management of Electrical Undertakings"; "Repay of Loans and Appropriation of Profits"; "Uniform Plant and Apparatus"; "Electric Traction"; "The of Accumulators in Connection with Lighting and Tr Systems"; "Switchboard and Auxiliary Apparatus" "Stand-by Supply." Mr. J. E. Stewart, of Derby, elected a member of the council, and the following cations were considered and approved:—As members: Chamen, Glasgow; J. E. B. Thornhill, Taunton; Clayden, Morley; T. H. Minshall, Croydon; A. Fell, Sheffield; and the electric lighting committees of S port and Morley. As associates: D. McFarlane Mel Aberdeen; P. S. Thompson, Huddersfield; W. N. L Halifax; and A. Sugden, Halifax.

Ways that are Dark.—The *Daily Mail* does appreciate the ways of the British Electric Traction pany; or is it that the brokers imagine they have done out of some of their pickings? This is what *Mail* says: "Much disgust was felt in the misc market at the way in which it had been deceived issue of preference capital by the British Electric Company. It was deliberately stated in the some time ago by the emissaries of the company th shares would be allotted at par in the proportion for every three ordinary shares, and that a pre from 2½ to 3 would be placed upon them, thus the ordinary shareholders with a bonus. Nothing

has been done, the shares being offered for public ...ption at £12 10s. each. This breach of faith is ...ed by the stock dealers as indicating a desire to get ...ares knocked down to a comparatively low figure ...the subsequent intention of working the market and ...g them out at a higher price. We hesitate to ... credence to such a report, which would suggest dis...ble conduct on somebody's part."

...ensland—We have received from the Queensland ...al engineer (Mr. J. Hesketh) a Christmas and New ... souvenir which not only sends greetings, but con... information. Queensland was established as a colony ...9, and in 1896 had a population of 472,179. A tele... system was established in 1861 and a telephone ... in 1880. The revenue of the electric telegraphs was ...8, £11,774 and in 1896, £76,986. The expenditure ...0 was £17,121 on the telegraphs, but we cannot ...ine the figures for 1896, as the amount is lumped ...ther Post Office expenditure. Loans on telegraph ...tion account of £800,000 seem to be outstanding ... 31, 1895. There were in 1870 45 telegraph offices, ... number had risen to 365 in 1896. The number of ... transmitted and received in 1871 and 1896 respec... were 89,368 and 1,141,711, having a respective cash ...f £11,774 and £76,975. The respective values of ...O.H M.S. were £5,424 and £10,981. In 1870 there ...132 miles of line and 3,221 miles of wire, which ...ed in 1896 to 10,026 miles of line and 18,036 miles .... In 1896 there were 6 telephone exchanges with ...scribers, including Government telephones.

... Cravath Excess-Current Recorder.—It is ...own that in handling electric tramcars the expert ... will in the course of a given run take much less ... from the wire than the inexperienced or careless ... At Dover this is being guarded against by placing ...tricity meter on each tramcar, so that the amount ...per day can be easily ascertained. A large amount ... is often caused by switching on the motors too .... Mr. J. R. Cravath, of Chicago, has devised ...od of recording excessive currents from this cause. ... a short horizontal German-silver wire placed in ... with the motor. This wire is stretched between ...minals in a long vertical box, and at right angles to ...ip of an alloy of low melting point. When the wire ... due to excessive currents passing, the strip is ...lly melted and sinks down, thus presenting a new ... to the hot wire. The length the strip descends in ... is thus an approximate record of the number of ...cessive currents have been used. The arrangement ..., and in many ways not so reliable as the use of a .... We remember seeing a small device designed by ...bert Kapp for the same purpose in 1893. In this ...the armature of an electromagnet acting against a ... spring recorded the number of times a certain ...rmined current was exceeded.

...les to Australia.—The Press Association ventilates ...ievances of the City merchants with respect to the ...lian cable service. The delay in commercial telegrams ...been very serious of late, and it is declared that the ...t match telegrams are partly responsible for this. It ... concluded by some that these messages are trans... at reduced rates, as is the custom with the usual Press ..., and that undue preference has been given to ... the detriment of commercial interests. This is not ..., as the cricket match telegrams have been forwarded ... messages, paying three times the ordinary com... tariff. The fact remains that the present lines of ...ication are insufficient, and that the land lines ...ustralia are the weakest link in the connection. The only effectual remedy seems to be to open up as many alternative land-line routes in Australia as possible. The proposed cable to Australia, *viâ* the Cape of Good Hope, would, by landing at Perth, establish an alternative route to the existing overland line between Port Darwin and Adelaide. Another land line might be opened up by effecting a junction between the South Australian and Queensland telegraph systems in the Gulf of Carpentaria, or by laying a cable from Port Darwin to Normanton or Cape York, whence an efficient land-line service is said to exist down the East Coast of Australia.

Telegraphy Without Wires.—The number of lectures delivered on the above subject each week is growing at an alarming rate. The best one we have noticed during the past seven days was delivered by Prof. Wertheimer on Saturday last at the Merchant Venturers Technical College at Bristol. The account we have received of this lecture shows that the subject was well covered, all the systems of communication by electricity without conducting wires being described. The professor would not commit himself as to the commercial value of the more recent and successful attempts to converse through space. Another lecture on the same subject was delivered at Leeds on Sunday, in the Theatre Royal, by Mr. R. Kerr. This lecture was of a more popular order, and the lecturer gave his imagination full play. It seems that the Eastern nations are miles before Hertz, Lodge, or Marconi. We are told that it was probable that some system of telegraphy without wires was known to Eastern nations; he mentioned that the news of Gordon's death at Khartoum was known in Cairo, which was 1,000 miles distant, on the day he was killed. Not long ago Mr. Kerr had met a Dutch officer in Amsterdam, who told him that when stationed in the Dutch East Indies some years ago he noticed that if any great catastrophe happened on one of the islands it was known to the natives on the other islands days before the arrival of ships bringing the news. It is a pity that the Eastern methods were not more fully explained.

The London County Council and the Telephones.—On Tuesday last the Highways Committee of the London County Council reported that complaints had been made as to the high charges prevailing in the telephone service in London and the inadequacy of the telephone system to the requirements of the public. They recommended "That with the view of obtaining an investigation with regard to the telephone service in London, similar to the enquiry recently held as regards that service in Glasgow, the Council do make an application under the Telegraph Act, 1892, to the Postmaster-General for a license empowering the Council to provide an independent municipal telephone service for the county of London." The recommendation was moved by Mr. Benn, who pointed out that some members of the Council appeared to shrink from the municipalisation of the telephone service of London, but all that was now sought was complete information. It was a pressing matter; in fact, there was at present a crisis in regard to the telephone system of London. The charge in London was 17 guineas per annum, while in Liverpool 10 guineas was the annual rate, and abroad the charges were still lower. The City had taken the matter up, and he hoped the Council would not be behindhand. The case of London against the telephone companies was much stronger than that of Glasgow. He hoped the Council would not await the result of the Glasgow enquiry before taking action. An amendment to the effect that the matter be referred to her Majesty's Government to appoint a select committee to consider the subject was then discussed and negatived. The above resolution was then passed, but we doubt that

the enquiry will be granted until the result of the Glasgow enquiry is made known.

Cathode and Rontgen Radiations.—A large and representative gathering met at the Royal Institution on Friday last to hear Mr. A. A. Campbell Swinton's lecture on the above subject. As the lecture was most liberally illustrated by experiments and lantern slides, the usual Friday night attenders found much to interest them. One experiment took the form of a Crookes tube, which contained a cross of aluminium. The cross threw a black shadow on the back of the tube, and when surrounded by a coil carrying a current of electricity the brilliant violet rays were produced, and the cross rotated as the ring conveying the current was moved. A similar effect was produced over a magnet. Mr. Swinton exhibited on the screen the bottom of a tube in which a square was clearly marked, and explained that this had been engraved by the action of the rays upon the interior. In fact, so penetrative were the rays that in the experiment with the magnet the tube had to be kept in motion or the glass would have been pierced. As to this action of the cathode rays upon the glass, he said it was difficult to be quite certain, but the effect was to split off little pieces of the glass upon the interior surface. Whether that was due to the bombardment by the particles which formed the cathode rays knocking off bits of glass, or a secondary effect due to the heat, was uncertain. It was, however, curious to find that sort of engraving going on in the interior of a perfectly enclosed bulb. Mr. Swinton supported Sir William Crookes's idea as to the constituency of the cathode rays, and showed some most interesting and successful examples of deflecting these rays by magnets. The lecturer also exhibited a large number of slides illustrating the effects of shifting the positions of either cathode or anode, or both, in the tubes. There was also a good collection of apparatus on view from various manufacturers.

Chambers of Commerce.—The annual meeting of the associated chambers is to be held in London on March 15, 16, and 17 next, and among other subjects for discussion are the following:—Metric system (Leeds): That in the opinion of this association the compulsory adoption within some limited period of the metric system of weights and measures legalised by the Act of last session be advocated by every possible means, with the view of inducing her Majesty's Government to afford facilities for the amendment of the law in this respect, and that a copy of this resolution be sent to the President of the Board of Trade and to the First Lord of the Treasury. Metric system and public contracts (Bristol): This association urges the Government to adopt the metric system of weights and measures, as far as possible, in all Government contracts and returns, so as to make it familiar to the people, and resolves that a communication to this effect be made to the President of the Board of Trade; it further recommends individual chambers of commerce to press the matter upon the attention of local governing bodies, to the end that these also may employ the system in all public contracts, and thus facilitate its general adoption. Anglo-French telegraph rates (Paris, British Chamber): That in the opinion of this association the telegraph rates between Great Britain and France are excessive and unwarranted, and that immediate steps be taken to reduce the rate to one penny per word, which would give full inland rate to both countries. Telephonic communication (Hull): That in the opinion of this association the utility to the mercantile community of the trunk telephone cables between mercantile centres is very materially decreased owing to the great delay in securing a turn, and the executive are respectfully requested to again press upon the telegraph department of the Government the necess[ity] of promptly increasing or improving the main cable conn[ec]tion. Trunk telephone system (Portsmouth): That [the] Government be urged to reduce the telephone trunk li[ne] charges, and to extend the minimum time allowed for [a] call from three to six minutes.

The Relative Importance of Central-Statio[n] Losses.—The general question of the relative importan[ce] of the loss of power at various points between the co[al] stack and the consumers' lamps is well discussed in [the] current number of the *Electrical World.* The cost [of] reducing these losses can as a rule be ascertained, but [in] all cases a certain definite reduction only is advisabl[e]. Beyond this the capital outlay costs annually more [in] interest than the value of the power saved. Our con[temporary] emphasises the fact that the losses are ma[ny] more serious at the lamp end of the line than at [the] boiler end. The loss of heat by the stack represen[ts] simply a waste of coal and firemen's wages. The loss [by] condensation involves besides these the necessary increa[se] of boiler capacity to supply it. Similarly, the dyna[mo] losses involve, in addition to these factors mentioned, [the] increased size of engines and the cost of engine attendan[ce] necessary to keep them in order; or, what amounts to [the] same thing in the end, without these losses the sa[me] boilers, engines, and attendance could carry a greater lo[ad]. In the same way, the line loss involves greater generato[r] and transformer losses greater lines. Finally, the los[ses] due to inefficiency in the lamps involve increased boil[ers], engines, dynamos, lines, and transforming devices, as w[ell] as attendance, and further increase the losses in all par[ts] of the system in which the losses increase with the lo[ad]. This recital sounds a great deal like the nursery tale [of] "The House that Jack Built," but it leads to the co[n]clusion that any percentage loss in the lamps is far mo[re] serious than the same percentage loss in the boiler-roo[m], the importance at intermediate points depending on the[ir] relative positions in the chain. A rough idea of t[he] relative advantage of a given percentage saving in t[he] lamps and in the boiler-room may be obtained by co[m]paring the total operating expense and fixed charges [of] the system, exclusive of the management and offi[ce] expenses, with the cost of fuel. If this ratio is taken f[or] the purposes of illustration at 6 to 1, it means that a [...] per cent. saving at the lamps is six times as great a savi[ng] as a 10 per cent. saving in the furnaces.

Electric Lighting for Profit.—A paper under th[is] title was read last month before the North-Weste[rn] Electrical Association of America by Mr. Alexander Do[w]. Some of his statements surprise us. For instance, th[e] announcement that "the conditions of the electric lig[ht] industry have so changed in the last few years that th[e] opportunities of profit are limited," and "that the marg[in] between earnings and expenses tends to vanish, and ca[n] only be kept in view by unceasing endeavours to increa[se] the one and reduce the other." The above experience w[e] cannot understand, as on this side the converse is mo[re] apparent day by day. He looks back with regret to th[e] time when a small business at high prices paid a good profit while here increased profits are made by lowering the price and hence gaining larger outputs. We gather that [Mr.] Dow complains of the municipal stations entering int[o] competition with the companies and cutting the pric[es] down. He advocates our present arrangement of "— town one electrical light supply," but there is still a fe[eling] in the States that that supply should be in the hands of [a] company. As regards economies to be effected and in[duce]ments to consumers to increase their demands, the autho[r] advises the adoption of the Brighton system of charg[ing]

e of one system of supply for arc lamps, incan-s, and motors is warmly taken up, and the wasteful of using three distinct systems for these three is pointed out. Mr. Dow sums up as follows: (1) ctric lighting business should pay, as a reasonable pproximately the same rate as any manufacturing which has similar risks. (2) Rates for electric should be so adjusted that each unit sold will pay e of operating and standing charges, and in addition a uniform proportion toward profit. (3) Every business that can be profitably done should be d, particularly if it improves the load factor, because rovement of the load factor reduces the amount of g charges to be borne by the existing load. (4) s once obtained should be kept by careful study of mpt attention to the requirements of each customer. t sufficient that a customer should be well served; t also be well pleased.

luctivity of Aqueous Solutions.—Prof. E. H. ld, B.Sc., sends us a very interesting paper "On culation of the Conductivity of Aqueous Solutions ing Potassium and Sodium Sulphates," which he fore the Nova Scotian Institute of Science. We pace only for two or three paragraphs of the which will be given in the author's own words: ding to the dissociation theory of electrolysis, held henius and others, the conductivity of a mixture of utions of electrolytes, 1 and 2, which have one ion non, and which contain n_1 and n gramme-equivalents t of volume, is given by the expression—

$$\frac{1}{p\,(v_1+v_2)}\,(a_1\,n_1\,\mu_{\infty\,1}\,v_1+a_2\,n_2\,\mu_{\infty\,2}\,v_2),$$

v_1 and v_2 are the volumes of the two solutions mixed, tio of the volume of the mixture to the sum of the s of the constituent solutions, $\mu_{\infty\,1}$ and $\mu_{\infty\,2}$ the ar conductivities, at infinite dilution, of the respec-ctrolytes under the conditions in which they exist mixture, and a_1 a_2 the ionisation coefficients of the ive electrolytes in the mixture." After describing liminary steps taken to ensure pure materials, the l employed is given thus: "The Kohlrausch method e telephone and alternating current was used. The ing apparatus consisted of four resistance coils and man-silver bridge wire, about 3m. long, wound on a drum. The wire was divided into 1,000 parts, and resistance of about 1·14 ohms. It was calibrated by ethod of Strouhal and Barus, the corrections thus ed being plotted against length on co-ordinate paper, e correction for any point on the wire taken off this The resistance coils were marked 1, 10, 100, and ohms. As I used only one coil (that of 1,000 ohms), it was not necessary to express the conductivities in its measure I did not need to know the relative cy of the coils or the absolute value of the one used. electrolytic cells were used, one for solutions more ntrated than 0·1 equivalent gramme-molecules per the other for solutions more dilute. They were of U-form, shown by Ostwald in his 'Physico-Chemical ements'; p. 226, Fig. 178. The electrodes were of platinum foil, not easily bent, circular in and about 3·5cm. in diameter. Care was taken en the electrodes always in as nearly the same in the electrolytic cell as possible. No change of nce could be observed for small differences in position could be detected by the eye and avoided. The on coil was small, and had a very rapid vibrator. kept in a box stuffed with cotton wool, that the ht not interfere with the determination of the minimum in the telephone. A Leclanché cell was found most convenient for working the coil. With this arrangement the minimum point on the bridge wire could be determined to within 0·3 of a division. This would allow an error of 0·12 per cent. in the determination of the resistance at the centre of the bridge, and 0·15 per cent. at the point farthest from the centre, used in my experiments." The results are tabulated, and show a diminution of conductivity with decrease of dilution, and hence an increase of concentration of wire. Thus, with a simple mixture of potassium sulphate, we get dilution 20, concentration of ions 0·0375, conductivity 959; dilution 1, concentration of ions 0·525, conductivity 672; with sodium sulphate, dilution 20, concentration of ions 0·0370, conductivity 784; dilution 0·847, concentration of ions 0·507, conductivity 456. The figures relating to mixtures are not so easily given, but the same law holds good that conductivity increase with concentration.

The Direct Transformation of Heat into Mechanical Work.—Prof. Marcel Deprez communicates a long article on the above to the *Revue Générale des Sciences*, and considers the problem of the use of ferro-nickel alloys in a magnetic field. He starts with the idea of a bar of the alloy in a magnetic field. The bar is pivoted on an axis, which is at right angles to the bar and also to the magnetic flux. The bar is then heated when laying in the direction of the lines of force to such a temperature that it loses all its magnetic properties. It is then rotated to a position at right angles to the field and cooled. The bar is then in a position to be attracted again to a position along the line of force, doing work during its motion. Thus, for a quarter of a revolution, the heating of the bar allows it to move freely in the magnetic field, and during the remaining quarter turn the magnetic field does work which can be utilised. The author then proceeds to examine the quantities involved. He laments the fact that he had not figures as to the possible intensity of magnetisation of the alloys, but assumes that a maximum of 1,000 C.G.S. units is possible, as compared with 1,500 for soft iron. With a range of temperature of 50deg. C., the author then calculates the efficiency of the device. He finds that for an expenditure of 41,690,000 ergs in heat, about 20,800 would be recoverable as mechanical work. This is equivalent to only $\frac{1}{2000}$th of the input. The author then considers how the efficiency could be augmented. The increase of the magnetic induction to 10,000 is the first proposed step, although to get this permanent magnets will have to be replaced by electro-magnets. The second step is the improvement in the methods employed to produce the change of temperature. The author states that if the above change in the magnetic field is made, it would only be necessary to give or take away one-tenth of the previous quantity of heat from the alloy. This we doubt very much, indeed, as it assumes that the magnetic flow through the alloy is directly proportional to the change in temperature. At any rate, Mr. Deprez commits himself to this extent. He describes a method of heating and cooling by means of a liquid having a high specific heat. This gives a fairly simple solution of the difficulty, and the idea is developed of having a series of such apparatus so that the circulation of liquid could be continuous, and that the range of temperature in any one would be the same. Here, again, a difference of temperature is confounded with the absolute temperature required to remove the magnetic properties of the alloy. The author concludes that a possible theoretical efficiency of 3 per cent. might be obtained. He points out, however, that although it is not impossible to use these curious nickel-iron alloys in this way, there are many practical difficulties to be overcome.

NOTTINGHAM ELECTRICITY WORKS.

These works were first able to supply light in 1894, and a description of the buildings, plant, and mains then laid down appeared in our issues of Feb. 23 and March 2. Since then we have visited them several times, and now, through the courtesy of Mr. H. Talbot, the borough electrical engineer, are able to give details of the progress made during the past three years. The extensions of the generating station and of the mains have been carried out without in any way interfering with the supply. As will be remembered, the works were designed by Mr. Talbot in the first instance, and he arranged at the time for extensions which were bound to be needed. As a result, the present works do not show that lack of uniformity in design seen in so many of our electric stations. There has, in fact, been nothing to remodel or change, and the work done by the original contractors has stood the test of time so well that all the new contracts have been placed in their hands.

Dynamos.

Turning to the illustration (Fig. 1) of the generating station, one can see at a glance the arrangement of the machinery now at work at Nottingham. The buildings have been extended since the first part of the station was completed in 1894. The old end wall stood about where the centre ventilator to the cable subway now is. In extending the buildings (for which work Mr. A. Brown, the borough engineer, was responsible), the details in the old part were faithfully copied. Thus at a casual glance the division between the old and new work is not noticed. The original machinery consisted of the three 80-h.p. sets of Willans engines direct coupled to Siemens dy which are placed on the left of the large switc These dynamos, running at 440 revolutions, can g amperes at 145 volts, and are used to take light lo to balance the three-wire system. They can also be em to charge the accumulators. The next size of ma represented by the four coupled sets on the right. supply to the two outside wires of the network pressure from 200 volts upwards, as may be requ provide for the drop in the feeders. Their current is about 370 amperes, and the capacity of each set is Finally, we come to the two large sets, which are of capacity. This size of dynamo, coupled to a hig engine of the Willans type, has become quite a st unit in all the large direct-current stations. The

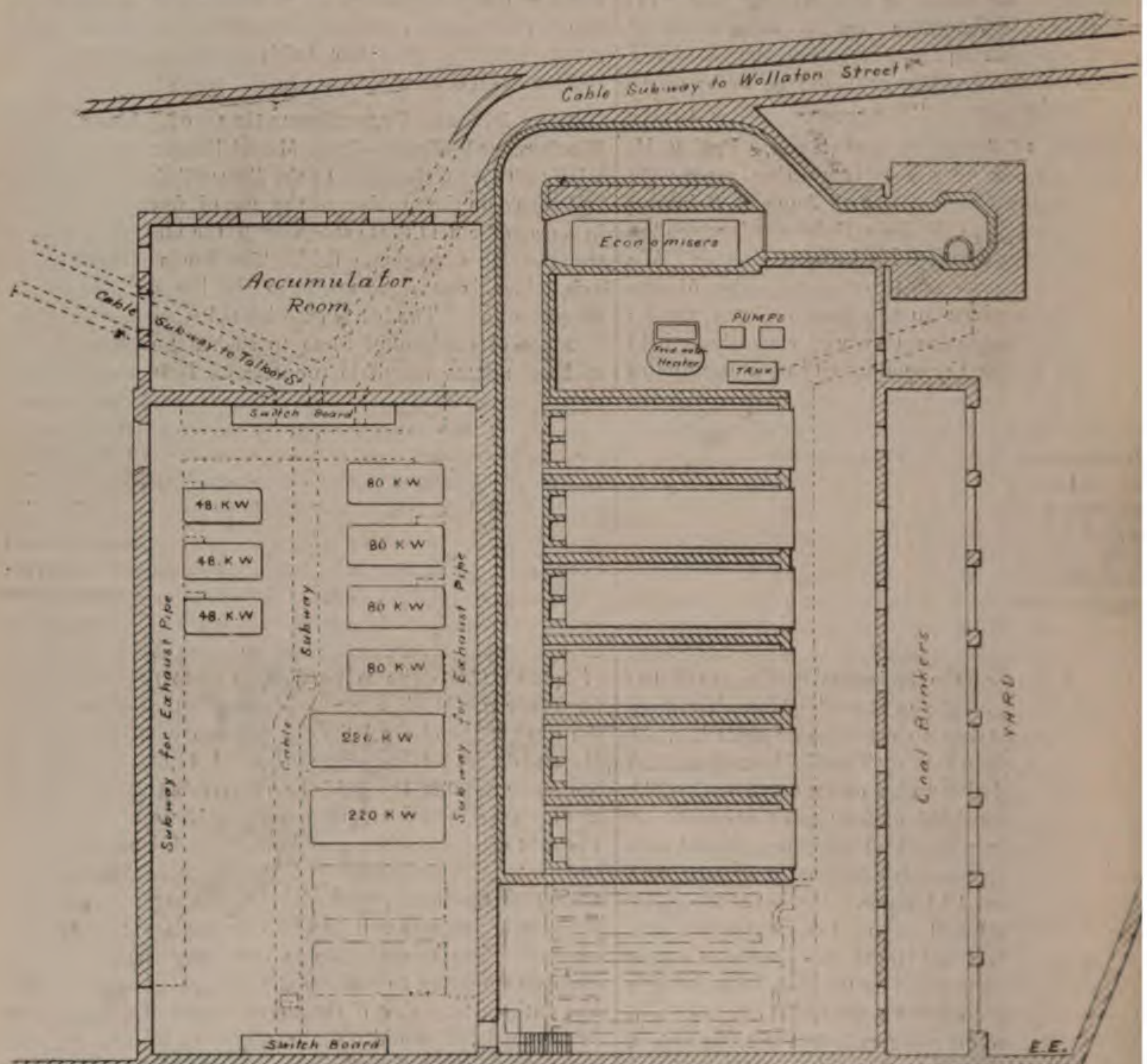


FIG. 1.—General Plan of the Nottingham Electricity Works.

the size were, we believe, used at the Naval Exhib 1891, and since then Messrs. Siemens Bros. have had a large number on order for different parts country. The dynamos are direct coupled to engines with three lines of cylinders, each being a compound single-acting engine. These two sets b total capacity of the station up to 840 kw., and fou space is provided beside the two large units for tw 220-kw. sets. Fig. 2 shows the general appearanc engine-room.

Steam Generating Plant.

The boiler-room has been extended in the same d as the engine-room, and the additional boilers mak total battery to six. Fig. 3 shows the fronts of these They have all been supplied by Mr. E. Danks, Oldbury Boiler Works, near Birmingham. The bo of the Lancashire type, each 28ft. long and 7ft. d Four of these were included in the original contr

others added since. The economisers have also been eased, the number of tubes being doubled. The feed er, before passing to the boilers, goes through the two omisers in series and then to the exhaust steam feed ers. These heaters are of the Berryman type, supplied Messrs. J. Wright and Co., of Tipton. The water for works is taken from the town mains and stored in a

FIG. 2.—General View of the Engine-Room at Nottingham.

0 gallon tank under the yard behind the boiler-house. ms to be of good quality as far as temporary hardness cerned, as the Berryman feed heater only requires ing about once a year. We are also informed that has not been any large amount of deposit in the s themselves. The original steam feed pumps have supplemented by an electric pump capable of deliver-

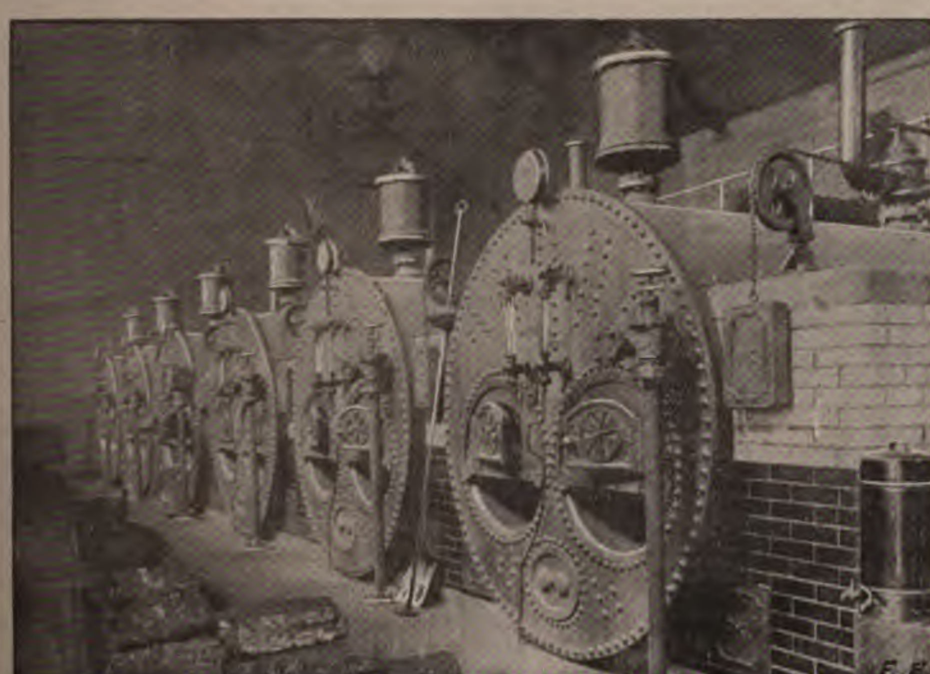


FIG. 3.—The Battery of Six Lancashire Boilers.

g 1,600 gallons per hour. This pump is placed inside a d partition to prevent the boiler-house dust from ring the motor and gear. The pump was supplied by ss. Hayward Tyler and Co., and the motor by the tric Construction Corporation, Limited. The motor the pump through a double-reduction gearing, with ons working into mortice wheels.

The steam-pipe arrangements are worthy of note as affording special safety against breakdown in case of a faulty joint, although faulty joints have been very scarce at Nottingham. The connection from each boiler leads from the stop-valve to a main placed along the outside of the engine-house wall. Valves are placed in this main between each boiler connection. In the engine-room there is a complete ring main hung round the walls, from which connections are made to the various engines. The boiler-house main is connected to this ring in six places, and, as before, valves are placed in between each incoming pipe. In this way one-half of the station can be worked from half the boilers without causing any undue drop of pressure in the pipes. The main steam-ring in the engine-room is 8in. diameter. The method of suspending this ring is seen in Fig. 2. All the valves are of Hopkinson's own make.

Switchboards.

We come now to the switchboards required to distribute the electrical energy. The original board is shown in Fig. 4, while Fig. 5 is a diagram of the additional board

as it will be connected when completed. At present only two panels out of five have been erected of this new board, and these were supplied by Joseph Blackburn, of the Gresham Works, Nottingham. In Fig. 3 the centre panel contains the accumulator switch-gear, the next two panels on either side contain the switches and meters for the dynamos, and the two outer panels are for + and −

FIG. 4.—View of the Original Switchboard at Nottingham.

feeders. This board was supplied by the Electric Construction Corporation. As regards the regulation of the feeders to ensure constant voltage on the network, it was at first arranged to use counter E.M.F. cells in them, and the two lines of multiple-contact switches near the bottom of the feeder panels were provided for the purpose. It has been found, however, that the design of the feeders does not require these to be used except in the case of the "Castle" feeder. The lights at Castle are used to illuminate the museum and library, and hence a heavy load is often

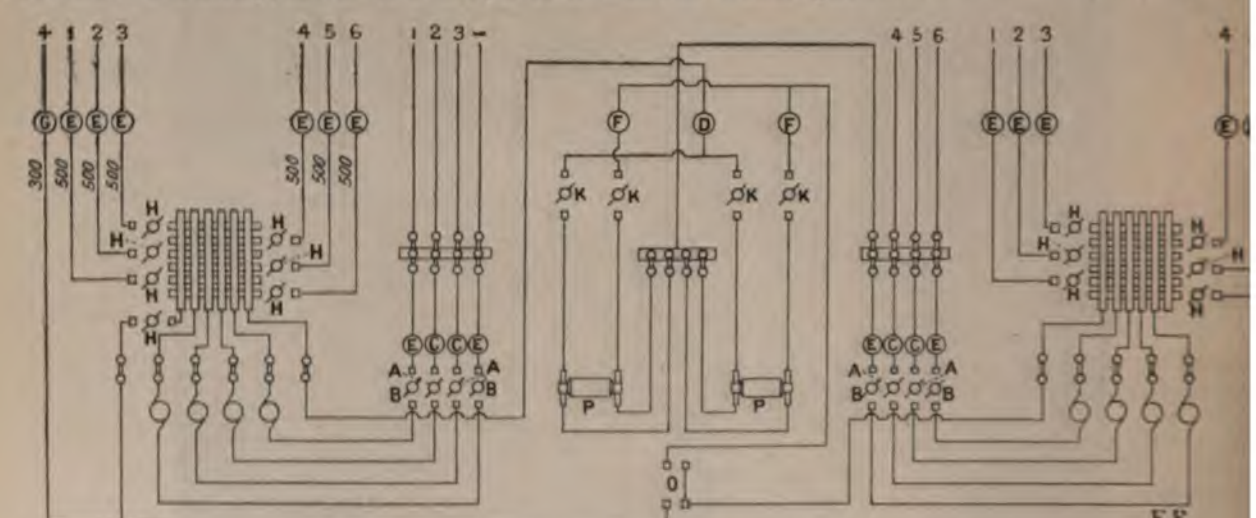


FIG. 5.—Diagram of the Switchboard Connections when the new board is completed.

taken when, as on holidays, the other circuits are lightly loaded. As regards the new board (Fig. 4) the connections in the centre are from a pair of motor-generators to hitch up the voltage to about 500 for a three-wire distribution in the suburbs at 220 volts. The two switchboards can be, and usually are, worked in parallel, but as certain of the new feeders are directly connected to the new board at times of heavy load, they are supplied by the large machines independently.

Mains.

The extension of these has been carried on regularly wherever a likely demand was to be found. It is however, that the oldest, and perhaps the most in residential, district is still unsupplied. We refer street and crescents known as The Park. A canvas district showed that only four houses would agree the light, and hence mains were laid to other part a better appreciation was shown. It will be curiou how the district in question will support the electr eventually, as often to promise to take the light is object to certain classes who would willingly do so if it were at their doors. As regards the feeders, the ends of th shown by lettered circles on the plan, Fig. 6. The s of these are as follows:

B. Market-street	·5	·25
C. Clumber-street	·6	—
D. Broad-street	·8	—
E. Wheeler-gate	·75	·3
F. Chapel-bar	·25	—
G. Albert-street	·6	—
H. Castle	·84	·3
I. Sneinton Batten	·75	—
J. Mansfield-road	·2	·1
K. Magdala-road	·3	—
L. Mapperley-road	·3	—
M. Parliament-street	·4	—

The mains and feeders have all been supplied an by Messrs Callenders, Limited. The first were draw Callender casing, and the more recent cables are conc

:hed, and iron armoured. The success of the been most marked, as the only trouble arising ue to careless workmen driving picks through This has occurred two or three times, but no 'as then experienced in finding and removing The mains on the map, shown by a full black those first laid to serve the compulsory area. n the three-wire system, with 200 volts, between as are also the extensions of mains shown by otted lines. The extensions, however, from

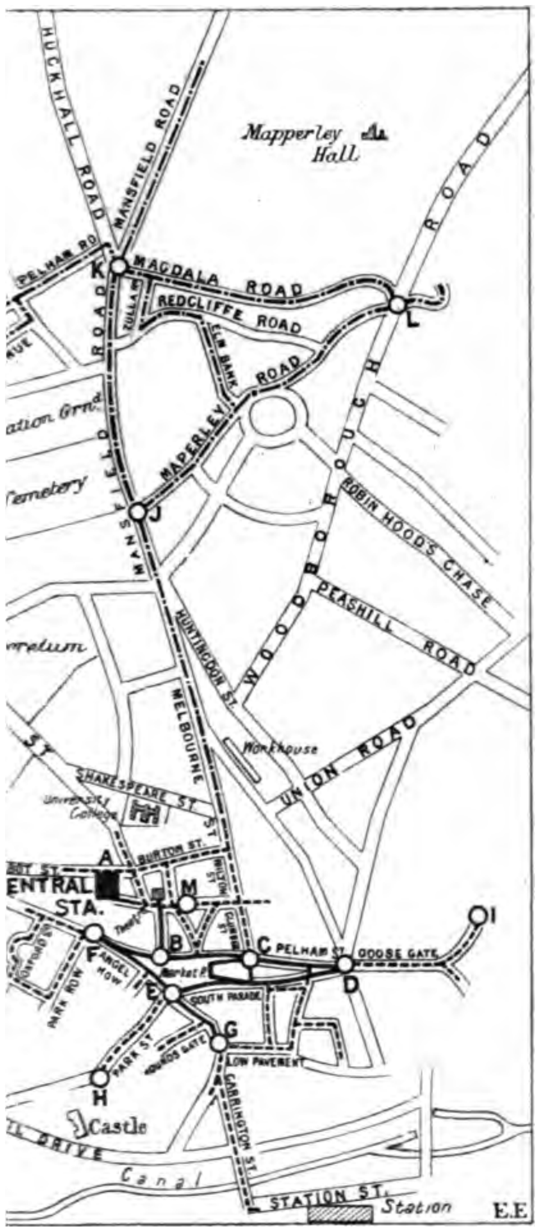


FIG. 6.—Map of the Nottingham Mains.

-street upwards, and denoted by the dot-and- supply customers at 200 volts, and will eventually volts between the outers. At present the centre nnected to one outer, and the mains supply on the ystem. The actual distance of the furthest main supply station is now about 3,000 yards.

Growth of Demand.

rves (Fig. 7) show how the demand for light has l since the commencement of supply. The final the curves show that the equivalent of some h.p. lamps are now connected to the mains, these are taken by some 420 different . The increasing grade of the curve is most as it shows that the rate of increase ing up. This is due first of all to the nd good supply given, and also latterly ion in the price rendered possible by the cess of the undertaking. Thus, in June last ighton system of charges was introduced, and charged for the first hour's average supply at the maximum output demand; after this the rate is reduced to 4d. per unit. Motive power is charged at 3d. per unit, but up to the present the demand has not been great. An aggregate of nearly 50 h.p. in motors is either connected or promised at present. The load curves (Fig. 8) on four separate days are of great interest. That for Dec. 22, 1897, shows the largest output on any day up to the present, and also the maximum load. The vertical scale is in amperes at 100 volts, so that the maximum load was, neglecting losses in the line, 542 kw.

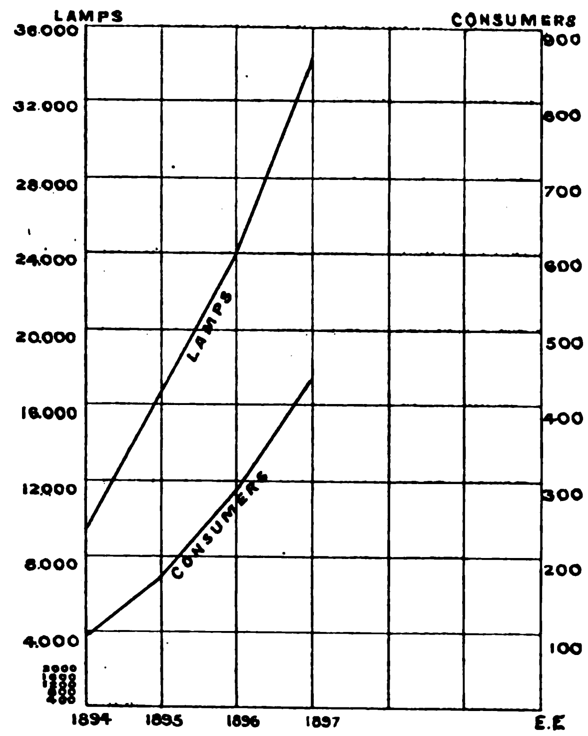


FIG. 7.—Curves of Lamps Connected at different dates.

The financial results for the year ending March 31 are as follows:

REVENUE ACCOUNT FOR YEAR ENDING MARCH 31, 1897.

Dr.	£	s.	d.	£	s.	d.
Generation of Electricity.						
Coal, etc.	£702	18	8			
Oil, waste, water, etc.	153	10	2			
Wages at generating station	476	8	0			
Repairs and maintenance as follows: buildings, £6. 11s. 4d.; engines and boilers, £39. 16s. 4d.; dynamos, etc., £6. 16s. 5d.; other machinery, instruments, and tools, £11. 8s. 4d.; accumulators and accessories, £172. 14s. 4d.	237	6	9			
				1,570	3	7
Distribution of Electricity.						
Wages	£13	8	7			
Repairs, maintenance, and renewals of mains, £2. 4s. 2d.; repairs, maintenance, and renewals of meters and apparatus on consumers' premises, £15. 12s. 3d.	17	16	5			
				31	5	0
Public lamps—attending and repairs				31	15	10
Rents				48	0	0
Rates				191	8	2
Salaries—engineer and staff				631	7	10
Stationery and printing				35	5	2
General establishment charges				115	7	1
Insurances				26	11	8
Consolidated stock, management charges, and stamp duty				44	4	4
				2,725	8	8
Bad debts				4	1	5
Balance carried to net revenue account				4 632	0	1
				£7,361	10	2
Cr.				£	s.	d.
Sale of current per meter at 6d., 4½d., and 3d. per B.T. unit				6,768	7	10
Public lighting				289	1	6
Rental of meters				237	0	2
Public lamps—attending and repairs				34	19	3
Consumers' connections, net				23	12	9
Discounts				2	9	10
Stores				5	18	10
				£7,361	10	2

BALANCE-SHEET, MARCH 31, 1897.

Liabilities.	£	s.	d.
Capital account—viz.: Consolidated stock	46,830	2	10
Less stock purchased and cancelled	763	18	9
	46,066	4	1
Loans	25,435	0	0
	71,501	4	1
Consolidated stock purchased and cancelled	763	18	9
Sundry creditors	1,065	18	5
Reserve fund—amount set aside	452	17	3
Sinking fund—amount set aside	2,734	0	10
	£76,517	19	4

Assets.	£	s.	d.
Capital account—amount expended—viz:			
Expenses of issue of consolidated stock capitalised	215	13	4
Discount on issue of ditto	1,614	9	6
	1,830	2	10
Preliminary expenses	331	6	0
Lands	10,823	10	7
Buildings	14,436	13	8
Machinery	17,455	15	9
Accumulators	1,421	15	8
Mains	18,945	14	0
Meters	2,331	17	0
Electrical instruments	185	4	8
	67,762	0	2
Less income on capital account	374	19	8
	67,387	0	6
Stores on hand: coal, £19. 15s. 3d.; oil, waste, etc., £19. 17s. 3d.; general, £267. 3s. 10d.	306	16	4
Sundry debtors for current supplied	2,734	0	11
Other debtors	1,034	1	1
Cash on bankers' hands, £2,318. 19s. 8d.; cash in hand, £3	2,321	19	8
Nottingham Corporation loans fund: proportion of sinking fund investments, £1,970. 2s. 1d.; consolidated stock purchased and cancelled, £763. 18s. 9d.	2,734	0	10
	£76,517	19	4

We are indebted to Mr. H. Talbot for hi[s kindness in]
giving us details of this station, and to his [assistant, Mr.]
W. M. Rogerson, for showing us round the w[orks.]

NOTES ON ACCUMULATOR CONST[RUCTION.]

BY DESMOND G. FITZ-GERALD.

[Copyright.]

LXXIV.

The third lithanode patent is of compar[atively recent] date, being No. 9,906 of 1893. This inven[tion relates to] the production of an alkaline plumbite com[pound, which] may be expressed as K_2PbO_2+xPbO. By [exposure] of this compound to the atmosphere, after pasting, the oxide of lead contained in it gradually and perfectly, and in a more or condition, by reason of the slow absorption of by the alkali, and the consequent precipit plumbic oxide previously held in combination a "seasoning" period of 14 days or more— "setting" process is sufficiently advanced—t without danger of disintegration, be immerse which the greater portion of the carbona removed in solution. They are afterwards i half-saturated solution of sulphate of magnes magnesic chloride) for the purpose of conve the oxide of lead into sulphate, without p violent evolution of carbonic acid which wou immersion in dilute sulphuric acid, in co residual carbonated alkali still present, togetl plumbic carbonate. Lastly, the plates are i solution of the same salt ($MgSO_4,7H_2O$) a sulphuric acid, and in this solution they may According to the percentage of alkali used of lead, any required increase of porosity ma

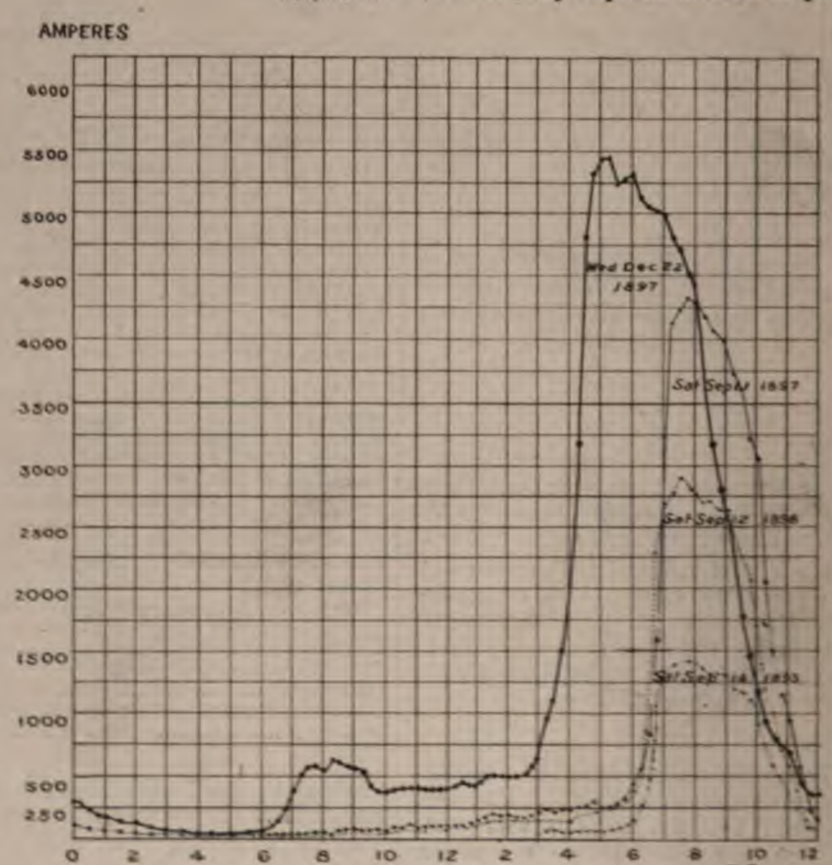


FIG. 8.—Load Curves.

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units (estimated)		316,638
Quantity sold: Public lamps	11,563	297,185
Quantity sold: Private consumers by meter	285,622	
Quantity used on works		3,621
Total quantity accounted for		300,806
Quantity not accounted for (estimated)		15,832
Number of public lamps		8
Total maximum supply demanded (kilowatts)		400

with very little loss of cohesive strengt[h] percentage of electrolytic peroxide of lead very kindly with the other ingredients, and a useful degree of conductivity to the unfor[med] The following extract from the complete spe[cification will] give some details in relation to this process:

"I mix litharge, or massicot, or minium, or

ı a solution of caustic potash (or with a mixed of caustic potash and caustic soda) having ı a specific gravity of from 1,100 to 1,150. oda alone might be used, but it is undesirable n of the subsequent efflorescence of the sodic formed. The quantity of solution used should ent to form the lead oxide or oxides into a stiff hich is then moulded in the ordinary way es or masses of any desired form, under a f pressure which need not exceed that obtainh an ordinary screw press. Such plates or ay have any suitable conductor embedded in the process of moulding, or a suitable conductor subsequently attached to the moulded plates or These are then exposed to an atmosphere conarbonic acid (preferably to a current of air conhe full normal or an increased percentage of acid) for a sufficient period to convert a conpercentage of the alkali into carbonated alkali." bove process has not yet been employed comon a considerable scale.

LXXV.

ructure of the peroxide or spongy-lead active —the direction of the pores as well as the degree ty—influences to a very considerable extent the f the material, more especially in the case of thick layers. As, I believe, is the case in the making of in the pasting of plates, the careless manipuy produce a better result than the over-careful have had occasion to point out to lads in the operation of pasting that the repeated g of the layer with the trowel, though it may be to a neat appearance, results in a stratification eatly impairs the porosity of the layer in the direction—viz., that transverse to the surfaces of An improvement on the ordinary pasting process, l be found of value in the case of thick grids or to fill or coat them with oxide of lead in a slightly dition, and to subject the material to a sufficient pressure between sheets of flannel, linen, or felt, g enough moisture to cause the surface particles ide to cohere. The material is then to be treated pouring on to its surface a quantity of the soluto produce the "setting" effect—such as that of sulphate (LXX.), which may be half-saturated, or ne solution referred to in the proceding section— to moisten the whole mass. The plate is then seasoned in the usual way. By this treatment fied structure is avoided, and the pores are proright angles to the plane of the plate.

LXXVI.

urth compound referred to under Section LXX., is ixture of the chlorides of lead and of zinc. The odding the zinc salt, the percentage of which may ı 3 to 10, is twofold: in the first place, it prevents chloride from splitting into fragments by the ontraction after fusion and casting into plates or and secondly, it gives any required degree of to the lead obtained by the reduction of the of this metal. The use of this compound was in this country, as a communication from Mons. A. ty, of Paris, in 1885, under No. 2,765.

final specification, the inventor says: "I melt or in a porcelain capsule (dish) chloride of lead, to then add a suitable quantity of chloride of zinc. . I agitate the mixture and permit it to cool, or I in a liquid state into a mould of thick lead, ı, platinum, or other suitable substance which s attacked by the chlorides, and whose coefficient sion is lower than that of the said chlorides. . I thus obtain a double chloride of lead and zinc, st a mixture of the two chlorides. ing the solidification of the mixture, a rod, having r less number of branches of platinum or lead conductor of electricity, and capable of resisting of sulphuric acid even under the influence of y, is inserted as an internal support. Such support may, however, be dispensed with, and al support or frame of cast or rolled lead be used, which support or frame is placed either upon the plate in the state of chloride, or upon the crystallised chloride of lead which is obtained as hereinafter described.

"In order to obtain chloride of lead which is completely and solidly crystallised, I proceed as follows: I mix with the chloride of lead from 3 to 6 per cent. of chloride of zinc, and I immerse the cast plate of double chloride in contact with a plate of zinc in a saline solution, preferably a concentrated solution of chloride of zinc, taking care that the reaction only produces chloride of zinc, and that the liquid is saturated in order that it shall not dissolve the cast double chloride."

Zinc chloride, it may here be observed, is a deliquescent salt, and since no solution of such a salt can be said to be saturated, it is difficult to understand what the inventor can mean when he states that care must be taken that the liquid is saturated. A 10 per cent. solution answers the required purpose.

"When a plate of the double chloride is immersed between two sheets of zinc [the inventor means either that the plate, with a conducting support or frame, is to form a voltaic element, or else that the sheets of zinc shall be in actual contact with it] a crystallisation takes place, needles being formed which divide the surfaces in the direction of the thickness. If there is only one sheet of zinc, the crystalline needles of chloride of lead [*sic*] extend throughout the entire thickness of the plate. In this manner I easily obtain plates of any desired dimensions, consisting of chloride of lead [?] in the form of beautiful crystals."

It appears obvious, both from what precedes and from what follows, that when the inventor speaks of "crystalline needles of chloride of lead" he means "crystalline needles of lead," such as are ordinarily produced when a plate of lead chloride is brought, directly or indirectly, into metallic contact with zinc, in an electrolyte.

"After thorough washing of the plates to eliminate the chloride of zinc, immersion thereof in water acidulated with sulphuric acid to dissolve the metallic zinc [?] and renewed washing with water, I dry the said plates by means of a gentle heat to augment the consistency of the crystalline mass of chloride of lead. I then arrange the accumulator [*sic*] or secondary battery in the ordinary manner in water acidulated with sulphuric acid, or in a solution of a metallic salt susceptible of electrolysis. It can be charged very rapidly. For charging the accumulator, a much stronger current may be employed than with other systems; it may be above 60 amperes."

The current will, of course, depend upon the size and number of the plates. But the current that could be employed would be comparatively very small if the plate were composed of crystals of lead chloride, instead of crystals of metallic lead.

"The improved plates, if they have been well prepared, are, after peroxidation, very hard, smooth, and sonorous, when struck. The oxidation of the plate can be accelerated either by the dry process, by causing it to be traversed at a suitable temperature by a current of oxygen or of air, or simply by heating it in the open air; or by the wet process in an oxidising liquid with or without the action of the current."

The inventor doubtless means that, *prior to peroxidation*, the lead crystals become oxidised by exposure to the air with or without the application of heat, or by immersion in an oxidising liquid. Crystals of lead chloride would be quite unaffected. He appears to have lost sight of the cathode in charging; but, further on, he, or his patent agent, says: "Very beautiful results are obtained (very brilliant crystals of lead), and the difficulties of the elimination of the chloride added to that of lead are avoided, by putting 7 per cent. of sal ammoniac in small pieces into the cast chloride of lead. The plates do not break by cooling, and when arranged in a battery in a concentrated solution of sal ammoniac they [the inventor is now losing sight of the anode in charging] are reduced to simple lead, and a washing with water is sufficient to completely free the lead from foreign matters; these [?] plates can be charged in an accumulator as positive plates in three hours under a current of six amperes."

The inventor probably means that the plates reduced to metallic lead can be so charged. The mysterious conversion

of *all* the plates into porous lead is perhaps to be accounted for on the hypothesis that anode plates of carbon are used, although these are not mentioned. It appears certain that the chloride plates were not used as anodes, because when so used they evolve torrents of chlorine, a gas of which the effects upon the human organism and metallic bodies are very noticeable indeed.

The claims under this patent are, like the specification, somewhat puzzling, suggesting a second or third hand knowledge of the invention on the part of a shrewd lawyer unacquainted with electro-chemistry.

The first claim is for "the manufacture of plates for accumulators or secondary batteries, without fracture or crack, by means of chloride of lead cast with chloride of zinc, the zinc being subsequently removed by sulphuric

The seventh claim is of some importance, and i "the employment of oxychlorides of lead in tl facture of the said plates."

The eleventh and last claim is a climax in mo than one, being for "the improved electrical acc or secondary battery provided with plates of cr chloride of lead, substantially as above set forth."

It scarcely needs to be pointed out that "an lator with plates of chloride of lead," cryst amorphous, would be no accumulator at all until and that the operation of charging it would, precautions, probably result in a coroner's inquest.

It may here be observed that the importanc patent is by no means so much due to its intrins as to the financial and commercial objects to whic

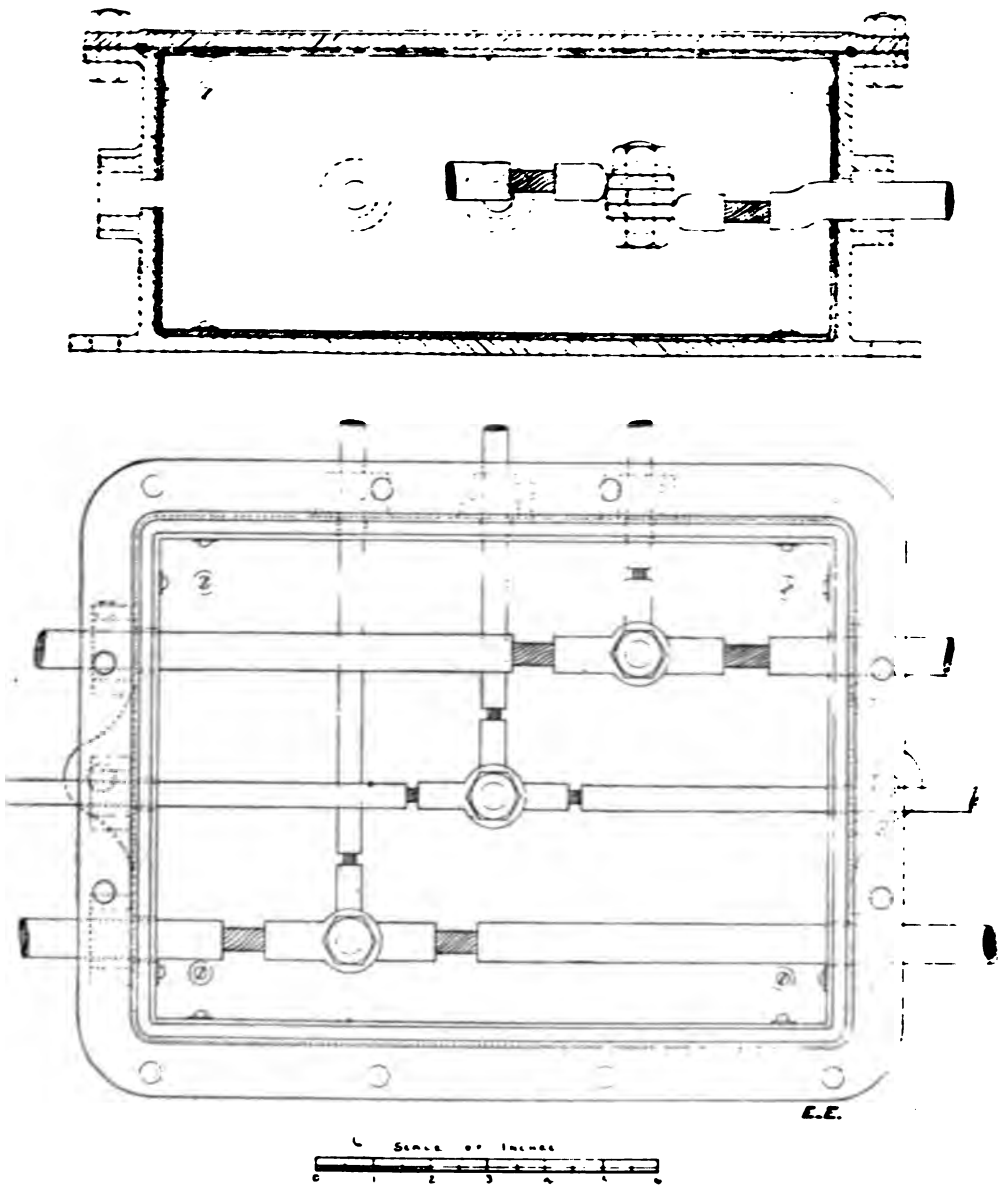


FIG. 1.—Glasgow District Subway—Cast-Iron Junction Boxes as used at the Passenger Stations.

acid, whereby plates of chloride of lead having a suitable degree of porosity are produced."

The "zinc" to be removed is doubtless the chloride of this metal in admixture with the chloride of lead. But the use of sulphuric acid for this separation is not mentioned in the specification; although water acidulated with sulphuric acid is used for dissolving metallic zinc, probably the residue of that employed to reduce the lead chloride to the condition of metallic lead. But the zinc mentioned in the claim cannot be metallic zinc, since the plates after its removal consist of lead chloride.

The second claim is for "the employment of oxygen, air, and heat, for producing a primary oxidation of the aggregated reduced lead."

According to the specification, it would appear that it is "the crystalline mass of chloride of lead that is oxidised." No mention is made of any reduced lead to be oxidised.

more or less conducive. Lead chloride, whethe applicable advantageously for the purpose in view happen to be—more especially in the fused and condition—amongst the compounds claimed in th under the control of the Faure-Sellon-Volckmar com

THE GLASGOW DISTRICT SUBWAY

(Continued from page 136.)

The Mains and Distributing Networ

The distribution throughout the system is carri the three-wire system, the lamps being 230-volt normal 460 volts across the two outside wires. It i for this installation that it is the first station t down on the three-wire system and originally des using 230-volt lamps, although it was quickly fol

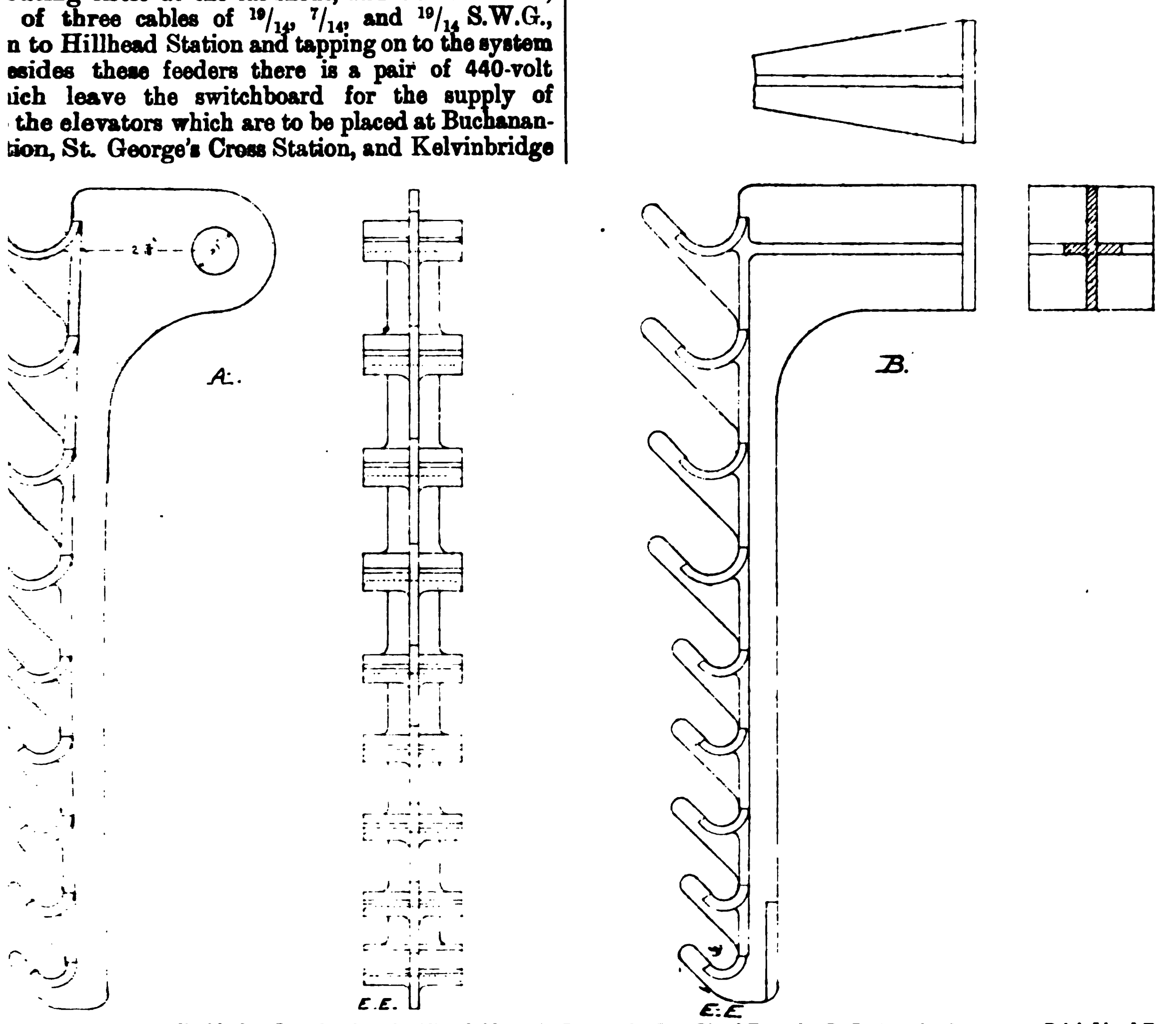
nd it had, of course, been preceded by one, if not ntral supply station, who changed over from the 10 to the double pressure, as recently allowed by d of Trade.

ain distribution for the lighting and power required ut the passenger stations, etc., consists of a com- le of three cables, fed at four points by feeders m the power station. The feeders run from the the switchboard in pipes to the traction cable nd so into the inner tunnel; one set, consisting ables of $^{19}/_{18}$, $^{7}/_{18}$, and $^{19}/_{18}$ S.W.G. respectively, the main distributing circle at the point of entry tunnel; then one set, consisting of two cables $^{7}/_{18}$ S.W.G. cables, run in a westerly direction to -street Station, where they tap on to the two wires of the distributing circle; the other follow round the tunnel in an easterly the first set consisting of two cables and $^{37}/_{16}$ S.W.G. respectively, tapping on to buting circle at the car-sheds, and the other set, of three cables of $^{19}/_{14}$, $^{7}/_{14}$, and $^{19}/_{14}$ S.W.G., n to Hillhead Station and tapping on to the system esides these feeders there is a pair of 440-volt ich leave the switchboard for the supply of the elevators which are to be placed at Buchanan- tion, St. George's Cross Station, and Kelvinbridge

different types for both the iron-lined tunnels and the brick-lined section, or 12 patterns in all. The cables are simply laid along these brackets, and then strained up and secured by means of split wooden blocks bound on to the cable close against the bracket; by this means all unsightly sag is prevented. Throughout the length there are from 3,500 to 4,000 supports.

At each station, and at the car shed, the main distributing circuit passes through a cast-iron junction, a specimen type of which is shown in Fig. 1. These boxes of course vary slightly in the different positions to meet the various needs of the particular case, but, generally speaking, the main circuit enters on one side and passes out at the other, while the feeders, where there are any, enter at the bottom of the box, and the mains to supply the local requirements leave the box at the top. This latter set of mains run directly to the main station distributing board.

It might be mentioned that the whole of the cables are of pure and vulcanised rubber of the Silvertown make, and



...sgow Subway—Malleable Cast-Iron Brackets for Nine Cables. A. Pattern for Iron-Lined Tunnel. B. Pattern for Concrete or Brick-Lined Tunnel.

this pair of cables runs alongside the other in a direction, and up as far as Buchanan-street Station square inch sectional area, following on to St. Cross with ·3 square inch sectional area, and on to idge with ·2 square inch. Running along with les there is also a multiple cable for use of the ls. This, then, means that at the power station running east (1) the three distributing cables, (2) Buchanan-street feeders, (3) the two elevator cables, the signal cable, or eight cables in all; while west (1) the three distributing cables, (2) the two car- s, (3) the three Hillhead feeders, and (4) the or nine cables in all. This number gradually s to only the three distributing cables between d Kelvinbridge.

les are all carried along the inner wall of the on malleable-iron bracket supports, as shown These supports are of various sizes to take sizes and numbers of cable, there being six

they have no lead covering, neither are they protected with armouring.

SOCIETY OF ENGINEERS.

Inaugural Address.

BY W. WORBY BEAUMONT, M.I.C.E., M.I.MECH.E., M.I.E.E., PRESIDENT.

The subjects which are of interest and occupy the attention of engineers of to-day are as numerous as the modern advances of civilisation, and may be said to stand in the relation of cause and effect. The increase in the comfort and well-being of mankind is so largely due to the exercise of the faculty of the engineer in the many branches of his profession, that it is, on the one hand, difficult to select those which are of most general interest from the many subjects which are his, and, on the other hand, difficult to select one which is not of interest.

There are, however, some which are occupying more thought at the present day than others, and it is on some of these, and some which have more particularly occupied my own attention, that I propose to address you on taking the chair to-night to which you have given me the honour of your election. The most important of these subjects relate, as it was first seen by Tredgold they would do, to the "direction of the great sources of power in nature for the use and convenience of man as the means of production and of traffic in states." It is the creation of artificial power by the direction of these natural sources that has occupied engineers for several generations—power which enables the world to benefit by the fact that:

"Each clime needs what the other climes produce."

It has enabled active people to add industrial produce to these needs, and thus build up and conduct the trade which keeps up the ceaseless traffic over continents and oceans. It has given value to that which was valueless because beyond reach, and, as compared with the days of our great-grandfathers, the steam-engine has created wealth by creating time as well as materials. The steam-engine, almost unnoticed until the improvements of Watt and others gave it the blossom which (like that of an unconsidered plant) showed the value of the previously unconsidered root and stem, has occupied engineers in its seemingly unending developments and new applications. Other motors, or mechanical creators of power, have added to the means "directing the great sources of power in nature," and of economising the time and materials nature places at our disposal.

There seems no end to the extent to which civilian engineering adds to the number of appliances by which mankind can add art to nature, and artificial conveniences to the comforts which are of nature's provision. If man is mainly distinguished from the lower animals by his tool-using propensities, then the engineer is pre-eminent in his distinction from the lower animals. He is a creator in profession and in trade; he creates a necessity and lives by the necessity for that creation, and every advance he makes is an advance in civilisation. The great advances made in agriculture by the engineer's mechanical aid have put the world under tribute for corn and meat for his sustenance, and the growth of corn and meat of some parts of the world for other parts have made necessary the tools of the engineer—namely, the railways, and the ships, and the mills, and refrigerators, and factories: all the tools of, and made by the aid of the tools designed by, the engineer. The field thus covered is co-extensive with the world's surface, and the record of the great advances which have marked the rate of the world's material progress and comfort, is the history of the results of the labours of engineers.

In the latter parts of the century now drawing to a close, the advantages derived from a change from the old to the new of the engineer were so great that the continued employment of the machinery and methods of half a century has been sufficiently profitable to render improvements of secondary importance in many industries. The time has, however, now arrived when engineers must devote ingenuity and ability to the improvement of their own works, to the development of the methods and tools devised a generation or more ago. Economy in production and use of mechanical power offers as great a field as economy in time and material, and economy in time occupied in travelling, notwithstanding all that has hitherto been done by the construction of railways, still demands the expenditure of large sums of money for town, suburban, and cross-town service. Economy in the work of haulage on more than a hundred of thousands of miles of road at home and in our colonies will secure a profit on a larger sum of money than has ever yet been expended in a generation in one important field, and the improvement of our roads will lead to as great a change in the time occupied in and the cost of distribution to two hundred millions of people and their goods as the railways brought about between 1838 and 1859. The same improvements will bring about a vast change in our common road vehicles, and their wheels and means of propulsion. The better the roads, the better and less destructive may be the wheels and the longer will the roads last; and great industries will grow up in the manufacture of motors and carriages, and motor vehicles for all purposes. The generations of good trade have made us more or less indifferent to some of these necessary improvements, and to the profits derivable from them.

In our factories and establishments we are still using old engines and machinery which cost £100 for fuel, where £50 would be sufficient, and where capital invested in new plant would earn a return of from 50 to 100 per cent. We are using old machines of which two are required to do the work of one new one, and we go on driving them, and the shafting for them, year after year, making very small instead of larger profits, and then investing what profits we do make in things one-tenth as pregnant of dividends as investment in the proper plant for the works that made them would be. It is quite safe to say that one-half the millowners in this country are paying twice the sum for coal they need pay, because they do not like to throw away an old engine that works well, and old boilers
that will work under present conditions for anoth
At least half the millowners are using double th
amount of power for transmission to their mach
most of them are refusing to pay £100 for chan
respect, or for a new machine which will earn them
although they will invest their savings in 3 per cent

Most ratepayers will object to an extra 1d. rate
road improvement, and yet do not object to pay 1
amount that rate would realise, for present cost in
horse food, carriage and wagon repairs, late de
many other inconveniences which happen not to
their observation as a direct tax. Many users of
are at the present day still using gas-engines whi
from 26 to 50 cubic feet of gas per horse-power h
30 to 35 per cent. more gas than necessary, but th
not know that they can, or will not, earn 10 to 2
profit on the investment in a new engine of to-d
suming 16 cubic feet. Most of the high-speed ste
driven by machinery which expends no inconsider
its power in setting up vibration to the detriment
and discomfort of passengers, and some of the oth
fortable paddle ships of high class have a *per saltum*
entirely due to the want of balance which might
All the screw steamships of to-day are fitted with re
which, with its heavy shafts, links, levers, and do
eccentrics, is worked for 10,000 revolutions one wa
may be wanted for 10 the other way. Yet this wa
and material, and fuel, and many of the screw sh
could be avoided by reversing only the screw prop
Enormous quantities of high-speed machinery in
factories of various kinds are causing destruction to
and to the buildings that contain them, by the
wasteful vibration they set up, and yet much of thi
might be automatically balanced. These are only
fields that are waiting for cultivation by engine
impossible in the course of an hour's talk to do
mention these, and I propose to dwell at length
or two of them.

By preference I would dwell upon some of the
engineering problems and inventions of practical
facturing interest, but I will refer chiefly to som
the widest of all fields of mechanical engineering
namely:

ROAD TRANSPORT, ROADS, AND TRAMWAY

There are some millions sterling thrown away e
the United Kingdom as a result of insufficient ex
roads and means of transport. The fact that ther
thousand millions sterling profitably invested in the
the kingdom is alone a proof of the national impor
best means of transport of men and materials.
only more transport facilities, but we want vast im
in our existing ways of conveyance. In another
said that "with the exception of land and ruin
few material things of value to man which do not
value, in part at least, from transport from th
position." This may seem to be a well-worn truism
necessary to remember it when it is urged that che
transit is one of the most important of all the subj
ing engineers to-day, and one which offers, as it
done, one of the most profitable sources of invest
not generally known that to-day it costs more to s
goods by rail between some places in this country
formerly to send it by horses on the common roads
one does know that the Post Office finds it cheape
parcels by road than to pay the rates demanded by
companies for that traffic. The cost of haulage by
small, but the terminal cost and cost of the railwa
ments as vast machines are so heavy that the cheap
way transit in many cases disappears. The r
under the many Acts for the regulation of railwa
this country, done much to bring this about; an
long distances goods are conveyed at cheap rates,
distance charges are necessarily heavy. The aver
transport to-day of goods between Liverpool and M
distance of 35 miles, is 9s. 6d. per ton. At the pr
horse keep it could be done for about 8s. 6d. by h
traction engines it can be done for from 1d. to 1·2
mile, or for 2s. 11d. to 3s. 6d. the whole distance t
per ton at a good profit. The quantities to be
however, are so enormous—at least 15,000 tons per
the common roads would be cut to pieces with a qu
a month. This is only one of many lines of com
where greater facilities are required, facilities whi
afforded by main-line railways as at present cons
equipped.

The great requirement is a means of transport
carry and deliver goods at a charge which shall
relation to the cost of haulage. There are hundr
of communication which are at present almost wi
of transport, but which may be served by railway
ways constructed under the now very popular Lig

r mechanical road vehicles. But with all that can be railways or tramways there are millions of tons of s and goods to be provided for between railway nd destinations. We call this a mechanical age, and e to-day as dependent on the horse and the common on for the delivery to us of the goods brought from of the country as were our forefathers. We pride on our road-constructing ability and apparatus, and oads are no better than some of those of the Roman sand years ago, and in our towns we admit this by the ion of tramways which are metallic admissions of the or insufficiency of our ordinary roads and pavements. amways and their cars we permit in our streets to the t of every other form of street vehicle, simply because ive resistance on a smooth hard road is less than on a ad. We find that two horses can haul 42 passengers on y instead of 26 in an omnibus, and so we allow our affic to be crippled by the hard-and-fast direction of it of the heavy cars on these street railways. We put ooved rails that wrench our carriage wheels off, and : spines, and cut our rubber tyres to pieces. These s of bad roads we tolerate rather than make good l suitable vehicles to run on them. We are converting ts into badly-managed railways, with level crossings re, and on which railway cars and common road struggle for supremacy, and horses struggle to keep a

to many of the London tramway and omnibus centres ing places shows that we are rapidly reaching a density impossible to contend with, if the streets are to be more than lines of free railways, on which every car ibus and coal wagon driver is traffic manager. In vincial towns this sort of thing has not been reached, are several in which it is already obvious, as it is in that a large part of all the passenger traffic must be from the streets to railways proper. Nothing but -distance passenger accommodation must be allowed treets either by tramcar or omnibus. As early as motor cabs and omnibuses must displace horses so as ie space now occupied by them, avoid the spreading the streets of that which renders them dirty and r, and avoid the pounding of pieces of the wood, and other of the best pavings with the 3cwt. hammers ood horses' feet.

suburban service railways are inevitable as the n increases, and a big question arises in the selection iscovery of the best and least objectionable form of The new deep underground lines will in London do a l to meet the increase in traffic in some ways, but . develop traffic of their own, which for the busy parts ay will detract from their powers as relief lines for excessive street traffic. Extended overground relief ls in only a few places and directions, and in London l be all required to relieve the crush which at pre- racterises such outlets to suburban homes as Ludgate- rpool and Broad street, London Bridge, Waterloo, and he metropolitan stations. The city and suburban pas- affic presents a problem which will occupy engineers talists some time, but it is essential now that the whole should be dealt with in a comprehensive and not a isolated schemes. When all this is done, the distri- f merchandise across towns and suburbs remains. If difficult to provide for the transport of freight which elf to and from the trains, how much more difficult is lem of cheap and expeditious transit of goods, which employ about 50,000 horses hauling vans and carts of kinds in London alone.

f the first necessities is the provision of the best possible ad road surfaces. At the outset of this problem we fronted with the difficulty of providing equally for y light traffic with not more than about a ton per axle, that up to as much as two tons per wheel. The latter e provided for, and hence the lighter vehicles must odate themselves to the best surface obtainable which thstand the wear of the heavy traffic. Fortunately, the hicles can be more readily made to accommodate them- to the roads than the roads can to withstand uses of the horses and vehicles, so that expediency brings back the n to one of improvement upon our existing methods of construction and maintenance of roads. To some of improvements I may refer briefly. They consist in (1) and more durable surface, well supported on a good tion; (2) better methods of maintenance and repairs, this I mean constant attention to, and repair of, defects appear, just as on a good railway watchful care is by an ample and well-drilled service of men on every the road; (3) the improvement everywhere of the s all over the country by minimising them to the possible extent.

dealing with each of these necessary improvements, pointed out that I am assuming the existing type s to be more or less permanent, or at all events persistent to so great an extent that the roads must be able to carry them. There is, however, I think, no doubt that the time is rapidly approaching when the load per axle on all heavy vehicles will be so far reduced by increased number of wheels per vehicle, that tyres of some yielding but good wearing material will be used for all purposes, and that we shall cease to use our roads and their materials as though they were the beds of mortar mills traversed continually by two-ton steel-shod edge-runners. We put minerals into the pans of edge-runner mills to get them ground to powder, and expect that this shall happen at a considerable rate of crushed output. We do just the same thing with the metal on our roads, and hope the same results will not follow. But they do; and so long as we construct roads as we do now, and run heavily-loaded iron-tyred wheels over them as we do, we shall continue to waste millions per annum in road renewals and in horse food and horse flesh. Assuming, however, that the improvements in vehicles do not occur rapidly, the first and second of the road improvements I have mentioned render it absolutely necessary, in the first place, that the almost inconceivable folly of the practice of making expensive roads and road beds one week and tearing them up the next, for more pipes and wires or repairs, shall be given up.

We live in an age in which people are every day making more and more use of artificial aids to comfort, and public supply and distribution of necessities. We get heat, light, fuel, and water supplied us by buried conveyors, and buried conveyors take away our sewage and drainage. We receive and send telegraph and telephone messages by buried conveyors, and we send packages of letters through buried air-pipes. All these conveyors we put under our costly street pavements, and generally act as though street and road surfaces were like pie crusts, the usefulness of which only becomes obvious when they are broken up. The cost of this burial of all the conveyors, the cost of the breaking up of the roads for new burials and renewals, the cost of remaking the roads even in the imperfect way in which it is accomplished, and the time lost to hundreds of thousands of travellers and trades, is so great per year, that to state the truth would appear like gross exaggeration, and yet in the whole of London there are only a few miles of subways by which the waste is prevented. Subways should be looked upon as a necessity. Until we have them, well-made roads and well-maintained road surfaces are impossibilities in London. The paving materials at present in use will be difficult to improve. Granite setts, where used, should generally be smaller, as well as properly founded. The macadam roads are, however, very far from being as good as they might be; they are neither properly nor efficiently maintained.

(To be continued.)

FORTHCOMING EVENTS.

FRIDAY, FEB. 11.

Physical Society, Burlington House.—At 5 p.m., annual general meeting, with presidential address. At an ordinary meeting afterwards a paper on "Electromagnetic Induction in Plane, Cylindrical, and Spherical Current Sheets, and its Representation by Moving Trails of Images," by G. H. Byran, M.A., F.R.S.

Institution of Mechanical Engineers.—At the Civil Engineers, at 7.30 p.m., continuation of the papers and discussion left over from Thursday; and "Steam Laundry Machinery," by Mr. Sidney Tebbutt, of Leamington.

Royal Institution, Albemarle-street.—At 9 p.m., "The Metals used by the Great Nations of Antiquity," by Dr. J. H. Gladstone.

Institution of Civil Engineers.—At 8 p.m., students' meeting. "The Protection of Power Transmissions from Lightning," by John T. Morris.

TUESDAY, FEB. 15.

Institution of Civil Engineers.—At 8 p.m., "The Stability of Channels through Sandy Estuaries," by Mr. P. M. Crosthwaite, A.M.I.C.E.

Royal Institution, Albemarle-street.—At 3 p.m., Prof. E. Ray Lankester, M.A., LL.D., F.R.S., on "The Simplest Living Things."

WEDNESDAY, FEB. 16.

Institution of Electrical Engineers.—Students' meeting, at 7.30 p.m., "Telephones and Telephonic Apparatus," by Mr. F. K. Tewson.

North-East Coast Institution.—At 8 p.m., at South Shields, ordinary meeting.

Liverpool Engineering Society.—At 8 p.m., "Engineering Survey Work," by Dr. J. H. T. Tudsbery, M.I.C.E.

THURSDAY, FEB. 17.

Institution of Civil Engineers.—Students' visit, at 2 p.m., to the London and North-Western Railway Goods Warehouse, Broad-street Station.

FRIDAY, FEB. 18.

Institution of Electrical Engineers.—At 6.30 p.m., students' visit to the generating stations of the St. Pancras Vestry.

THE

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TO CORRESPONDENTS.

 Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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BOUND VOLUMES.

Vol. XIX. of new series of "THE ELECTRICAL ENGINEER" *can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.*

COMMON ROADS AND TRAMWAY

Mr. Beaumont, in his presidential addr
Society of Engineers, has given electrical
plenty of food for thought. On the one
indicates the extinction of tramways; on
an enormous extension of motor vehicles.
his contentions are correct, and if "tram
metallic admissions by engineers and the
the badness of ordinary roads," so muc
the necessity for paying more attentio
ordinary roads. What Mr. Beaumont u
to prove is this, ordinary roads are b
structed and maintained; hence the tract
required to move a load over them is fa
than it ought to be, and the cost of ma
is larger than is necessary. He shows
decreasing the tractive effort required lar
may be carried and fewer horses requ
the saving to be effected is enormous.
the point underlying the whole argumen
under existing circumstances the dev
of motor traction is retarded. Owing
badness of the roads, vehicles whic
perhaps, to have a two-horse motor, m
four-horse motors in order to drive t
may not be quite clear from the word
address, but we are under the impression
motors present to Mr. Beaumont the best
driving motor vehicles. This opinion may
or it may be wrong. We incline to the la
but at present it is not necessary to discuss
we have to keep in mind at the moment is
of good or bad roads upon the electrical
If, owing to bad roads, it is necessary
a four-horse motor, with its heavier ac
also the greatly increased weight of batteries
in self-contained vehicles, there is no dif
seeing how important it is for the successf
electricity that the roads should be the bes
obtainable. Let us assume that Mr. Bea
right about tramways, and that greater
paid to roads and vehicles will bring the
capacity of an ordinary road very much th
that of a tramway, then tramways will be
required. Having got so far, we shall have
that electrically-driven vehicles must be
tained, that neither overhead nor conduit
will be required, hence the outlook un
circumstances points to an enormous dev
in self-contained electrically-driven vehi
this particular direction the term "infan
well be applied, and every improvement
assists the forward movement. Of co
question to be solved is, Gas, steam,
tricity—which? There is the other
the question. If self-contained vehicles
place of tramways, what of the pro
tramways? Quite recently there has been
descence of energy in this direction, but th
rested in such matters will have seriously to
the position if public opinion forces local a
to move in the direction of bettering the
The weak point of the whole matter
be that with horse traction the wear
of the "three hundredweight hammers

horses' feet" commences directly the road ished, and keeps the surface in a bad condi-

If horse traction could be abolished one day notor traction commence the next all might be but as things are, the one will give place only ually to the other, and perfection either in roads hicles cannot be obtained till the end is reached. result must be gradual improvement in both tions. As motor vehicles increase, horse trac-will decrease, and better roads may be expected; so the improvement will go on till towards the of next century historians will write of tram- and horse traction in the past tense instead of e present. Verily, there is something yet to one.

ECTRICAL ENGINEERS, ROYAL ENGINEERS (VOLUNTEERS).

above corps is about to take up active work and to recruits. An announcement to that effect is being ched to every member of the Institution of Elec- Engineers by the president, Mr. J. W. Swan

following details will interest our readers: The uarters of the corps will be at 13, Victoria-street, ninster. The uniform will be the same as that worn ter Royal Engineer Volunteers, with such modifica- as the War Office approve. Members will pay for own uniforms; but the corps will reimburse the cost icient members to the extent of one-half of the nment grant they earn by their efficiency, so that two years' efficiency the cost of the uniform will be . The corps will be armed with the Lee-Metford

The training is to be divided into two kinds— ry and technical. The military work consists of ry drills, musketry, etc. The technical work includes application of electricity to war, with the exception egraphy, and such other work as will be useful to an ician or engine-driver in carrying out his duties, such nalling, fitting, loading, priming, and connecting up rine mines, a certain amount of boat work, and ing, splicing, etc. This work will be carried out at headquarters, but mainly at defended ports. In to become efficient each member must attend a con- us training at a defended port for at least eight days year. In addition, 78 hours' technical work must be each year (48 after passing as "expert"). Each ng day—after the first eight—of the continuous ng counts as six hours; each full day counts six ; each half day four hours. The remainder may be up in periods of 1, 1½, 2, 2½, 3, and 3½ hours. The ition allowance is £5. An allowance of 5s. is made whole day, 2s. 6d. for a half day; but a "recruit" attend 40, a "trained man" 20, an "expert" early drills before earning these allowances. During ntinuous training each member earns 5s. a day. The of these allowances will be devoted to the main- ce in camp and to the remuneration of efficient bers. Drills, both military and technical, will begin as members are enrolled. Intending members are sted to study the conditions of efficiency. Every t will be made to make it easy to comply with them. the rules of the corps every enrolled member who is cient in any year shall pay to the funds of the corps before Nov. 10 in that year a sum equal to half the ent capitation allowance which he failed to earn. The commanding officer shall have power to remit , wholly or in part, in special cases. No person admitted as member or honorary member unless pro- one or more members of the corp, and approved by anding officer. Any member wishing to leave the y do so on Nov. 2, providing he shall have given his intention not later than the 30th of the pre- eptember. Failure to comply with this rule shall render him liable for half the amount of the succeeding year's capitation grant.

Intending members should write to the adjutant, Captain Brady, R.E., 13, Victoria-street, S.W., who will supply all information. They should give their full name, address, occupation, and electrical qualifications. If they wish to join as engine-drivers they should state their qualifications for that work. Every application must be accompanied by a reference to a member of the corps or to some other person well known to the commanding officer. Before enrolment, each candidate must be passed as fit by a medical officer. Every member shall be enrolled for three years at least. A member leaving before completing three trainings shall be liable to a penalty. Hence a member who serves for three years, and is efficient in each year, will be put to practically no expense, as he will have incurred no penalties, and the cost of his uniform and camp expenses will have been refunded to him.

The above information was kindly given us by Major Hopkinson, F.R.S., the commanding officer of the Electrical Engineers, R.E. (Volunteers).

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *two shillings and sixpence* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared, and should be written on one side of the paper only. Questions may be sent at any time.

QUESTIONS.

36. Describe, with sketches, what you consider to be the best system of main steam-pipes for central stations. Give reasons.—R. GASKELL.

37. Discuss the advantages and disadvantages of high and low frequency respectively for an alternate-current supply to lamps and motors from a central station.—A. D. J.

ANSWERS.

Question 31.—State the principal causes of the waste of fuel in boilers, and the best means to use in reducing such waste.

Best Answer to No. 31 (*awarded* 10s.).—Assuming the waste of fuel in boilers to be the loss caused by defects in working or managing the boiler, the following will be the causes of the principal losses: (1) bad stoking; (2) cold feed supply; (3) insufficient cleansing of boilers; (4) boilers not properly lagged; (5) insufficient draught; (6) priming; (7) defective joints.

There are many causes of waste outside the boiler—in the engine, steam-pipes, and fittings; but I presume the question is limited to the waste in the boiler alone. The design of a boiler is most largely responsible for its efficiency, but when a boiler has been laid down, if defects appear in the design, little can be done to avoid them, so that it is outside the scope of the present question to discuss these points.

1. Bad stoking. The most effective means to avoid this is probably to obtain a fresh stoker, either human or mechanical. The functions of a good stoker should be (*a*) to avoid clinkering; (*b*) to keep the fire of a perfectly uniform thickness—"holes" in the fire admit a rush of cold air, which is not used in burning the fuel, and cools the gases in the boiler tubes, and also in the chimney, spoiling the draught. The fuel should be put in the furnace evenly, keeping it well in the front, that the smoke produced may be burnt in the furnace when passing over the incandescent coal beyond. Stoking, if mechanical stokers are not used, should be done as rapidly as possible, as the cold air entering the furnace doors will largely cool the boiler. The fires should be cleaned once an hour, if steaming rapidly, otherwise the accumulation of clinker will choke the furnace and be more difficult to remove. A good stoker may be known by the rapidity with which he can properly clean his fires.

2. Cold feed supply is most wasteful; for instance, in warming up water from 60deg. F. to boiling point, nearly one-quarter of the amount of fuel is required of the quantity that will convert this water into steam. The exhaust steam may be used to heat the feed water. In condensing engines the condensed steam will be used over again, and this will be fairly warm, depending upon the vacuum; the better the vacuum is kept, the lower will be the temperature of the condensed steam. By the use of economisers the feed water may be warmed up to nearly the temperature at which it is evaporated in the boiler. Economisers are worked under pressure; by this means the water attains a temperature above that at which it would boil at atmospheric pressures.

3. Insufficient cleansing of boilers is a large source of loss. The water will deposit scale, which is practically a non-conductor of heat, and prevents access of the water to the tubes or fireboxes. The only really satisfactory way of removing scale is by mechanical means, chipping in the case of Lancashire or similar boilers, and in water-tube boilers by means of the scrapers supplied by the makers. Many kinds of water-tube boilers—notably those for marine work—are only suitable for working with condensing engines, in which case no scale is deposited, as the same water is used continuously, allowing for the necessary waste. No provision is made in these boilers for removal of scale. To prevent scale forming, lime may be added to the water, or one of the well-known patent processes used. I say well known, as caution must be used in selection, as many so-called processes remove not only the scale, but the metal from a boiler; boilers are frequently found pitted from this cause.

4. Boilers not properly lagged. All boilers should be covered with a good layer of non-conducting composition, otherwise loss will take place by radiation. The greater loss will be in the steam-pipes, however, if these are not also lagged.

5. Insufficient draught is a frequent source of loss, and one not very readily detected. The result is that a large amount of unburnt gases are passed into the flues. The remedy will depend upon the way the trouble is produced. The chimney or flues may be of insufficient area, or the chimney may require heightning. Flues with sharp corners are also very detrimental to a good draught. If the flues or chimney cannot be reconstructed, a fan will often give good results. Poor draught will sometimes result from the gases being too much cooled before reaching the chimney.

6. Priming probably causes the greatest loss of fuel in the boiler. Boilers with a small steam space, or so constructed that the steam cannot escape from the water quietly, will always prime very much. The chief causes of priming are (*a*) small steam space; (*b*) insufficient surface of water from which the steam may escape; (*c*) bad design, preventing a good circulation of the water and causing violent ebullition; (*d*) steam outlet too near the surface of water; (*e*) forcing the boiler beyond its rated capacity. The only practical remedy is to place an anti-priming tube in the boiler—that is, a tube so arranged that the steam is collected from a large area near the top of the boiler, or to put a steam-dryer in the main steam-pipe near the boiler that the condensed water in the steam may be collected and returned to the boiler.

7. Defective steam or water joints are usually easily seen and remedied; the only troublesome leaks are those which occur under the boiler, and which allow the water to leak direct into the drains. The blow-off cock is perhaps the most frequent source of waste. This may leak, or be left partly open, and the waste-pipe leading directly into the drain. The loss may go on quite unheeded.—A. D. J.

Answer to No. 31 *(awarded* 2s. 6d.*)*.—There are many causes of waste in steam-boilers, some of them, such as the high temperature of the gases which escape into the chimney, being unavoidable; but others may be removed, or greatly lessened. Indeed, if the saving claimed by inventors of patent boiler accessories were real, we could use one man's fuel economiser, another's furnace tubes, yet another man's firebars, and someone else's boiler mountings, and we should then require no coal at all; in fact, we should make coal! However, with all these improvemen *do* waste fuel, and of the causes of waste whicl removed or considerably lessened the followin principal: (1) boiler dirty; (2) low temperatur water; (3) loss by radiation from uncovered boiler pipes; (4) careless firing; (5) too much or too litt furnace.

1. By a dirty boiler is meant a boiler with scal tubes or shell, soot in the flues, or sediment at th of the boiler. Scale is caused by using feed w taining either carbonate of lime, sulphate of magnesia, and at high temperatures these are pr and are deposited partly as mud and partly as sca furnace tubes and hottest parts of the boiler, an heat-conducting power of scale is only about $\frac{1}{50}$t of metal, it will be seen that a layer of scale will cause an enormous waste of fuel. There a chemical compounds sold for preventing scale, are not of much use, and some of them are injuric plates. The best way is to purify the water enters the boiler, but this requires a large pla expensive; large settling tanks are used, and the and sulphate of lime are precipitated by adding proportion of carbonate of soda and a little bu The ordinary way of preventing scale forming is about 1in. of water out of the boiler four or fi every 24 hours, and to have it thoroughly cleane regular intervals. Soot is also a great non-conc heat, so the flues must be kept clean.

2. The higher the temperature of the feed water economical will the boiler be, and if, therefore, water can be heated by waste products of comb great saving will be effected. This can be done a fuel economiser, which consists of a number of tubes placed vertically in the main flue to the chim having the feed water circulating through them, thus raised to a high temperature. The exhau from the engines may also be used to heat the fee This is very efficient for one or two boilers, and i than a fuel economiser, which is rarely used for boiler. An exhaust injector will feed the boiler w at a high temperature, and acts very well with qu engines, but a pump must also be provided for u the engine is not running.

3. The tops of boilers and all steam-pipes shoul covered with a non-conducting material, as the los by radiation from naked pipes is very considerabl careful experiments it has been found that 1,500 units will be radiated per hour from a surface of o foot of naked steam-pipe than from the same surfac with hair felt, and therefore a large saving in fu effected this way. Steam-pipes are covered fron 3in. thick and boiler shells up to 6in. thick, acc the non-conducting properties of the material u felt being about the best, but asbestos, slag wool, meal and hair are largely used. Joints in steam- left uncovered on account of having to make th sometimes, which causes a loss of heat.

4. Careless stoking has a good deal to do with fuel, and in many places where the load is con firemen should be given a bonus for saving coal, case with the large railway companies. The furnac be fed a little at a time and alternately, and the larg should be used again and not thrown away. T pressure should be kept constant and as high as and the water kept at the best steaming level, whi with different boilers, but is generally about thre glass. These points are important, and should looked after.

5. To ensure the proper combustion of the coal amount of air is necessary—about 300 cubic feet p of coal consumed, and with this quantity of air v smoke will be produced, and therefore more hea got out of the coal, as the production of smoke m of fuel. Mechanical stokers will do a great deal t smoke, and are more economical with small coal an number of boilers than hand firing.

These are the principal causes of loss of fue

ed modern boilers, but, of course, with old boilers, lly-designed ones, other causes, such as insufficient area, short flues, bad circulation, low steam pressure, vill cause considerable loss of fuel.—R. S.

ITUTION OF ELECTRICAL ENGINEERS, Feb. 9.

eeting of the Institution was held on Wednesday last at stitution of Civil Engineers, when the following candidates alloted for:

bers.—A. K. Baylor, 23, Cadogan-gardens, S.W.; A. P. 47, Victoria-street, S.W.; H. L. Leach, 28, Leigham Court-Vest, Streatham, Surrey.

ciates.—A. Armitage, 94, Mansfield-road, Nottingham; H. fin, 10, Nevern-mansions, Earl's Court, S.W.; J. Corneille, ctoria-street, S.W.; A. H. F. Fitz-Herbert, 42, Otter-street, ; A. C. Hanson, 68, Oseney-crescent, N.W.; E. Rothwell, field Cottage, Marland, Rochdale; N. A. Thompson, ds, Redhill, Surrey.

ents.—T. P. E. Butt, Faraday House Charing Cross-road, F. W. Purse, 5, Salisbury-road, Redland, Bristol; M. on, 22, Linden-gardens, Bayswater, W.; C. H. Taylor, ry Villa, Chertsey-road, Woking; H. H. Williams, 36, n-road, Chorlton-on-Medlock, Manchester; W. T. Wright, khall-rise, Clapham, S.W.

discussion on Major Webber's paper on the "Electro-al Treatment of Ore containing the Precious Metals" was ontinued. **Mr. Sulman** had sent a number of questions to **talan**, who had answered them; both questions and answers ad out. They were as follows:

ion 1. The capital cost of each tank and the total tankage ry, and the installation cost of this on a scale to treat s per 24 hours *without crushing plant*?—*Answer.* One treat-ank with connections and appliances costs £60—*i.e.*, a 9ft. er tank of five tons capacity per 24 hours. Twenty such re required to treat 100 tons of ore per day. The cost of allation having a capacity of 100 tons per 24 hours does not £5,000, everything complete and ready to work, but crushing plant.

ion 2. The sludge having been stated to contain 60 per f water only, and being, therefore, very thick, how is it to agitate thoroughly such a mass at an expenditure of h.p.? Would not this imply that the whole mass resting layer of mercury would be *revolved on the mercury*, as on a le, and hence efficient agitation reduced to a minimum? agitation of an ore charged with cyanide in a stationary der like conditions of liquor contents has been hitherto has been generally found to consume energy to an extent hing 1 h.p.?—*Answer.* A sludge with 60 per cent. of water ll be very thin. All depends upon the density and nature re. It is true that sometimes with slimy and light ores as s 100 per cent. of water must be used. At all events, a od agitation is obtained with only ½ h.p. per tank, corre-ng to ⅒ h.p. per ton of ore. The trials alluded to, in which h as 1 h.p. per ton of ore was required to ensure agitation, ave been made with revolving bands, with which friction is eat.

ion 3. Total cost required for treating a double charge of s of ore in one tank for 24 hours, including the following (1) cost of electrical energy; (2) cost of the agitation ; (3) cost of salt; (4) consumption and cost of cyanide; ils as to the use and necessity of the consumption and cost rganic acids which are mentioned as essential parts of the ; (6) what is the weight of charge of mercury for each tank e loss of mercury on each operation; (7) what is the cost of and supervision per tank; (8) total cost per ton, exclusive shing?—*Answer.* The cost of treatment per ton for the e ores on the basis of 100 tons treated per 24 hours will vary ing to the consumption of chemicals and the circumstances m cost of chemicals, including salt, cyanide, lime, etc., ry, 2s. 6d. to 4s.; cost of power, 1s. to 1s. 6d.; cost of , 6d. to 1s.—total, 4s. to 6s. 6d. In the case of slimes the ay be still reduced. Six hundred pounds of mercury are d in each tank. The loss is purely mechanical, and amounts more than 2oz. of quicksilver per ton of ore at the outside.

stion 4. What is the fineness of the bullion from the mercury ed from ore of a varying character?—*Answer.* The bullion ed from average ores contains at least 800 fine unless they idised and yield copper oxides or copper salts, when the r is dissolved to a certain extent and afterwards deposited mercury, together with the gold and silver.

stion 5. Is any cyanide recovered from the spent liquors, ow are these dealt with?—*Answer.* The exhausted sludge wn away without the liquors being separated, and no pt has been made to recover any cyanide, as it would not rth while.

tion 6. What would be the cost of dealing with 100 tons of concentrates or heavily pyritic ore containing copper and , such as is being treated by bromo-cyanide process at in Canada, including cost of clean up?—*Answer.* No accurate can be given, nor even approximate ones for an ore the ition and nature of which are only given in a very general d which has not been tested.

Question 7. Information as to the nature of the ores scheduled on p. 9 with reference to the mineralised contents, the nature of the gold contained therein; as to coarseness or fineness, and how far such could be amalgamated (before solution treatment) by ordinary methods.—*Answer.* The ores scheduled in General Webber's paper (p. 9) are respectively: Rose: Oxidised iron ore, with very fine gold (very slimy). Delamar: Decomposed felspar and quartz, with some pyrites and some argentite. Oaxaca: Rusty quartz, with some pyrites. Bassick Tailings: Quartz, with pyrites and tellurides. Baby: Soft conglomerate, with iron pyrites (very slimy). Phœnix: Talcose quartz (slimy). Leroi: Diorite with an abundance of iron and copper pyrites. Alma: Talcose quartz, with good quantity of iron pyrites. Miller: Oxidised iron ore, with some manganese. All these ores give very poor and, in some cases, no result by the ordinary method of amalgamation.

Question 8. In the treatment of an arsenical copper ore, how much arsenic and copper go into the mercury, and how is this purified for reuse?—*Answer.* No arsenic at all goes into the mercury, and almost no copper when found as copper pyrites; only copper oxides and soluble salts are really objectionable; the mercury in a vat can be used over and over again, the amalgam being drawn from it every fortnight or every month as the case may be.

Question 9. We are told on p. 11 that iron and copper go into solution to a considerable extent under the action of chlorine and the hypochlorates, and that these metallic salts are precipitated by lime before the cyanide is added. What becomes of the ferrous and cupric hydrates that form in the sludge, and how is this cyanide-destroying effect overcome, and at what expense?—*Answer.* The former answer deals partly with this question. Nothing more than adding lime is done to prevent destruction of cyanide, and the result proves to be both good and cheap.

Question 10. As to the footnote on p. 11 with reference to the production of slimes, I would point out that the *actual extraction* by fine crushing does not become less effective, *but more effective*; it is the difficulty of *percolation* that is the bar. As to the readiness of makers of milling machinery to supply plant for crushing ores to 80 or 100 mesh there can be no question of this; they would only be too glad to get the orders for such greatly increased crushing plant as would be necessary. It is those who would have to pay for the milling who would look blank at the prospect.—*Answer. All percolation processes* are limited in their efficiency, as far as extraction of the gold is concerned, by the fact that it is impossible to percolate the solutions properly through slimes. The Pelatan-Clerici process does not resort to percolation, and therefore its extracting power is much greater. For medium-grade and rich ores very fine crushing will lead to an extra expense, which will be amply repaid by the gain made in the recovery. After having tested the ores of more than 200 mines in the U.S.A., we find that if crushing from 80 to 100 mesh only, 10 per cent. of the ores treated will yield less than 80 per cent. of the gold contained therein.

Question 11. At the top of p. 12 it is stated that the dissolved *cyanogen* will readily unite with the lightest particles of gold. This is quite incorrect. A solution of cyanogen as potassium cyanide is *quite* without effect on gold; it is only nascent cyanogen which acts in this way.—*Answer.* The cyanogen alluded to here is "*formed at the anode*" (by the electric current); it is therefore in the nascent state, and, according to Mr. Sulman himself, it can unite with the light particles of gold.

Question 12. Finally, an essential point has been missed in relation to slimal treatment. The author of the paper has not shown in any way that slimes can be more readily dealt with by this than by any other process. The tabulated results on p. 9 show an average extraction of 82 per cent.; the balance of 18 per cent. would easily correspond to the gold contained in from 30 to 40 per cent. of slimes produced from such ores, and the invariable experience is that *electric amalgamation* or *electro-deposition* of gold from cyanide slime *will not work at all*, whilst the mass remains *turbid with suspended slimes*. If the contrary were the case, there would have been (for the past 10 years) no *slime question at all*. Hundreds of experiments have been made with the view of *electro depositing* the gold from a cyanide solution in which the *depleting* slimes still remain suspended, but a clear solution is imperatively demanded to effect this. The same difficulty applies in as great a degree to electro-amalgamation. I could instance at least a dozen cases within my own knowledge in which this has occurred, and would again, as what evidence the inventors have that they have overcome this difficulty?—*Answer.* The fact that the Pelatan-Clerici process can deal with ores crushed to 100 mesh, 150 mesh, and more, is sufficient evidence that it can deal with slimes. This is equal to saying that if the tailings of the Rand could be cyanided together with the slimes, the gold in the slimes would not be dissolved at all, or we fail to understand it. We have extracted 82 per cent. of the gold from the ores scheduled (crushed at 40 mesh). If the crushing had been made at 60 or 80 mesh we would have extracted more, and consequently left less tailings. The entire remark about electro-amalgamation or electro-deposition is exceedingly valuable to us, especially expressed by an inventor. The novelty of our process could not have been established and emphasised by a more competent authority.

A communication was also read from **Mr. D. A. Lucey**. He took, he said, great interest in the Pelatan-Clerici process. The general data given in the paper with regard to the process was far from indicating economy. Except that the milling was prodigious, there was nothing very uncommon about it. There was nothing

to indicate that the results might not have been just as good, if not better, if done by any other process.

Mr. Cooper said he would like to ask if the action of the chlorine here described was necessary to the process? It could not be said to be nascent when separated from the anode by the circulation.

Major-General Webber, in replying, said he was gratified at the way his paper had been received. They had been told that it took 36 horse-power hours per ton of ore treated. This was not the case, and the statement was not in his paper. He had been reproached for not having given the cost of the process, but he thought that was not the side of the question they had under consideration. It was purely the electrical side they had to look at. With regard to Mr. Jenkin's statement that the treatment would cost 6s. per ton for milling, that would only be when very large quantities were dealt with. Though as much as 500 to 1,000 tons a day were treated at the Rand, there were no other places where this was so. They had three treatments in the ordinary process, but in this they had only one. In the other process the plant required was larger and covered more ground, and also the time taken was greater. As regarded the question of labour, this varied all over the world, and did not lend itself to comparison, as, in the Rand, Kaffir labour cost but 2s. per day, as against in some places 12s. for white labour. Messrs. Sulman and Teed, who were very anxious about the cost of the process, had omitted to give any figures about their own method. At the Hannans-King mines in West Australia, where 4oz. of gold were extracted per ton, the estimated extraction was from 80 to 90 per cent. The dust had to have a separate treatment, and altogether, with the present price of labour in West Australia, amounted to 18s. per ton for the whole. With regard to Dr. Teed's remarks, he did not say that with refractory ores roasting might not be employed. He did not intend his paper to be a commendation of the Pelatan-Clerici process, but rather a scientific review of a new step in the reduction of refractory gold ores by the aid of electricity. Neither of the inventors had seen his paper before they had been presented with the paper at the meeting. Turbidity was an essential feature, and a great number of circulating processes had been tried. The Siemens-Halske process was the best example of the circulation of a clear liquid. Amalgamation, not deposition, was their ultimate object.

A vote of thanks having been passed, a paper on "An Electrolytic Process for the Manufacture of Parabolic Reflectors," by Sherard Cowper Coles, was then read and discussed.

TRANSFER OF THE SHEFFIELD ELECTRICITY WORKS.

At a meeting of the Sheffield City Council on Wednesday last it was agreed to purchase the undertaking of the Sheffield Electric Light and Power Company. The full terms of the agreement are given below, and by it the Council agrees to pay £220 of 2½ per cent. stock for every £100 spent by the company. The total expenditure of the company is £124,472, of which £118,500 is to come under this arrangement, and £5,972 is to be repaid at 5 per cent. interest. The company take the profits of the last year, and are to receive 10 per cent. on the original capital until completion of purchase. It will be remembered that the repurchase clause in the company's provisional order was rendered abortive from the fact that under it irredeemable stock had to be paid for the undertaking. An Act preventing such stock being issued by municipal bodies was passed the same date that the order was granted. The present terms are more onerous on the Corporation than those in the order, but in any case the ratepayers would have had to pay dearly for the laxity of their representatives in the past. The supply of the light should have been kept in the hands of the Corporation from the first.

The following is the full text of the agreement:

1. The company shall sell and the Corporation shall purchase the whole of the undertaking and other works of the company and all its property and assets, real and personal, including the wiring and fitting department and goodwill of businesses (but except as hereinafter is mentioned), with their rights, powers, and privileges as the same stood on Dec. 31, 1897 (which said undertaking, works, property, assets, rights, powers, privileges, and goodwill are hereinafter referred to as "the undertaking"), subject to all enactments, contracts, obligations, rights, and liabilities affecting the undertaking at that date, and excepting out of the purchase, first, all cash in hand or at bankers on Dec. 31, 1897; secondly, all moneys then or which have since become, or are accruing, owing or payable for or in respect of calls on shares in the capital of the company, and all interest payable or hereafter to become payable in respect thereof; and thirdly, all the minute books of the company, provided that the share registers, transfer books, books of account, letter books, and documents of the company shall remain in possession of the company until its dissolution, after which the same shall be handed over to the Corporation; but after the completion of the purchase the Corporation or its officials shall have access to the said books and documents whenever required by the Corporation.

2. The company shall be entitled to retain for its own use and to distribute by way of dividend or bonus amongst its members the sum of £10,562. 5s. 1d., being the net profits of the company for the year ending Dec. 31, 1897.

3. The sum properly expended by the company upon the undertaking down to and inclusive of Dec. 31, 1897, and chargeable to capital account, is hereby agreed at the sum of £124,472 (which sum is hereinafter referred to as "the capital expendi

4. The purchase-money and consideration to be paid Corporation for the undertaking shall be as hereinafter sta

5. For each £100 of the sum of £118,500 (part of the expenditure) the Corporation shall on the day fixed for com of the purchase, issue or transfer to the company, or as direct, £220 of new 2½ per cent. redeemable Sheffield Corp stock (being stock of the description mentioned in Sectio the Sheffield Corporation Water Act, 1896), such stock no redeemable before the year 1925, and to carry interest fr day fixed for completion of the purchase, payable half-year to be issued free from stamp duty. Provided that it shall be for the company to require that the Corporation instead and of issuing or transferring to the company for each £100 £22 said stock, shall in respect of all or any part of the said £118,500 to be specified by the company, pay to the comp each £100 the sum of £213. 8s. in cash each, such £213. 8s. t interest from the day fixed for completion of the purchase rate of 5 per cent. per annum until actual payment thereof.

6. The sum of £5,972. 7s. 5d., being the balance of the expenditure, shall be paid by the Corporation to the comp cash on the day fixed for completion of the purchase, togeth interest thereon at the rate of 5 per cent. per annum, from t or dates of the expenditure thereof respectively, to Jan. 1,

7. The Corporation shall also pay to the company in c the day fixed for the completion of the purchase, the am the book debts due or owing to the company on Dec. 31, 18 the company shall guarantee the amount of such debts, a debts shall be duly apportioned as on that day.

8. The Corporation shall also pay to the company in cash day fixed for completion of the purchase a sum equal to the gate amount of a dividend of 5 per cent. per annum, as fr date of the company's provisional order, on the total of the expenditure mentioned in Clause 3 hereof, from the date o of such expenditure to Jan. 1, 1898, less the aggregate am first, the dividends declared by the company prior to Dec. 3 and, secondly, the sum of £10,562. 5s. 1d., being the am the net profits of the company for the year ending Dec. 31,

9. The Corporation shall also pay to the company in c the day fixed for completion of the purchase the sum of 12s. 10d., being the agreed value of the stock-in-trade and of the company as on Dec. 31, 1897.

9A. The company shall be entitled to require that the payable by the Corporation to the company under Clauses and 9, or any part thereof, to be specified by the company instead of being paid in cash, be satisfied by the Corp issuing or transferring to the company, or as it may such an amount of new 2½ per cent. redeemable Sheffie poration stock of the description mentioned in Clause carrying interest from the day fixed for completion purchase, payable half-yearly, and to be issued free from duty as at the market price thereof on the day fixed for tion of the purchase (such market price in case of differen fixed by the chairman for the time being of the Sheffiel Exchange), shall be equal in amount to the moneys wh company shall require to be satisfied by the issue of t stock.

10. The Corporation shall pay to the company in cash day fixed for completion of the purchase such a sum of m shall be equal to a dividend at the rate of 10 per cent. per free from income tax, from Dec. 31, 1897, to the date fixed completion of the purchase on the share capital of the co from time to time called up and introduced into the busin the company or any of such businesses.

11. The amounts payable by the Corporation under Clau and 10 shall be agreed by the accountants of the company Corporation, and failing agreement shall be ascertained by tion under the Arbitration Act, 1889.

12. The Corporation shall pay to the company interest rate of 5 per cent. per annum on the moneys payable by poration to the company under Clauses 5, 6, 7, 8, 9, and 10 as from the day fixed for completion of the purchase u actual payment of such moneys respectively. If the p shall not have been completed on March 1, 1899, the c shall be entitled out of the receipts and assets of the unde to retain an amount equal to a dividend at the rate of 10 p per annum, free from income tax, for the year ending 1898 on the share capital of the company called up an duced into the businesses of the company or any of such bus and to distribute the same by way of dividends amon members, but credit shall be given to the Corporation amount so retained as against the dividend payable under C hereof.

13. The company shall be entitled out of the receipts an of the undertaking to discharge the debts other than its de debt (not exceeding, however, in the whole the sum of owing by the company on Dec. 31, 1897, but the am applied shall on completion of the purchase be deduc retained by the Corporation from the moneys payable Corporation under Clauses 6, 7, 8, and 9.

14. The company has a debenture debt of £25,000, redeemable on March 31, 1899, and interest on which rate of 4½ per cent. per annum, and such interest as from 1897, shall be borne and paid by the Corporation, and

n shall, if required by the company, as from the day fixed
pletion of the purchase take to and indemnify the company
the said debenture debt, or any part thereof specified by
mpanv, and the interest thereon respectively in respect
period subsequent to the day fixed for completion of the
se, and if the Corporation shall be required to take over the
benture debt, or any part thereof, the Corporation shall be
l to deduct from the amount of stock to be issued by them
Clause 5 hereof such an amount of stock as on the day fixed
pletion of the purchase shall be equal in amount at the
arket price thereof (which market price, in case of differ-
hall be fixed as provided by Clause 9A hereof) to the deben-
pital taken over, and shall also be entitled to an allowance
shall be made from the moneys payable by the Corporation
Clauses 6, 7, 8, and 9 hereof) of interest at the rate of
ent. per annum on the debenture capital taken over from
fixed for completion of the purchase to April 1, 1899

'he purchase shall take effect as on and from Jan. 1, 1898,
from Dec. 31, 1897, until completion of the purchase, the
y shall be deemed to have carried on the undertaking and
nesses on the account, for the benefit, and at the risk of
poration, and to have been authorised by them to make all
penditure and incur all such liabilities on capital account,
borrow, or otherwise provide at interest, all such moneys
ect thereof as the company have deemed or shall deem
ry for the reasonable conduct of their businesses and the
on of the undertaking, in order to enable them to carry out
atutory obligations or otherwise, in the proper conduct of
inesses of the company. All proper and usual apportion-
hall be made as on Dec. 31, 1897. Any share capital paid
he shareholders subsequent to Dec. 31, 1897, and introduced
undertaking or businesses of the company shall be repaid
Corporation to the company in cash on the day fixed for
tion of the purchase.

ubject as hereinafter in this clause provided and subject as
lebenture debt of the company to the provision hereinbefore
ed, the company will pay the debts owing by it on Dec. 31,
nd the Corporation will take to the benefit and obligation
ontracts and engagements in connection with the under-
existing on that day or since entered into. The moneys
under such contracts and engagements existing on Dec. 31,
s do not relate to capital expenditure, will be appor-
between the company and the Corporation as on that day,
Corporation will pay all moneys on Dec. 31, 1897, remain-
e paid under contracts or engagements relating to capital
ture, other than such moneys as were actually due for
t on or before Dec. 31, 1897, and are entered in the books
nt of the company as on that date.

'ntil the completion of the purchase, the company shall
heir present control and management of the undertaking,
ll carry on and manage the same, and the businesses of
pany in the ordinary and regular course of business on
for the benefit and at the risk of the Corporation, and
so continue to keep proper accounts, and may expend on
account such sums and incur such liabilities as may be
ry for the reasonable extension of the undertaking. in order
le them to carry out their statutory obligations or otherwise
proper control of the businesses of the company, and may,
the Corporation shall provide the amonnt, from time to time
, or otherwise provide at interest. such sums as may be
ry for the purposes aforesaid, but shall not make any other
iture on capital account, except at the request of the
ation, or a committee thereof.

On completion of the purchase the Corporation shall offer an
ment dating from the day hereby fixed for completion of
rchase to Mr. William Johnson, the manager and secretary
company, and on the same terms as to position, emoluments,
herwise (except as to notice and duration of office), under
he was employed by the company on Dec. 31, 1897. The
ment of the said William Johnson shall continue until
ined on some June 30 or Dec. 31, subsequent to the expira-
f five years from the day fixed for completion of the purchase
e Corporation, giving to the said William Johnson, or the
William Johnson giving to the Corporation six calendar
hs' previous notice in writing of intention to determine the
, and the said William Johnson shall, when in the service of
rporation, be entitled to take pupils and also continue to
s a consulting electrical engineer, and to receive remunera-
therefore, but he shall so act to such extent only as in
pinion of the chairman of the committee of the Corpora-
having control of the undertaking shall not interfere with the
r discharge of his duties to the Corporation. On the com-
n of the purchase the Corporation will take over every other
r or servant then in the employment of the company (unless
officer signifies in writing to the Corporation within one
th after the completion of the purchase that he does not desire
nter their service) on the same terms as to position and emolu-
those under which they shall respectively be employed
mpany on the day of completion of the purchase.

bject to the provisions of Clause 22, the costs and expenses
mpany in respect to the transfer of the undertaking,
the costs, charges, and expenses incurred by the com-
nnection with, and by reason and in consequence of an
tice served by the Corporation on the company, requir-
mpany to sell its undertaking on the terms of the com-
visional order and including the company's costs and
this agreement, and of all negotiations in connection
and all costs and expenses of the company in winding up its affairs shall be paid by the company, except that the Corporation shall pay the company's taxed costs of the action recently commenced by the Corporation against the company, and shall, on completion of the purchase, pay to the company the sum of £650 on account of the other costs, charges, and expense in this clause hereinbefore mentioned, and the Corporation hereby accept the title of the company to the freehold and leasehold hereditaments included in the sale and purchase, and shall not be entitled to any abstract or evidence of title beyond copies of the assurances of such hereditaments to the company.

20. The Corporation shall, at their own expense, procure this agreement, and a duplicate hereof to be duly stamped, with the proper *ad valorem* and other stamp duty, and the duplicate to be denoted.

21. The Corporation shall pay the remuneration of the directors of the company, including the special remuneration of the managing director from Dec. 31, 1897, until the expiration of 90 days next after the completion of the purchase, or the earlier dissolution of the company.

22. The costs, charges, and expenses of the company as between solicitor and client in respect of and incidental to preparing or obtaining or passing, or assenting to or assisting or supporting any application for any provisional order or Act requisite for the purpose of confirming or sanctioning this sale and purchase, and enabling the same to be carried into effect shall be paid by the Corporation, and the company, if required by the Corporation, will assent to assist or support an application for such provisional order or Act as aforesaid.

23. The Corporation will, with due diligence, apply for and endeavour to obtain in the present session of Parliament an Act confirming and sanctioning this sale and purchase, and enabling the same to be carried into effect, and will procure the insertion in such Act of provisions to the effect of the provisions set forth in the schedule hereto.

24. The purchase shall be completed on such March 31, June 30, Sept. 30, or Dec. 31, as shall happen next after the expiration of 60 days next after the Royal assent shall be given to the Act mentioned in the last preceding clause, and unless such Act be passed on or before Oct. 31, 1898, the company may by notice in writing to the Corporation rescind this agreement, whereupon the original rights and liabilities of the Corporation and the company shall revive. Provided always that if the Corporation shall (by reason of either House of Parliament refusing to suspend standing orders) be unable to obtain during the present session of Parliament such an Act as is mentioned in Clause 23 hereof the Corporation will with all due diligence apply for and endeavour to obtain such an Act in the next succeeding session of Parliament, and in the event last aforesaid Sept. 30, 1899, shall be substituted for Oct. 31, 1898, in this present Clause No. 24, and for the purposes of such clause.

25. This agreement is conditional on the same being sanctioned by the company in such manner as may be requisite, and if not so sanctioned within 56 days from the date hereof shall determine and be of no effect; provided that the company shall call and hold a meeting for the purpose of obtaining the sanction of the shareholders to this agreement within 14 days from the receipt of a notice in writing from the Corporation that such agreement has been approved by the City Council.

The following is the city accountant's report on the matter:

In presenting to you the following figures, I deal only with the considerations for capital expenditure, and purchase price of stores and stock in hand, because, although the Corporation have to pay cash for amount of book debts owing to the company on Dec. 31, 1897, such debts are guaranteed, and the Corporation would ultimately be recouped. With reference to payment of a sum equal to the aggregate amount of a dividend of 5 per cent. per annum, from the date of the company's provisional order on the total of capital expenditure mentioned, from the date or dates of such expenditure to Jan. 1, 1898, less the aggregate amount of (firstly) the dividends declared by the company prior to Dec. 31, 1897, and (secondly) the sum of £10,562. 5s. 1d., being the amount of the net profits of the company for the year ended Dec. 31, 1897, I am of opinion that no considerable sum will have to be paid to the company in respect thereof. The confirmation of the provisional order of the company is dated June 27, 1892.

The dividends declared by the company appear to be as follows—viz:

For the nine months ended Dec. 31, 1892 .... 5 per cent.
(Whereof six months elapsed from the date of the confirmation of the provisional order.)
For year ended Dec. 31, 1893 .... Nil.
For year ended Dec. 31, 1894 .... Nil.
For year ended Dec. 31, 1895 .... 5 per cent.
For year ended Dec. 31, 1896 .... 7½ per cent.

For year ended Dec. 31, 1897, the net profits amounted to £10 562. 5s. 1d., which is more than equal to a dividend of 10 per cent., but, say, 10 per cent. The aggregate dividends for five years and six months at 5 per cent. per annum would equal 27½ per cent. The aggregate dividends paid, or to be paid, will probably amount to 27½ per cent. The amount of stock to be delivered in respect of £118.500 at £220 per cent., or stock to be issued in order to raise £213. 8s. per cent., in cash therefore, is based on, and is equal to, a value of £97 per £100. Hence I take £260,700 as the consideration for £118,500 in either case. In like manner, £11 699 to be paid in cash represents £12,060 in stock raised at £97 per cent.

£118,500 represented by 2½ per cent. stock after the rate of £220 per cent. amounts to		£260,700
£5,972 7 5 balance of capital expenditure.		
5,726 12 10 purchase-money of stores and stock-in-trade.		
£11,699 0 3 paid in cash, or in 2½ per cent. stock at a discount of £3 per cent. represents a stock amounting to		12 060
Total of stock		£272,760

Annual charge in respect thereof:

Interest thereon at £2. 10s. per cent.	£6,819 0 0
Annual contribution to loans fund to redeem the stock in 25 years on a 3 per cent. basis of interest on accumulations	7,481 4 6
Total	£14,300 4 6

Every increase of £1 per cent. above the discount of £3 per cent. in issuing the above amount of stock would entail an increased annual charge of about £150. The net profits which the company made during the year ended Dec. 31, 1896, amounted to £7,635. 4s. 8d., according to their published statement, from which £1,125, interest on debentures, had to be deducted. The company states that the net profits for the year ended Dec. 31, 1897, and divisible amongst its members, is £10,562. 5s. 1d. I have ascertained that the interest on the debenture debt had been deducted before the said net profits were arrived at. As the before-mentioned stock of £272 760 provides for the repayment of the debenture debt, it follows that the sum of £1,125 annual interest on debenture debt should be added to the net profits of £10,562 5s. 1d., so as to ascertain the probable annual income of the Corporation. Should, therefore, the Corporation in their first or any one year make only such a profit as the company made for the year ended Dec. 31, 1897, the financial result would be as follows:

Annual interest and sinking fund contribution	£14,300 4 6
Less annual net profits, £10,562. 5s. 1d., plus £1,125	11,687 5 1
Annual loss	£2,612 19 5

Subject to variation according to the price the stock may have to be issued at.

COMPANIES' MEETINGS AND REPORTS.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY, LIMITED.

The ordinary general meeting of this Company was held on Tuesday last at their offices in Carnaby-street, W.

Mr. E. J. A. Balfour presided, and, in referring to the growth of the Company's business, said that with the increasing popularity of electricity their present rate of interest would not only be maintained, but greatly exceeded. From Jan 1 they had had in force a new rate of 6d. per unit for the first £100 of the annual lighting bill and 4d. per unit for the rest, while electricity used for motive purposes would be charged at 3d. per unit. The average price of 5d. per unit for the current year was a reasonable sum, and was below the statutory price and less than the charges of most other companies. The net earnings during the past year had been £29,093. Of this £6,996 was distributed last August in payment of an interim dividend of 7 per cent. per annum for the half-year ending June 30 on ordinary shares, and 7 per cent. per annum on preference shares. The balance, with £328 from last year's account, left £22,425 to be dealt with. This the directors proposed to deal with as follows: by paying a dividend of 7 per cent. per annum on preference shares for the last half of the year, £3,500; by paying a dividend on ordinary shares for the second half-year of 11s. per share, making altogether 14½ per cent. for the year, £10,989; paying a dividend of £75. 10s. per share on founders' shares, £7,551; and amount to be carried forward, £384. The extensions at the Carnaby-street station would soon be completed. They had secured a freehold site for extra works, and were now considering the question of further extensions.

The report was adopted and the dividend approved.

An extraordinary general meeting was afterwards held to confirm a resolution proposed on Jan. 18 to approve of an agreement with the founders' shareholders, and to increase the capital of the Company to £300,000 by creating 20,000 new ordinary shares of £5 each, of which 12,000 £5 shares were to be issued at par to the holders of the founders' shares, and thereby giving the Company £60,000 additional capital at once, and at the same time extinguish the founders' shares.

Mr. Foster asked what of the other 8,000 shares still remaining.

The **Chairman** said that these new shares should be offered to the shareholders in proportion.

ANGLO-AMERICAN TELEGRAPH COMPANY.

The ordinary meeting of the Anglo-American Telegraph Company was held last week at Winchester House.

Mr. F. A. Bevan presided, and, in moving the adoption of the report, said for the first time since 1884 they were able to declare a dividend of 3 per cent. upon the ordinary stock. That improve-
ment did not arise from any spasmodic increase of traffic,
the result of steadily-growing traffic, which had been in
during the last five years. The receipts for January, 18
a record for any January they had ever had. They migh
fore hope that the current year would be a good one. T
net increase was £9,258, but the increase in expenses w
£371; the increase in the expenditure on repairs
amounted to £469, and but for that there would ha
an actual decrease in their expenses. They broug
£6,704 more than in the corresponding period of 18
there was available for dividend £15,509. The distrib
the corresponding half-year was at the rate of 29s. per sh
they now propose to pay one at the rate of 33s. 6d. pe
leaving only £371 to be carried over. Regarding the
fund, which, in his opinion, was not sufficiently strong, con
that two of their cables were 24 and 23 years old respecti
said they had during the past year really only added
because the repairs to the 1880 cable during the perio
review had cost £11,000. Their cables were in good workin
except a very short cable on the other side, and their tr
never been carried better than it was now.

Sir G. Fitzgerald seconded the motion, which was agree

LIVERPOOL OVERHEAD RAILWAY COMPANY

The half-yearly meeting of the shareholders of this rail
held at Liverpool this week, Sir W. B. Forwood, ch
presiding. The directors recommended the payment of a
for the half-year at the rate of 3½ per cent. per annum
ordinary shares, being an increase of ¼ per cent. upon the
paid for the corresponding period of the previous ye
directors' report was duly carried.

WESTMINSTER ELECTRIC SUPPLY CORPORAT LIMITED.

Directors: The Right Hon. Lord Suffield, K.C.B.;
Boulnois, Esq., M.P.; W. Hayes Fisher, Esq., M.P.; Sir
Galton, K.C.B., F.R.S.; J. Browne Martin, Esq.; James
Powell, Esq.; R. W. Wallace, Esq., Q.C. Engineer-
Prof. Alex. B. W. Kennedy, LL.D., F.R.S., M.I.C.E.
manager: Captain Edmund I. Bax. Secretary: Frank Ia

Report of the directors (with abstract of accounts) to
sented to the shareholders at the ordinary general meetin
Company to be held at the offices of the Corporation, E
place, S.W., on Wednesday, Feb. 16, at 11 a.m.:

The board of directors, in presenting their report
accounts for the year 1897, are pleased to state that the
of the Corporation continues to make satisfactory progre
supply of current, which on Dec. 31, 1896, was provided
equivalent of 249.318 lamps of 8 c.p., had increased by
1897, to the equivalent of 290,561, and at the present tim
are on circuit the equivalent of 292,883 lamps of 8 c.p., an
cations have been received for a further 10,886. The le
roadway in which mains have been laid now exceeds
making about 180 miles of ways, into which upwards of
of copper (strip and cable) have been drawn. The exte
the central stations, rendered necessary in consequenc
increase in the business of the Corporation, as reporte
last general meeting, has been proceeding during the y
the Board are glad to be able to report that the addition
ings and plant are now nearly completed. The plant and m
have been working satisfactorily throughout the year, a
been fully maintained from revenue, and the directors
that, although the economical working of the stations
greatly affected by building operations, it is satisfactory
that there is no increase in the cost per unit generated. A
in their last report, the Board had approached the holder
founders' shares, and had agreed with them a scheme for c
the founders' shares, but on further consideration it w
that difficulties might arise thereafter, and an amended sch
proposed, in accordance with resolutions passed at special
of the shareholders called for that purpose. Your direct
pleasure in stating that, owing to the way in which they
by the holders of the founders' shares, those shares hav
to exist, and all the shareholders are now on the same
The net revenue of the year amounts to £49,461. 3s. 1
interim dividend, at the rate of 8 per cent. per annum
half-year ended June 30, 1897, has been distributed. The
to the credit of the account is £34,013. 17s. 5d. The Board
recommend the payment of a dividend at the rate of 16
per annum, less income tax, for the past half-year, makin
cent. for the year ending Dec. 31 last, carrying forward a
of £3,119. 4s. 1d. The directors having considered the qu
provision of future capital gave notice to pay off the
mortgage debentures bearing interest at the rate of 5 per
4½ per cent. per annum on March 1 next, and have cre
first mortgage debentures of £250,000, bearing interest at
of 3½ per cent. per annum. Of this amount £200,000
issued, and after providing for repayment of the old de
the balance will be expended in further plant and machi
the extension of existing stations. The Board much re
owing to the issue having been subscribed four times, t
unable to make any allotment to a large number of ap
In accordance with the articles of association, two of the
(the Right Hon. Lord Suffield, K.C.B., and Edmund
Esq., M.P.) retire, but, being eligible, offer themse
re-election.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1897.

Dr.				£	s.	d.
To Generation of Electricity.						
al, carriage, unloading, etc.	£11,450	6	3			
, waste, water, and engine-room stores.........	1,737	0	1			
portion of salaries of engineers and officers	2,016	3	4			
ges, etc., at generating stations	5,097	16	9			
pairs and maintenance: buildngs, £450. 10s. 5d.; plant, 3,150. 16s. 10d.; instruments, 16. 10s. 5d.	3,617	17	8			
				23,919	4	1
To Distribution of Electricity.						
pairs and maintenance of mains: materials, etc., £30. 5s. 4d.; proortion of salaries of officers, 122. 10s.; wages, etc., £426. s. 7d.	579	3	11			
pairs and maintenance of meters—materials, etc., £462. 15s. 7d.; rages, etc., £720. 5s. 1d.	1,183	0	8			
				1,762	4	7
To Rents, Rates, and Taxes.						
nts........	1,019	3	1			
es and taxes	3,983	2	5			
				5,002	5	6
To Management Expenses.						
ectors' fees........	1,500	0	0			
aries of manager, engineer-inhief, secretary, clerks, etc.	5,981	9	2			
tionery and printing	359	2	6			
eral charges and office expenses	579	8	0			
ges of meter readers, inspectors, c........	745	7	9			
reciation on office furniture......	44	0	0			
				9,209	7	5
and parliamentary charges				260	2	6
To Depreciation, etc.						
king fund	1,500	0	0			
reciation account	13,790	0	0			
s on coal stored	81	13	11			
				15,371	3	11
To Special Charges.						
urance........	445	3	7			
rd of Trade audit	80	0	0			
t of supplying steam	1,558	17	6			
enses of cancelling founders' hares	171	12	10			
				2,255	13	11
Total expenditure........				57,780	11	11
ance to net revenue account........				49,585	9	1
				£107,366	1	0

r.	£	s.	d.
s of current by meter........	100,857	0	6
s of current by contract	35	11	8
	100,892	12	2
Less bad and doubtful debts	331	10	2
	100,561	2	0
ntal of meters, etc., on consumers' premises......	4,343	12	3
nsfer fees	69	10	0
pply of steam	2,391	16	9
	£107,366	1	0

GENERAL BALANCE-SHEET, DEC. 31, 1897.

Dr.	£	s.	d.
pital account	499,500	0	0
ount received on founders' shares cancelled ...	500	0	0
nporary loan from bankers	12,000	0	0
ndry creditors	7,821	15	4
benture interest accrued, £2,323. 10s.; less ncome tax, £77. 9s........	2,246	1	0
claimed dividends	2	18	0
preciation account	43,192	0	0
king fund	7,653	13	9
serve fund	9,032	16	2
t revenue account, £49,461. 3s. 10d.; less nterim dividend to June 30, 1897, at the rate f 8 per cent. per annum, £15,980; and less ncome tax, £532. 13s. 7d., £15,447. 6s. 5d.	34,013	17	5
	£615,963	1	8

r.	£	s.	d.
ital account	560,388	9	5
s in hand: coal, £413. 18s. 7d.; stores, 37. 7s. 7d.; general, £355. 1s.	1,006	7	2
ry debtors for current supplied to Dec. 31, 97	36,304	7	1
r debtors........	1,605	6	0
at bankers (Messrs. Barclay and Co., Limited)	5,781	5	6
in hand	20	6	11
sits with vestries, etc........	208	7	0
stments at cost	10,648	12	7
	£615,963	1	8

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC., YEAR ENDING DEC. 31, 1897.

Board of Trade units generated		5,046,500
Quantity utilised—		
Sold to consumers	4,355,781	4,416,877
Used on works for lighting, meter-testing, etc.	61,096	
Quantity expended in distribution—		
In batteries	24,772	556,712
In feeders	531,940	
Total quantity accounted for		4,973,589
Quantity unaccounted for		72,911
Number of lamps on circuit, Dec. 31, 1897		290,561

WATERLOO AND CITY RAILWAY COMPANY.

The eighth half-yearly general meeting was held at Waterloo Station yesterday, Mr. Wyndham S. Portal in the chair.

The **Chairman** said they might be interested to know that the number of shareholders was 723, as against 669 in August and 600 at this time last year. The total capital was £473 776 of which £113,170 was expended during the past half-year. The shares being now fully paid up, it was recommended to convert the shares into general capital stock, in accordance with the Act of 1845. The engineers reported that the works were nearly completed. The electric machinery was nearly ready for use. One train was completed, and the others were very far advanced. They expected to have part of the line open in March They had made two temporary exits, at Mansion House and Queen Victoria-street, pending the completion of the Central London Railway stations.

The report was adopted, and the retiring directors were re-elected.

NATIONAL TELEPHONE COMPANY, LIMITED.

The report of the directors of the National Telephone Company, Limited, for the half-year ended Dec. 31 last, to be presented to the general meeting to be held in London on 17th inst., states that the income accrued in respect of the half-year amounts to £507,603, as compared with £439,978 for the corresponding period of 1896, being an increase of £67,625. The working expenses for the half-year were £283,086, as compared with £245,279 for the corresponding period of 1896, being an increase of £37,807. The net result for the half-year (after deducting the Post Office royalties, amounting to £46,060) is a profit balance of £178,457, as compared with £154,982 for the corresponding period of 1896, or an increase of £23,475. The rentals carried forward for unexpired terms of running contracts amount to £473,587, as compared with £414,714 at the corresponding period of 1896, or an increase of £58,872. Out of the available balance of £156,435 shown by the net revenue account, the Board recommend the payment of a dividend of 6 per cent. per annum, less income tax, on the first and second preference shares, 5 per cent. per annum, less income tax, on the third preference shares, and 6 per cent. per annum, free of income tax, on the ordinary shares. The sum of £40,000 is to be transferred to the reserve fund, leaving a balance of £10,034 to be carried forward. The expenditure spent on capital account during the half-year was £267,375, partly in the erection of 5,663 additional exchange and private lines, and partly in the construction of underground lines in substitution for overhead wires in several important places. The entire system of underground mains in Manchester has been completed. In Belfast, Birmingham, Blackburn, Bradford, Bristol, Dublin, Dundee, Leeds, Liverpool, Nottingham, Portsmouth, Sheffield, and other leading cities and towns, the underground works are being proceeded with as rapidly as possible. The vacancy in the Board caused by the appointment of Mr. Alderman Joseph Thompson to Manchester, has been filled by the election of the Right Hon. Sir Henry Hartley Fowler, G.C.S.I., M.P.

ISLE OF MAN TRAMWAYS COMPANY.

A meeting of the Isle of Man Tramways and Electric Power Company, Limited, was held at Douglas on the 7th inst. The Board were authorised to construct an electric tramway from Laxey to Ramsey (10 miles) without going to English contractors. The **Chairman** said that comparing the price at which the Company would construct the line with certain lines in England, theirs would be a very cheap one. Local labour would be employed, an industrial technical school was to be founded, and the practical work of equipment would be done by their own people. The line is to be opened on July 1.

CAMBRIDGE ELECTRIC SUPPLY COMPANY, LIMITED.

Directors: D. Munsey, Esq., chairman, Meadowcroft, Cambridge; the Hon. C. A. Parsons, M.I.C.E., M.I.E.E., managing director, Wylam-on-Tyne; Sir B. C. Browne, D.C.L., Westacres, Benwell, Newcastle-on-Tyne; Wm. C. Hall, Esq., J.P., Elm-hurst, Cambridge; P. W. Latham, Esq., M.D., Trumpington-street, Cambridge; John B. Simpson, Esq., M.I.C.E., Bradley Hall, Wylam-on-Tyne. Manager and engineer: John H. Barker, A.M.I.C.E., M.I.E.E.

Report of the directors (with abstract of accounts) to be presented to the ordinary general meeting of the Company, to be held at the Company's Offices, Cambridge, on Friday, Feb. 18, 1898, at 12 noon.

Your directors have pleasure in reporting that the prospects of the Company continue to be satisfactory. During the year 1897 there has been added to the Company's mains the equivalent of 2,562 8-c.p. lamps, making the total 21,195 The number of units supplied has been 221,507, an increase of 23,992, or 12 per cent. The total cost of coal has been diminished by 5¼ per cent.; 42 new consumers have been added, making the total 329. The capital expenditure for the past year has been £5 872. 11s. 4d.; 2,027 yards of main conduit pipe and cable have been laid down, making the total at present 15,298 yards. To insure the continuity of supply in the event of an accident to any one line a duplicate system of distribution has been nearly completed; a large amount of the cable laid has been for this purpose. During the year the mains have been extended from the end of Regent-street as far as Norwich-street and Harvey-road, a sub-station having been built to supply this district. Preparations have been made to convey the mains to Madingley-road in order to supply the new Presbyterian college, now building, and the district. The Company after paying all charges, placing £400 to the reduction of preliminary expenses and £300 to depreciation account, has a balance of £2,460. 19s. 10d., which, added to £278. 19s. 7d. brought forward from last year, makes £2 739. 19s. 5d. An interim dividend of £953. 9s. 10d. and interest on debenture and temporary overdraft £48. 1s. 8d. have already been paid, leaving a net balance of £1,738. 7s 11d., out of which the directors recommend the payment of a dividend of 3½ per cent., making, with 2½ per cent. already paid, 6 per cent. for the year. This will absorb £1,445. 11s. 1d., leaving a balance to carry forward of £292 16s. 10d. Mr. Munsey and Mr. Hall retire by rotation Both are eligible and offer themselves for re-election. The auditor, Mr. Arthur Rutter, also offers himself for re-election.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1897.

Dr.	£	s.	d.
To Generation of Electricity.			
Coal, including dues, carriage, unloading, storing, etc.	1,099	3	0
Oil, waste, water, and engine-room stores	133	18	7
Proportion of salaries of engineers and officers, as certified by the engineer	100	0	0
Wages at generating stations	670	3	6
Repairs and maintenance	417	4	11
To Distribution of Electricity.			
Proportion of salaries of officers, as certified by the engineer	10	0	0
Wages to linesmen, fitters, labourers	23	0	7
To Rents, Rates, and Taxes.			
Rents, rates, and taxes ...	339	2	0
To Management Expenses.			
Directors' remuneration for year 1896	147	0	0
Salaries of managing engineers, secretary, accountants, clerk, messengers, as certified by manager	243	0	8
Stationery, printing, etc.	150	0	10
Auditor of Company	10	10	0
Auditor appointed under the provisions of the order	15	0	10
Cost of issue of new capital	67	12	0
To Law Charges	14	12	4
To Depreciation.			
Depreciation in respect of leasehold works, buildings, plant, machinery, etc.	300	0	0
Reduction of preliminary expenses	400	0	0
To Special Charges.			
Insurances, etc.	21	12	6
Total expenditure	4,162	1	11
Balance carried to net revenue	2,460	19	10
	£6,623	1	9

Cr.	£	s.	d.
Sale of current	5,833	10	9
Public lighting	22	18	6
Rental of meters	293	3	6
Transfer fees	2	1	11
Cash discounts, etc.	431	7	1
Premiums on shares	40	0	0
	£6,623	1	9

GENERAL BALANCE-SHEET.

Liabilities.	£	s.	d.
Capital account—amount received	44,211	0	0
Sundry creditors	553	11	4
Net revenue account, £2,691. 17s. 9d.; less interim dividend, paid Aug. 10, 1897, £953. 9s. 10d.	1,738	7	11
Depreciation fund account	700	0	0
Bankers	576	0	11
	£47,779	0	2

Assets.	£	s.	d.
Capital account—amount expended for works	43,922	8	10
Stores on hand at Dec. 31, 1897: coal, £85. 18s.; oils, waste, etc., £16. 5s. 10d.; general (lamps, etc.), £149. 8s. 6d.	251	12	4
Preliminary expenses, £1,752. 14s. 8d.; less amount written off, £1,002. 14s. 8d.	750	0	0
Sundry debtors for current supplied to Dec. 31, 1897	2,851	9	3
Cash in hand	3	9	9
	£47,779	0	2

TRAMWAYS UNION COMPANY, LIMITED.

The report of the directors of the Tramways Union Co Limited, for 1897, to be submitted to the general meetin held in London on 15th inst., states that the revenue accoun a net profit of £12,366, making, with £235 brought forwa last account, a total of £12,601. From this amount the dividend per share of 2s 6d. on 45,000 fully paid up sha 1s. 6d. on 5,000 shares, £3 paid, amounting to £6,000, was dis on Aug. 2 last, leaving a balance of £6,601 to be dealt wit directors recommend the payment of a further dividend of per share making, with the interim dividend, 5s., or 5 p for the year, free of income tax, which will absorb the £5,625; the payment of 2s. 6d. each on 5,000 shares, £ making, with the interim dividend (1s. 6d. per share, £3 4s. per share, or 5 per cent. for the year, free of inco amounting to £625, making together £6,250, and to carry £351. The traffic receipts show an increase for the past £7,794, as compared with those of 1896, and the working e an increase of £6,570. The increase in expenditure is attributed to increased mileage and increased cost of f Bremen and Bucharest. The work of relaying the perman at the first city has now been completed, the lines havi doubled in many places. The Company's relations with the authorities are stated as satisfactory. The formal sanctio Madrid Municipality has been obtained for electrical tract the work of transformation is now in active progress. The d expect that the line will be in full working order earl coming summer. By resolution of the shareholders, the d have raised £150,000 by the issue of 5 per cent. registere debentures.

BRISTOL TRAMWAYS AND CARRIAGE COMPA

The report of the directors of the Bristol Tramw Carriage Company, Limited, for the half-year ended Dec. to be presented to the general meeting to be held at B Thursday next, states that the gross receipts for the h amount to £69,483, and the working and general expen renewals are £52,623, leaving a net balance of £16,860 it is proposed to appropriate as follows: interest on cent. mortgage debenture stock, etc., £2,260; dividend rate of 6 per cent. per annum, free of income tax, for t year, £8,750; balance carried to reserve and renewal namely, leased premises redemption, £250; horse re £1,000; contingencies, £2,000; electrical renewals £1,69 manent-way renewals, £908—together, £5,850. The recei the tramways department show an increase of £9,494 carriage department returns an increase of £771. T number of passengers (excluding postal riders) carried the six months on the Company's cars and omnibu 11,060 817. The extension of the electric line fro ville to Staple-hill was opened for public traffic as Fishponds on Sept. 28, and throughout to Staple Nov. 4 last. A suitable site at the termination of th having been acquired, a commodious car depôt is in of erection. The Light Railway Commissioners have de grant the Company's application for the St. George and light railway order. The shareholders have already unan approved the two Bills deposited in Parliament this ses the resolution will be submitted for confirmation at a ordinary meeting following immediately after the ordinary meeting.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO LIMITED.

Directors: Alderman T. G. Gibson, J.P. (chairman); D Spence Watson; Dr. J. T. Merz; Colonel F. F. Shep Tennant, Esq.; J. H. Armstrong, Esq.

Report of the directors (with abstract of accounts) p to the tenth general meeting of the shareholders, held at the Station Hotel, Newcastle, on Thursday, Feb. 10, at 12 no

The directors have pleasure in presenting the balance-s profit and loss account for the year ending Dec. 31, 1897 stating that the demand for electricity continues to impro factorily, the units sold having been 660,906 against 535, year. The total profit for the year, including the balance forward from last year, represents a sum of £5,059. 10s. of this the directors recommend a dividend at the rate cent. per annum for the year, on account of which an dividend at the rate of 5 per cent. per annum was paid on last. The total dividend will absorb £3,144. 15s. 6d., l balance of £1,914. 14s. 9d., which the directors have dealt follows: (a) in writing off the preliminary expenses in co with the recent increase of capital sanctioned last year, £ (b) in increasing the reserve and depreciation account to £ a further sum of £1,200; (c) in carrying forward to next balance of £651. 19s. 9d—total, £1,914 14s. 9d. In order the developments rendered necessary by the constantly in demand for electrical energy, it is intended to issue at o of the new capital sanctioned at the last general meetin directors recommend that the shares be offered to existin holders *pro rata* at a premium of £1. 10s. per share; the of this premium to be added to the fund for deprecia reserve. The directors feel themselves greatly indebted Durham College of Science for assistance in scientific que various occasions in their past history, and they desire to authority from the shareholders to make an annual sub of not exceeding £50 to that institution. The retiring

T. Merz and Colonel F. F. Sheppee, who are eligible, themselves for re-election. The auditor, Mr. Thos. also retires, and is eligible for re-election.

BALANCE-SHEET, DEC. 31, 1897.

Capital and Liabilities.	£	s.	d.	£	s.	d.
:apital—20,000 shares of £5 each				100,000	0	0
i allotted—9,529 shares, fully paid				46,295	0	0
:ent. mortgage debentures				25,000	0	0
—on sundry accounts				14,302	9	5
:count—As at Dec. 31, 1896	£4,004	3	7			
m 1897 profits	1,200	0	0			
	5 204	3	7			
insfers to capital expendi- uspense account	3,004	3	7			
				2,200	0	0
loss account—balance as ectors' report of Feb. 2,	241	9	8			
ectors' fees voted at annual ng, Feb. 11, 1897	131	5	0			
	110	4	8			
year to date	4,949	5	7			
	5,059	10	3			
insfer to reserve account,); preliminary and forma- xpenses account, £62. 15s.; n dividend at 5 per cent. num for half-year to June 97, £1,122. 11s. 6d.	2,385	6	6			
				2,674	3	9
				£90,471	13	2

Property and Assets.	£	s.	d.	£	s.	d.
and plant—As at Dec. 31,	£54,417	8	7			
to date	3,875	19	2			
				58,293	7	9
ansformers, etc.—As at 1896	10,053	2	4			
to date	1,728	6	8			
				11,781	9	0
nased—as at Dec. 31, 1896				10,998	1	5
visional order—as at Dec. 31, 1896				659	14	11
				81,732	13	1
y and formation ex- as at Dec. 31, 1894	1,123	12	10			
y and experimental i at Dec. 31, 1894	1,880	10	9			
	3,004	3	7			
sfers from reserve account, tra	3,004	3	7			
				0	0	0
t and tools				520	18	6
iture				117	2	5
raluation				2,819	6	6
i current supply and for work done, etc.				5,194	12	1
nd				87	0	7
				£90,471	13	2

T AND LOSS ACCOUNT YEAR ENDING DEC. 31, 1897.

	£	s.	d.
harges—salaries, wages, coal, water, and nance	3,516	13	3
arges - salaries and maintenance	708	5	6
es, taxes, and insurance	309	11	11
charges — directors' remuneration, 10s.; office salaries, legal and accountancy s, stationery, stamps, telegrams, etc., l. 18s. 7d.	1,269	8	7
carried down	6,876	0	9
	12,680	0	0
expenditure on line improvements, etc., g year	476	7	0
—on debentures, £1,064. 5s. 4d.; on pur- price of land, £345. 1s.; on loans, £32. l.; on bank overdraft, £8. 15s. 1d.	1,450	8	2
carried down	4,949	5	7
	£6,876	0	9

	£	s.	d.
supply—Household	11,099	12	8
lamps	587	11	3
	11,687	3	11
ms rental	987	11	5
sale of lamps	2	4	8
r fees	3	0	0
	£12,680	0	0
rought down, being gross profit for year	£6,876	0	9

EASTERN TELEGRAPH COMPANY.

The **Marquis of Tweeddale** presided at an extraordinary meeting of the Eastern Telegraph Company at Winchester House on Monday to confirm a resolution authorising the introduction into Parliament of a Bill for the conversion of the existing preference shares of the Company. In moving the necessary resolution, he said that assents had already come in very freely, and they were coming in daily.

Mr. J. Denison Pender seconded the motion, which was carried without discussion.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bristol.—The Electrical Committee require tenders for 214 arc lamp-posts, for particulars of which refer to our advertisement columns. Tenders by Feb. 21.

Brussels (Belgium.)—For 38 closed electric tramcars. Specifications are to be obtained from, and tenders addressed to, the Société Nationale des Chemins de Fer Vicinaux, Rue de la Science 26, Brussels, by Feb. 16.

St. Chamond (France).—Tenders are invited for lighting the town by electricity or otherwise. Particulars are to be obtained from, and tenders addressed to, Municipal Authorities at above place (Department Loire) by March 31.

Braila (Roumania).—Tenders are invited for the electric lighting of the town. The deposit required is £600. Specifications are to be obtained from, and tenders addressed to, the Municipal Authorities at Braila by Feb. 20 (March 4), at 4 p.m.

Pembroke (Ireland)—The Lighting Committee of the Pembroke Township (co. Dublin) are prepared to receive tenders for the supply and erection of various plant, etc., for particulars of which refer to our advertisement columns. Tenders by March 5.

Belmonte (Spain)—Tenders are invited for electric lighting of the town for 15 years. The estimated price of the concession is 500 pesetas per annum, and the deposit required is 25 pesetas. Tenders to Municipal Authorities, Belmonte (Orviedo) by Feb. 15.

Madras.—The Secretary of State for India in Council announces that the time allowed for the receipt of tenders by the Chief Engineer for Irrigation, Madras, for the utilisation of water power of the Periyar Lake has been extended from Oct. 31, 1897, to July 1, 1898.

Melbourne (Victoria).—The Telegraph Department of the Victorian Government Railways are inviting tenders for the supply of alternating-current transformers and one main switchboard. Tenders to the Telegraph Superintendent's Office, Spencer-street, Melbourne, by March 21.

Kolding (Denmark).—For complete establishment of electric lighting works, etc. Specifications are to be obtained from Byraadets Udvalg for Electricitätsvaerket, Sugförer Edv. Lau. for 50 kroner (£3. 3s) to be returned on receipt of bona fide tender, and tenders addressed the same at Kolding.

Burgo di Osma (Spain)—Tenders are invited for the electric lighting of the town for four years. The estimated cost is 2,500 pesetas per annum, and the deposit required is 500 pesetas. Specifications are to be obtained from, and tenders addressed to Municipal Authorities, Burgo di Osma (Province of Sovia), by Feb. 20.

Novorossisk (Russia).—Tenders are invited for the construction, etc., of an electric tramway. The deposit required is 5,000 roubles. Specifications, etc. (in French), are to be obtained from, and tenders addressed to, the Municipal Authorities, Novorossisk (Russia), by March 1 (13). The time has been extended from November 15.

Hampstead.—Tenders are invited for one or three years, at the option of the Vestry, for (1) oils for machinery at electric lighting station; (2) carbons, lamps, and other stores for electric lighting station. Forms of tender may be had, and further particulars obtained, on application to the Surveyor at the Vestry Hall. Tenders to be delivered to Mr. Arthur P. Johnson, vestry clerk, by 4 p.m. on Feb. 16.

Salford.—The Electric Light Committee are prepared to receive tenders for electric cables. Specifications, and any further information required, may be obtained from the Electrical Engineer, Walness-road, Broughton. Tenders, sealed and endorsed, addressed to the Chairman of the Electric Light Committee, to be delivered to Mr. Saml. Brown, town clerk, at the Town Hall, Salford, not later than 10 a.m. on Feb. 18.

Portsmouth.—The Corporation invite tenders for the supply and erection of additional Lancashire boilers, feed pumps, mechanical stokers, coal conveyor and elevator, economiser, steam, feed, condensing water, and other pipes, chequer plating and sundry ironwork, for particulars of which refer to our advertisement columns. Trade union rates of wages and hours to be observed. Tenders by Feb. 22.

Copenhagen.—Tenders are invited for the supply of dynamos, accumulators, etc., for the central station at Frederiksberg. Specifications are to be obtained from, and tenders addressed to, Frederiksberg Sporveis-og Electricitets-Aktieselskab, Gammel Kongerei No. 140, in Kopenhagen V. Tenders to be endorsed "Tilbud paa del electriske Anlaeg til Frederiksberg Central-station," and sent in by March 12.

Glasgow.—The Corporation are prepared to receive tenders for the construction of several sections of tramways. Specification, with form of tender, can be obtained on application to Mr. John Young, general manager, 88, Renfield-street, Glasgow, where plans can be seen and any information obtained. Sealed tenders, marked "Tender for Laying Tramways," to be lodged with Mr. J. D. Marwick, town clerk, City Chambers, Glasgow, by 10 a.m. on Feb. 18.

Madrid.—The Secretary of State for Foreign Affairs has received a despatch from her Majesty's Chargé d'Affaires at Madrid, enclosing copy of a Royal decree announcing that a public auction for the contract for repairing the national submarine telegraph cables during the next five years will be held at Madrid on Feb. 22. Further particulars as to the cables in question may be inspected at the Commercial Department of the Foreign Office any time between 11 and 5.

Rochdale.—The Corporation invite tenders for the following: (Contract No. 1) steam dynamos, balancer and boosters, etc. Specifications, conditions of contract, and form of tender may be obtained at the offices of the engineers, Messrs. Lacey, Clirehugh, and Sillar, 10, Delahay-street, Westminster, on payment of £5. 5s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed and endorsed "Electricity Works," must be delivered at the office of Mr. Jas. Leach, town clerk, Town Hall, Rochdale, by Feb. 19.

London, S.W.—The Secretary of State for War is prepared to receive offers, in writing, accompanied by competitive designs and specifications, for the supply of portable electric search-light apparatus. General particulars as to requirements can be obtained on application, either by letter or personally, to A. Major, director of army contracts, War Office, Pall-mall, S.W. The offers and designs must be delivered at the War Office, Pall-mall, London, S.W., by April 27, addressed to the Director of Army Contracts, and marked on the outside "Designs for Search-Light Apparatus."

Canterbury.—The Town Council are prepared to receive tenders for the electric wiring and fittings for the Beaney Institute, Canterbury, according to plans, specifications, and conditions of contract, which may be seen at the office of the City Surveyor, 28, St. Margaret's-street, from whom also specifications, with form of tender, may be obtained on deposit of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders to be lodged with Mr. Henry Fielding, town clerk, sealed and endorsed "Tender for Wiring the Beaney Institute," by Feb. 23, at 10 a.m.

Guipuzcoa (Spain).—The Secretary of State for Foreign Affairs has received a despatch from her Majesty's Consul at Bilbao, reporting that the Provisional Board appointed in connection with the electric tramway which it is proposed to lay from Zumarraga to Zumaya, in the province of Guipuzcoa, invite plans and tender, to be received by February 28, for the construction and equipment of the line. Further particulars of the conditions of the tenders for the above-named tramline and branch, which together measure 30 miles, may be inspected at the Commercial Department of the Foreign Office between 11 and 6.

London, N.W.—The Vestry of St. Pancras invite tenders for the supply of dry-back marine boilers, 11ft. diameter, 13ft. 6in. long, with superheaters and brickwork seatings. Copies of specification, conditions of contract, and form of tender to be obtained on application at the Electricity Department Offices, 57, Pratt-street, Camden Town, N.W., on payment of a deposit of £1, which will be returnable on receipt of the specification, accompanied by a bona fide tender. Tenders to be sent to Mr. C. H. F. Barrett, vestry clerk, Vestry Hall, Pancras-road, London, N.W., endorsed "Tender for Boilers, etc.," by 12 noon on Feb. 22.

Carlisle.—The Corporation are prepared to receive tenders for the erection of a central electric lighting station, consisting of engine-house, boiler-house, office, stores, chimney, etc., in James-street. Persons desirous of tendering for the above works may inspect the drawings, stipulations, and conditions of contract, and obtain a copy of the specification, bill of quantities and form of tender, at the office of Mr. Henry C. Marks, A.M.I.C.E., city engineer and surveyor, 36, Fisher-street, Carlisle, on deposit of £1. 1s. for each trade, or £3. 3s. for the full set, returnable on receipt of a bona fide tender, and the return of the specification and bill of quantities. Sealed tenders, endorsed "Tender for Electric Lighting Station," to be delivered at the City Engineer's Office by 10 a.m. on Feb. 25.

Redditch.—The Urban District Council are prepared to receive tenders for the following: (Contract 1) central-station buildings, foundations for plant, etc.; (2) gas-producing plant for 230 h.p.; (3) three double-cylinder gas-engines, total 350 h.p.; (4) three alternators, total 235 kw.; (5) concentric lead-covered armoured cables; (6) alternating-current transformers, for 200 kw.; (7) switchboard and instruments; (8) countershaft, pulleys, ropes, and belts. Sealed tenders, marked "Electric Lighting," must be sent in to Messrs. Browning and Hobson, clerks to the Council, Redditch, by Feb 14. Any of the specifications can be obtained from Mr. J. A. McMullen, M.I.E.E., Hornchurch, Essex, consulting engineer to the Council, on payment of a deposit of £2. 2s., which will be returned on receipt of a bona fide tender.

St. Helens.—The Corporation invite tenders for the following work in connection with the supply of electricity for electric traction: engines, condensers, dynamos, switchboards, battery, overhead conductors, poles, and other appurtenances. Copies of the specification may be obtained from Mr. W. J. Jeeves, town clerk, on payment of £25 (to be returned on receipt by the Corporation of a bona fide tender). Specifications and drawings can be seen at the temporary offices of Dr. J. Hopkinson, F.R.S., 34, Victoria-street, London, and at 29, Princess-street, Manchester, and at the Town Hall, St. Helens. The Corpor
also be prepared to consider any tenders providing
alterations or other arrangement or system that a contr
desire to specify. Tenders, on the prescribed form,
delivered at the office of the Town Clerk not later tha
1898.

Egremont (Cheshire).—The Wallasey Urban Distric
invite tenders for the following works—viz., (a) engine,
and exciter; (b) two Lancashire steam-boilers and one
steam-boiler; (c) condensing apparatus. Copies of the
tions may be obtained on application to the engineer,
Crowther, Gas and Water Works, Great Float, near Bi
A charge of £2. 2s. will be made for copy of each specifi
be returned on receipt of a bona fide tender. Sealed t
the form provided for the purpose, addressed to the Ch
the Gas, Water, and Electricity Committee, and endorse
for Engine and Alternator," or any other contract, a
may be, to be delivered at the office of Mr. H. W. C
Public Offices, Church-street, Egremont, Cheshire, by
March 17. Contractors will be required to enter into a
approved sureties for the performance of contract.

Northwich.—The Weaver Navigation Trustees invi
for the construction and erection of the necessary elect
plant for lighting and working the new swingbridges
wich. The current will be supplied by the Northwic
Supply Company, and while the machinery will have
structed on the general lines laid down in the specific
shown on the drawings, the details will be left largely
cretion of the contractor, who will be expected to suppl
information and drawings to enable a decision to be ar
to the suitability of his proposals. The specification and
may be seen, and all further information obtained, from
Saner, Engineer's Office, Weaver Navigation, Northwic
after Feb 14. Tenders and plans will have to be sent
"Tender for Electric Plant," and addressed to the Cler
Navigation Offices, Northwich, on or before March 5.

Sophia (Bulgaria), March 5-17.—Her Majesty's Se
State for Foreign Affairs has received a despatch
Majesty's Agent and Consul-General at Sophia to the
the Municipality of Sophia have issued a notice inviti
(a) for electric lighting of the town, town hall, and fi
barracks; (b) for an electric tramway for the town and
ings. Only bona fide electrical firms are allowed
Tenders must be in by March 5-17, at 11 a.m.
certificate of the National Bank of Bulgaria of £
accompany each tender; also documents showing the
tracting firm has already successfully carried out sim
If up to the 10th-22nd of March, at 10.30 a.m., a pr
reduction of at least 5 per cent. per kilowatt-hour of
tender is received, a new adjudication will take place
day at 11 a.m. Specifications are to be obtained from
of the above town (8s. prepaid), where tenders are to be
Further particulars may be obtained, and a copy of th
tion and other papers may be inspected, on applicati
Commercial Department of the Foreign Office, between
of 11 and 5.

Watford.—The Urban District Council invite tend
supply and erection of the following plant: (Section A)
plant, water-tube boilers and fittings, economiser, fe
injectors, etc., steam alternators and exciters, condense
fittings, etc., steam exhaust, blow-off, and sundry pi
water tank, etc.; (B) switchboard and all connections
head travelling crane; (D) conduits and mains for gene
(E) public lighting and adaptation of existing pub
(F) transformers, sub-stations, and switching gear; (G)
and posts. Tenders may be sent in for any section or
for the whole of the sections, but not for part of a sec
ground plan of works, plan of streets, etc., and sp
with forms of tender, may be obtained at the offices of M
Hawtayne, consulting engineer, Mansion House-cha
Bucklersbury, E.C., on and after Feb. 14, on payment
which sum will be returned on receipt of a bona f
Tenders, sealed and marked "Tender for Electric
must be addressed to Mr. H. Morten Turner, clerk to t
at the Council Offices, Watford, and be delivered on
12 noon on March 16.

RESULTS OF TENDERS.

Newport (Mon.).—The Corporation have accepted th
C. D. Phillips, Emlyn Works, at £305, for a tempor
lighting plant at Wentwood waterworks. Thirty-se
were received.

Burnley.—The tender of Messrs. G. E. Belliss
Birmingham, for the supply of two combined engi
with dynamos for the electric lighting station, at a su
has been accepted.

Tarragona.—The tender of D. José Guad (the on
for the construction, etc., of a telephone system in
Spain—at the time noted by us—has been accepted su
decision of the Spanish Postmaster-General.

Burnley.—The following tenders have been accept
in connection with the extension of the electric li
J. Foster and Co., ironfounder, £350. 5s.; W. Stanw
£100; Owen and Co., plumber and glazier, £205; T.
plasterer and painter, £99.

St. Pancras.—The Vestry have accepted the te
Fowler-Waring Cable Company, Limited, in the sum
5s. 10d., in connection with the work for the exten

ight to Queen's-crescent, Malden-road, and Prince of ad.

rd.—The tender of the Westinghouse Electric Company, to equip the new tramways to Bolton and Great Horton working, for the sum of £14,664, has been accepted. The tenders are also recommended for acceptance: Messrs. Bros., and Co., Limited, for the supply of two dynamos at electricity works in Valley-road for £2,800, and extra for £600, and Messrs. Willans and Robinson to supply wo 600-h.p. steam-engines at the same works for £4,590.

a.—The following tenders have been received for electric ing of Messrs. Welch, Margetson, and Co.'s new ware- oor-lane, E.C.:

af	£1,183	2	0
d Co.	1,004	1	0
l, Tamplin, and Makovski	904	16	3
and Co.	770	15	0
ti and Crookes (accepted)	702	12	0

a, S.W.—The following tenders have been received for ight wiring of the Abbey-mansions, North Block, Victoria- W.:

and General Engineering Company	£1,656	0	0
tins, and Co.	1,242	14	0
af	1,147	10	0
d Gorham	1,095	0	0
l, Tamplin, and Makovski	1,046	2	6
harton, and Down	991	9	6
Dymond, and Co.	968	0	0
and Co.	909	15	0
mingway (accepted)	838	12	0

on.—The Town Council have received the following or the completion of the electric light wiring, etc., of the ll, Brighton:

ood, Army and Navy-mansions, Victoria-street, , S.W. (accepted)	£705	0	0
mes, Mills, and Co., 79, Trevelyan-buildings, ster	860	0	0
Miles, 60, Western-road, Brighton	899	14	0
d and Son, 26, North-street, Brighton	985	10	0
harton, and Down, Limited, 82A, New Bond- London, W.	1,010	15	0
r and Co., Limited, Sloane-square, London, W.	1,233	5	6

-Only above tenders were entertained, being the only complied with the conditions of the specification, which he submitting of samples of materials and fittings pro- be used.

BUSINESS NOTES.

.—The Corporation is applying for powers to institute a phone service.

g.—The District Council have decided to introduce the ght into their district.

l.—The Council are proposing to purchase a site for an l electric lighting station.

ld Tramways.—The Council have agreed to the purchase at Kelham Island for a generating station.

borough.—A London company has approached the Town with respect to the electric lighting of the town.

ncras.—The Vestry have decided to lay mains in St. -road, Regents Park, and Lime-street, Camden-road.

politan Electric Supply Company.—A meeting of this y was held on Tuesday last. The proceedings were

n-on-Trent.—Mr. Frank Bailey has received a deputation urton-on-Trent with respect to the electric lighting .

nham.—The Urban District Council have agreed to ke the supply of electricity to the district at an estimated £36,000.

rford.—The City Fathers are urged by the local Press to lood money from the company wishing to lay down the traction scheme.

n.—The Local Government Board have sanctioned a loan 00, to be applied in repairing and completing the electric system of the city.

er.—The gas company report that the demand for gas has d slightly owing to the introduction of the electric light, t the number of consumers had increased.

ames, Piccadilly.—The Vestry has decided to co-operate e Corporation in an application to the Treasury for an into the cost and efficiency of the telephone service in .

ystwith.—It is proposed, in view of having a fresh agree- ith the electric lighting company, to obtain their terms extension of the arc lighting, and also for three years' scent lighting.

broke.—The Commissioners have resolved to adopt the lighting system for the township, and to apply to the Government Board for a loan of £33,000 to defray the s of its introduction.

n.—At the meeting of the Vestry it was said that the scent gas light having proved a failure, they had applied for powers for electric lighting, which he hoped they would succeed in getting at no distant date.

Bromley.—The electric lighting scheme was further discussed at the meeting of the Urban District Council last week, but the debate was again adjourned.

Hampstead.—The Vestry has decided to apply for a loan of £40,000 from the London County Council in order to pay for some very extensive plant for electric lighting it has just added to the central station in Finchley-road.

Peterborough.—Mr. W. O. E. Meade-King, M.I.C.E., Local Government Board inspector, held an enquiry on the 8th inst. into the application of the Town Council for sanction to borrow £15,000 for electric lighting purposes.

Penzance.—The Municipal Electric Supply Company are writing the Penzance Council to induce it to place the electric lighting of the borough in their hands. A free trip to Brighton is suggested at the company's expense.

Wednesbury.—The Mayor said at the quarterly meeting of the Council that it was his intention to bring the matter of electricity before the town either by calling a meeting or some other means, in order to get the public opinion upon the question.

Derby.—The Town Council have passed a resolution that £346 be granted for wiring Ford-street yard stables, etc., so that they could be lit by electricity, and that application be made to the Local Government Board for sanction to borrow the same.

W. T. Henley's Telegraph Works Company, Limited.—The directors of this Company have resolved to recommend a dividend at the rate of 12 per cent. per annum on the ordinary shares, including the interim dividend of 3 per cent. paid in September.

Edinburgh.—The Lord Provost's Committee is considering the advisability of constructing a tramway from Preston-street, Edinburgh, *via* Dalkeith-road, to Joppa and Portobello, returning by Meadowbank and Waterloo-place, to be worked by electric haulage.

Kirkcaldy.—The proposal to introduce electric tramways and traction in Kirkcaldy and district is being favourably received. The provost and magistrates of Dysart have appointed a committee to confer with the Kirkcaldy committee on the whole subject.

Telegraph Construction and Maintenance Company.—The directors of this Company propose paying a dividend of 10 per cent. (£1. 4s. per share), subject to the audit of the accounts, in addition to the 5 per cent. already paid, making 15 per cent. for the year 1897.

Ipswich.—After a strong debate, it has been decided to refer several offers from companies to take over the electric lighting provisional order to a committee for consideration. Those in favour of the Corporation carrying out the scheme themselves were out-voted.

New Catalogue.—Messrs. Cole, Marchent, and Morley, of Bradford, send us their new catalogue of independent condensing plants. We note that this firm have introduced electric motive power for driving the circulating and air pumps. The catalogue is well illustrated.

Bootle.—Contracts have been accepted for the boilers, machinery, plant, mains, and other works required in connection with the supply of electrical energy in Bootle. These are in accordance with the plans and specifications prepared by Mr. Thomas Lodwick Miller.

Mitchelstown.—With reference to the Mitchelstown electric light scheme, the plans and maps of which have been lodged in the Houses of Commons and Lords for parliamentary sanction, the local guardians have given notice that they will on March 17 next ask the local authority to make good the statutory requirements.

Darwen.—A motion that the Council apply to the Local Government Board for sanction to the borrowing by the Corporation of £30,000 for electric lighting purposes, and including the site of station on Shorey Bank Estate, and £270 for site of destructor proposed to be combined with the electric station, is before the Corporation.

Devonport.—It has been decided by the Borough Council to retain Prof. Kennedy as consulting engineer to the Corporation, and to request him to report upon the best means of exercising the powers conferred by the Devonport Electric Lighting Order, with special reference to the question of public and private lighting, motive power, and utilisation of heat for refuse destructor.

Scarborough Electric Supply Company, Limited.—This Company has made a profit on the year's working of £2,044, as against £1,617 in 1896, and a sum of £1,845. 1s. 9½d. is available for distribution. The directors recommend that this should be applied in paying a dividend of 5 per cent. (less income tax), which will absorb £1,656, leaving a balance of £188. 11s. 9½d. to be carried forward.

Birkenhead.—At a recent meeting of the Council, the Gas, Water, and Electrical Committee reported that they considered the time had now arrived when they should appoint a resident electrical engineer for the borough. The quantity of electricity now applied for was equal to what they were able to supply by their present plant, and an early extension would probably be necessary.

Bradford.—At a meeting of the City Council on Tuesday, the Gas and Electricity Supply Committee recommended that the electrical engineer be authorised to extend the electric cables along White Abbey-road from Westgate to Carlisle-road. A sub-committee has been appointed to inspect central electrical stations on the Continent supplying current for lighting purposes and tramway traction.

Kidderminster and Stourport Electric Tramway Company.—The ordinary general half-yearly meeting of this Company will be held at their offices, Donington House, Norfolk-street, Strand. London, W.C., on the 24th inst. at 3 p.m., for the purpose of election of directors, and for transacting the ordinary business of the Company.

Municipal Officers' Association.—The Right Hon. the Lord Mayor of London will preside at the annual general meeting of the Municipal Officers' Association. to be held in the Council-chamber, Guildhall, London, on Tuesday, Feb. 22, at 7 p.m., supported by J. L. Wanklyn, Esq., M.P., James Bailey, Esq., M.P., Major Dalbiac, M.P., L. Atherley-Jones, Esq., M.P., J. H. Rutherglen, Esq., and others.

Partnership.—We are informed that having negotiated the recent transfer of the business of the Fowler-Waring Company to the Western Electric Company, Mr. Mervyn O'Gorman has joined with Mr. E. H. Cozens-Hardy, chief assistant to the Brush Company's engineer, in an examination of Continental and American methods, with a view to a subsequent partnership in consulting work on their return to London.

Islington.—The report of the Electric Lighting Committee of the Vestry for 1897 shows a profit on the second year's working of £4 432. The number of units sold in 1896 was 298,000. Last year 504,000 units were sold. With an increased cost of production of 31 per cent. the output has advanced 69 per cent., and the revenue 62 per cent. The gross profit in 1896 only amounted to 21 per cent. in the revenue, but last year it rose to 36 per cent.

Grimsby.—At a meeting of the Public Lighting Committee of the Corporation last week it was decided to recommend to the Town Council that Prof. Kennedy, of London, be asked to prepare an estimate of the expenditure for the putting in of an electric lighting installation for Grimsby, and that application should be made to the Board of Trade to approve of the scheme, and to the Local Government Board for sanction to borrow the necessary money.

New Cycle Lamp.—A new acetylene gas cycle lamp has been placed on the market by Messrs. H. Fentum Phillips and Co., Guildford Electrical Works, Guildford. It is made of silver-plated aluminium, and the gas is produced by simply regulating the flow of water on to the carbide. It gives a white light of 20 c.p. After this result the firm might now with profit concentrate their efforts upon the production of a really serviceable electric cycle lamp.

Smoking Concerts.—The smoking concert of the staff of the City of London, the Metropolitan, and the London Electric Lighting Companies will be held at the Crown Room, Freemasons' Tavern, Great Queen-street, Holborn, W.C., on Friday, 18th inst., 1898, at 7.30 p.m. Mr. P. W. D'Alton will preside.—Messrs Drake and Gorham's employés' smoking concert will be held at the Grosvenor Hall, 200, Buckingham Palace-road, to-day, 11th inst., at 7.45 p.m.

New Catalogue.—We have received Messrs. Alley and Maclellan's new list of their "Sentinel" steam-engines. It will be remembered by our readers that this firm make the Westinghouse type of engine under the above distinctive name. The list is fully descriptive, and enables the reader to gather the complete details of the engines in question. The lists of brake-horse power for the various sizes of engines with different boiler pressures is most handy for reference. We are also glad to note that prices are given.

Business Amalgamation.—We understand that the well-known business, Messrs. G. R. De Wilde and Co., carried on for the past 12 years by Mr. George Rexworthy De Wilde at 10 and 11, Archer-street, Shaftesbury-avenue, has been purchased by Messrs. Thomas Potter and Sons and amalgamated with their own business, carried on at 44, South Molton-street. Mr. De Wilde has joined Messrs. Potter and Sons, and will in future have charge of the wrought-iron, brass, and copper department of their business.

Huddersfield.—At a meeting of the General Purposes Committee of the Corporation, on the 8th inst., it was stated that the application for a municipal telephone license had been refused by the Postmaster-General. A sub-committee was appointed to consider terms of agreement with the National Telephone Company with regard to their application to lay their wires underground. The Corporation had previously refused this, and at the same time had cancelled an agreement with reference to the overhead wires of the company.

Cheltenham.—The electrical engineer has reported to the Town Council that the two new boilers have been erected and subjected to a hydraulic test with satisfactory results; that the first 220-kw. steam alternator has been practically completed, and that it will be ready for the steam trials on the 9th prox.; that good progress has been made with the building extensions during the past month, and with a continuance of the present mild weather the stores, battery-room, etc., should be finished in about another month's time.

Merthyr.—At the last meeting of the Urban District Council a letter was read from the Board of Trade to the effect that after consideration of the representations of the District Council in reference to electric lighting, they had revoked the provisional order granted to Messrs. J. C. Howell. A notice of motion was tabled to consider the expediency of including a sum in the next estimates with a view of engaging an expert to report upon the electric lighting of the district, and probably on a scheme of electric tramways.

Brown v. I E.S. Accumulator Company.—This was a motion for judgment as a short cause in default of defence, heard by Mr. Justice Romer on Saturday last. The Company was incorporated
in 1895 for the purpose of carrying on business as manuf
of electrical batteries, and the plaintiff was the holder of
tures in respect of which the company had made defa
company named New and Mayne were also made defendan
being interested in the taking of the accounts. Mr. Justice
made the usual order in a debenture-holder's action.

Edison and Swan United Electric Light Company
directors of this Company have resolved that a paym
account of the dividend of the current year be made at
of 5 per cent. per annum, less income tax, on the "A" s
respect of the half-year ended Dec. 31, 1897. This will w
at 1s. 6d. per share on the partly-paid £5 shares (£3 pa
2s. 6d. per share on the fully-paid £5 shares, less incom
The payment will be made upon the register as it stood
8th inst., and the dividend warrants will be issued on the 2

Newburgh.—A representative from the National Te
Company has been making enquiries regarding the advisab
opening a telephone exchange here connected with Pert
junction wire, from which communication can be maintain
the company's system in Scotland, England, and Ireland by
of the Post Office trunk wires. The terms are stated to b
annual rental for premises within half a mile of the town,
communicating with outside towns an additional fee varyin
3d. for Perth, Dundee, and Kirkcaldy to 6d. for Edinbur
Glasgow.

Lambeth.—At the last meeting of the Vestry, the L
Committee reminded the Vestry that the South London
Supply Corporation had undertaken to supply energy free of
for 25 arc lamps to be erected by the Vestry in certain
The committee submitted a list of positions, among the
the Triangle, Kennington Cross; Nine Elms-lane; White
Brixton; Kennington Church; Tulse hill and Norwoo
Swan, Stockwell; corner of Brixton and Atlantic roads;
road and Camberwell New-road; and two near Brixton O
Loughborough Junction. These were approved.

Lincoln.—The Electric Lighting Committee have report
Messrs. Close having withdrawn their tender for the chi
the electric lighting station, they have agreed to let
Wright and Son undertake the work at the same price—
The committee resolved to request the Finance Committee
Corporation stock to raise £10,000 for the electric lighting
and contracts. The electrical engineer has been empow
invite tenders (1) for supplying the timber for the trenches
electric lighting wires in the public streets, and (2) for the
pillars, brackets, etc., for the public lighting by electricity

Southwark.—At the meeting of the Vestry of St. Geo
Martyr were discussed reports recommending (1) that the
committees as to the disposal of dust and electric ligh
amalgamated under the title of the "Electric Lighting a
Disposal Committee"; (2) that the plans of the County of
and Brush Provincial Electric Lighting Company, Limited,
approved, and that the London County Council and the Post
General be also recommended to disapprove the plans;
that this committee be empowered, if thought necessary, t
expert advice with regard to the provision of an electric insta

British Electric Traction Company.—The Electric and
Investment Company have offered for subscription a first
the British Electric Traction Company, Limited, of 10,0
cent. cumulative preference shares, of £10 each, at £12
share. The share capital of the latter company is £60
equal proportions of 6 per cent. cumulative preference and o
£10 shares, and the undertaking was, the prospectus
formed in November, 1896, to acquire the business of the
Electric Traction (Pioneer) Company, and to develop
traction in the United Kingdom and elsewhere. Lists
yesterday.

Newington.—At the last meeting of the Vestry, Mr. C
called attention to the energetic way in which the London
Supply Corporation were approaching tradesmen in orde
them to take electricity from the company. The latter we
ing to supply the light at 5d. per unit within three weeks
signing of the contract. What effect, he asked, would th
upon the Vestry's scheme? It appeared that the compa
cutting the ground from under the Vestry, and supply
energy at a lower price than the local authority would b
Mr. Edwards said the matter would come before the Vestr
next meeting.

Centrifugal Fans.—We have just received a copy of t
catalogue of their high-pressure centrifugal fans, issue
Sturtevant Engineering Company, of 73 Queen Victori
These fans are mainly designed for blowing cupolas, e
notice from the text that electric motors for driving t
coming into great favour. The catalogue is not at present
list, but all other details are given, together with a v
amount of useful information. At the latter part of the
comparisons are made between centrifugal blowers an
blowers respectively, and we need hardly say that the fi
up their end of the plank exceedingly well.

Darlington.—At the quarterly meeting of the Town C
was recommended that the Gas Committee be autho
employ an electrical engineer to advise as to the best sy
electric supply to adopt for the electric lighting of the b
and to prepare plans and specifications for the installatio
electric light; and that in the meantime no further steps b
towards the erection of the new gasholder An amendme
minute suggesting, after the words "electric light," the i
of "but that the borough surveyor be instructed to con
Mr. Hepworth or other suitable expert, and arrange for

e Gas Committee and discuss the position of the town in to the gas," was carried.

e-to-House Electric Light Supply Company. — This y having petitioned for the reduction of their capital, Mr. Romer on Saturday granted the same. The Company med in 1888 with an original capital of £350,000, which had duced to £200,000. Amongst the shares issued by the y were 100 founders' shares, which it was desired to get and the general scheme of the petition was that the s' shares should be surrendered to the Company, and that lers should subscribe for a certain number of ordinary and ce shares which were part of the original capital of the y, leaving the capital at £199,500 instead of £200,000.

of London Electric Lighting Company, Limited. — The return for the quarter ended Dec. 31, 1897, shows a venue from sale of current for public lighting, after deduc- allowances to consumers, etc., of £3 119, compared with esponding quarter last year of £2,970 ; gross revenue from current for private lighting, etc., after deduction of allow- consumers, etc., £59,798, against £53 399 ; gross revenue ther sources (estimated), £2,000, against £1,000—total, , against £57 399 ; showing an increase of £7,546. The of 8-c p. lamps connected on Dec. 31, 1897, was 296,012, an increase during the quarter of 17 850. The increase the corresponding quarter of last year was 19,045.

leton. — The Earl of Jersey opened a Board of Trade on Saturday to consider the proposal of the British Elec- ction Company to construct tramways, eight miles long, iddleton to Rochdale, Oldham, and Heywood, at an esti- ost of £52,000. All the local authorities concerned were ted. No authority objected totally to the scheme, except- ddleton, who objected because the application was made he Light Railways Act and not under the Tramways Act. on preferred to make tramways in their own districts, and ected because of the purchase clause. Lord Jersey inti- hat the commission were agreed it was desirable in the interest to have intercommunication between the towns ed.

ourne. — The Council have agreed to the following resolu- "(1) That in the interest of trade, industry, and social nce, it is essential that the fullest development of the e service in this country should be promoted ; (2) that in effect such development it is necessary that only a e rental should be charged ; (3) that the best and cheapest an only be secured by competition ; (4) that this Council y requests the Postmaster-General to grant licenses to alities or companies which comply with the Treasury f May 23, 1892 (which provides that 'competition should prevented'), without further enquiry as to charges or y of present service, such enquiries involving unnecessary and delay."

ary. — We regret to chronicle the death of Mr. G. K. F.R.A.S., M.I.C.E., M.I.E.E., which took place at on the 17th ult. The deceased, of whom the Indian ublish highly complimentary notices, and who was in his h year, had been connected with electrical work since he en, and he had occupied the position of telegraph engi- the Madras Railway Company during the last 34 years. the son of Dr. W. Winter, of Henburgh, near Bristol, well known as the inventor of the Winter patent block which is in use in India, New Zealand, and some parts of America) and Winter's inter-communication signalling ; e recently he had brought out an improved lock instru- ket apparatus.

pool. — At a meeting of the Lighting Committee of the tion held on the 4th inst., authority was given the elec- gineers to proceed with a portion of the extension of the provided for by the estimates of this year. The work ed includes a trunk main for Paradise-street *via* Hanover- to Ranelagh-street ; mains dealing with the residential t of Wavertree, Smithdown-road, Allerton-road, and Green- main to join the Mossley Hill district by Penny-lane, and the Park district *via* Greenbank drive ; mains in Wavertree- -road, Lodge-lane, and Bentley-road, joining to Lark- ; and mains in Byrom-street and Scotland-place, con- with mains already laid. The estimated cost of this portion work is £16,947. — The minutes of the Tramway Committee in our last issue were adopted by the Corporation on the

— In reference to the proposal to equip the Headingley, , and Hunslet sections of the Leeds tramways with , the Corporation officials have been instructed to statement showing the entire outlay in connection with installation between Roundhay Park and Kirkstall, as the cost of working per mile. The management have ly discontinued the four steam cars travelling between and Kirkstall, and substituted three electric cars. is now the only form of traction employed on the . It is expected that the other electric cars ordered ration will shortly be ready and in use. The Tram- ittee have decided to extend the tramways from Wall y, to the city boundary at Stanningley. The estimated proposed electric tramway 2 373ft up Ingleborough is 5,000. It is stated that the tramway could be laid ths.

s and Belgrano Electric Tramways Company. — Trust, Loan, and Agency Company offer for sub- at par by the Buenos Ayres and Belgrano Electric Tramways Company, Limited, of £260,000 5 per cent. debenture stock, and £200,000 "A" 6 per cent. cumulative preference shares of £5 each. The Company's share capital is £850,000, made up by the above issue of 40,000 "A" preference, 30,000 "B" 6 per cent. preference, and 100,000 ordinary, all of £5 each. The debenture stock is redeemable after 1910 at 15 per cent. premium on 12 months' notice, or at par on Jan. 1, 1930. The prospectus states that the Company has been formed to acquire and amalgamate the concessions, lines, and properties of the Buenos Ayres and Belgrano Tramways Company, Limited, and the concession recently granted to Mr. Charles Bright for an electric tramway between Buenos Ayres and Belgrano, together with the lines constructed or in course of construction.

Coventry. — The Council have passed the following resolutions : "That in the interests of trade, industry, and social convenience it is essential that the fullest possible development of the telephone service in this country should be promoted ; that in order to effect such development it is necessary that only a moderate rental be charged ; that the best and cheapest service can only be secured by competition ; that, as the Treasury minute, dated May 23, 1892, provides as a matter of general policy 'that competition shall not be prevented,' this Council earnestly requests the Postmaster-General to grant licenses without enquiry as to the charges or efficiency of the present service to any municipalities or companies which comply with the requirements of the Treasury minute, such enquiries being inconsistent with the spirit of the Treasury minute, and involving unnecessary expense and delay ; that this Council desires particularly to support the claims for licenses made by the New Mutual Telephone Company, Limited, of Manchester, and by the Corporation of Glasgow."

Durham. — The following letter shows that Durham is proceeding on novel lines as regards electric lighting. It is addressed to the town clerk, and reads : "Dear Sir,—I am writing to inform you that proposals have been made by my company, and favourably received by the Dean and Chapter, for our putting down an electric lighting plant, to be worked by their water power, for supplying electric current to the cathedral and college. We propose to put sufficient plant down, not only to supply the cathedral and college, but to leave a margin to supply electric current to any consumers who may wish to have it in the city. My object in writing to you is to request the consent of your Corporation to mains being laid through the streets to supply any intending consumers, and I shall be glad if you would kindly lay this request before your Council at their next meeting. Of course, you will understand that any such permission must be given upon the usual conditions, giving the Council full control of the way in which such mains are laid underground, and the way in which the pavement, etc., is made good again after the work is completed.—I am, sir, yours faithfully (Edmundson's Electricity Corporation, Limited), F S GRIPPER, managing director." It was resolved at the last meeting of the Council that permission be granted.

Appointments Vacant. — The Corporation of Birkenhead require a resident electrical engineer at a salary of £300 per annum, clear of all office and other expenses and disbursements. Applicants must have practical experience in the various branches of electrical engineering, and in the designing and laying down of plant, cables, and machinery in connection with the generating of electrical energy for lighting purposes, and for power in connection with the working of tramways and other similar works. The person appointed must devote the whole of his time to the duties of his office, and must not engage in private practice, and must perform such other duties as may be assigned to him. No application from any person exceeding 45 years of age will be entertained. Applications, stating age, experience, and present occupation, with copies of not more than three recent testimonials, sealed and endorsed "Electrical Engineer," must be sent to Mr. Alfred Gill, town clerk, Town Hall, Birkenhead, by 18th inst. Personal canvassing of members of the Council is prohibited, but candidates are at liberty, if they choose, to forward to members of the Council printed copies of their applications and testimonials.—Applications are also invited for the post of electrician-in-charge in the gas-driven works of the Northwich Electric Supply Company, Limited, Cheshire. Applications, in writing, should be addressed to Messrs. Beckett and Sclater, 2, Cooper-street, Manchester.

Swansea. — A meeting of the Sub-Electric Committee of the Swansea Corporation was held last week, and the position with the tramway company was further discussed. Though no definite step was decided, it appears that the committee is disposed to recommend that a report on the lighting section of the old triple scheme, with the addition of the provision of a supply of power for works requirements, be adopted by the Council and at once proceeded with. The *South Wales Daily News* says : "In an interview on the electric lighting scheme the Mayor of Swansea said, 'I think you may take it we are resolved to act now whether we can come to an agreement with the tramway company or not. The tramway company, I must confess, are rather disappointing. We cannot, however, compel them to sell. We can only insist on their keeping the road in proper repair, and that we shall do. We shall look to the people who now use steam and gas engines for our day load. We can get from them a better price per unit than we could from the tramway company, and yet supply them with power much more advantageously than they are at present. The matter has been put before a good many tradespeople, and we have received such encouraging promises of support as to warrant us in going on. Without the day load it will pay all right, but we should have to charge something like 6d. per unit, and that is what we don't want to do. At Newport, where they have a lighting scheme alone, it pays ; and what Newport can do, surely we can. The Newport engineer, by the way, was in Swansea

yesterday, and he was good enough to attend the committee, one of the consequences of his visit being that we shall probably send a deputation to Newport in the course of the next few weeks. Whatever happens, we are determined to make a start.'"

General Electric Company's Annual Dinner.—Under the most favourable auspices, the directors and staff of the above Company met together with a goodly number of their friends on Saturday evening last at the Empire Room, Trocadero Restaurant, for their eighth annual dinner. Among the guests one saw a number of gentlemen whose names are well known all over the electrical world, and as the General Electric Company has relations with every branch of electricity, so one saw all these various branches adequately represented—viz., the General Post Office, the telephone world, consulting, railway, and central-station engineers, as well as numerous contractors, including representatives of the Colonial branch of the trade. The chair was taken by G. Byng, Esq , and at the conclusion of the excellent dinner he proposed, in an admirable style, the toast of "The Queen." The next toast was that of "The Guests," given by Mr. Byng in a speech full of dry humour and wit, which was responded to in suitable terms by several gentlemen. Mr. Max Byng then rose and proposed the health of "The Staff," and it was easy to see from his speech what cordial relations exist between them and their directors. This speech was replied to by Mr. Beavis and Mr. White on behalf of the various departments. When Mr. Hirst rose to speak with much feeling about the sympathy which has been shown him during his illness, he was received with the greatest applause, it being his first appearance for four weeks amongst his staff. The enjoyment of the evening was greatly enhanced by the brilliant array of ladies who graced the tables by their presence. A smoking concert followed, the programme of which is too long to be given, being greatly enjoyed and appreciated by all present, and was an excellent one in all respects. The concert concluded with the singing of "Auld Lang Syne."

London County Council.—On Tuesday last a report was submitted by the Fire Brigade Committee on lighting the chief fire station by electricity. The chief officer suggests that the National Electric Free Wiring Company's system of wiring should be adopted, and he proposes that, instead of the necessary plant being obtained from various firms, a contract should be entered into with the company for the supply and fixing of the plant and fittings, but that some of the fixing and the making of brackets, etc., should be executed by the workshops' staff, the company reimbursing the Council the wages of the men thus employed. The company has submitted a tender amounting to £992, such sum to include the provision and fixing of an engine and dynamo, with switchboard, cables, mains, distribution boards, branch wires, switches, incandescent lamps, batteries, etc., and 14 arc lamps. The company undertakes to employ the Council's men to assist in every possible way, and to credit the Council with the amount of their labour at trade union rates, for which purpose the company will issue time-sheets to each of the men. It is estimated that the expense of this labour will be about £100, by which sum the amount ultimately payable to the company will consequently be reduced. The only remaining expenditure will be in connection with the provision of accommodation for the engine and boiler. The boiler proposed to be used for the purpose is one taken out of the tug "Condor." The chief officer suggests that the painters' shop at the chief station should be utilised as an engine-house, and the architect informs us that the cost of the necessary work, including the building of a brick chimney shaft, will be about £103. Provision to the extent of £1,000 will be made in the estimate for next financial year for the installation. The committee finally recommends that the Council accept the tender of the National Electric Free Wiring Company, Limited.

Hastings.—At the last meeting of the Town Council the Tramway Committee recommended as follows: (1) That the scheme for a suggested system of tramways submitted by Mr. T. W. Barber, C.E., with which is coupled an extensive street improvement scheme (but in respect of which no parliamentary notice had been given on plans deposited), be not entertained. (2) That consent be not given to the Hastings and St. Leonards tramways scheme — viz., that in respect of which Messrs. Tahourdins and Hitchcock are acting for the promoters, and of which Mr. Chadwell is engineer. (3) That the Hastings and St. Leonards light railways scheme, of which the British Electric Traction Company, Limited, are the promoters, under which it is proposed to construct a line from a point near the west end of George-street, *viâ* Castle-street and Robertson-street, to a point near the Bopeep Hotel, and a line from the Albert Memorial *viâ* Bohemia-road to Hollington, be not assented to. (4) That consent be given to the carrying out of the Hastings, Bexhill, and district light railways (electric) scheme, subject to a single line only being laid on that part of the front between London-road and the Fountain Hotel, West Marina, and to the promoters of the scheme entering into a binding undertaking not to construct that portion of the line on the front between London-road and the Albert Memorial without the previous consent of the Council, and also subject to terms and all matters of detail being arranged with the Council, and that it be referred to the committee to negotiate with the promoters as to terms and details and report. The following amendment was carried: "That the report be adopted with the exception of recommendation No. 4, relating to the Hastings, Bexhill, and district light railway (electric) scheme; that no part of the borough front line should be utilised for any experiment with tramways; that all necessary inland lines to the suburbs and outskirts of the borough should be constructed by the Corporation; that it be referred to the Council in committee to consider and report as to what inland lines should be
so constructed, and generally thereon; and that the town
instructed to take the necessary steps to oppose all the sc

The "Gem" Wall Plug.—Mr. A. P. Lundberg send
inspection a sample of his "Gem" concentric wall con
which he is just putting on the market. It is, as can be
the adjoining cut, of simple construction, small in size, a
in appearance, and an improvement on several unsightly
at present on the market. It is also much safer, as the bra
of opposite polarity are well separated, and on this accoun
short-circuiting is made a more difficult matter. The sm
in the cover (the plug being only ¼in. in diameter) is also an
tage. In outside appearance it closely resembles the "Do
pin wall connection, which is in such great demand, and
fitted with similar varieties of covers and plugs as that pat

is only 1⅞in. diameter and 1¹⁄₁₆in. height over all when pl
connection with socket part. A long fuse is provided for
is required, and all plugs and sockets are made interchang

Shoreditch.—The Vestry discussed at some length at th
meeting various proposals for reducing the charges for
light. The Lighting Committee reported that they ha
consideration a report from their engineers, Messrs. C.
Russell and C. H. Doughty, on the question of charges for
and having also received a memorial and a deputation f
consumers of current, the committee recommended the
to make the following reductions, especially having re
statistics presented for the committee's information
extremely satisfactory returns of the past half-year at the
station: That consumers be charged at the rate of 6d.
for 1½ hours and 2d. afterwards. That consumers using
than 75,000 units per annum for power purposes be char
lighting 3½d. all hours, and those using 50,000 units 4d. a
That the charges for public lighting be reduced from 5d
per unit; the reductions to come into force at the end of
June quarter. Mr. Kershaw moved the adoption of the
The scheme of generating electricity by the burning of
refuse had been so successful that the whole cost of the station
out far below the average of most municipal stations. T
the committee, taking into consideration that the scheme
existed six months, felt justified in recommending this re
which would place their charges pretty nearly second to non
Cox said the report was a rather unusual one. Everybody w
extremely glad to support and to receive this reduction,
a single figure was given to the Vestry as to the expend
income or anything to do with the lighting departmen
Vestry were simply called upon to vote in the dark, wh
not in harmony with the undertaking. Mr. Wells belie
was the outcome of an agitation among several custom
declared they would discontinue using the light unless it
much reduced in price. Mr. Winkler moved that the repo
over until the balance-sheet of the electric lighting was p
on March 25 next. Mr. Kershaw said this undertaking
run in a commercial spirit. Their loss on the first quar
£500, but in the second quarter they recouped the loss
£300 to the good. One of the contractors had not yet fulf
guarantee, and if the figures given to the committee
print, it might be the worst day's work the Vestry ever di
quantity of electricity generated last quarter was 95,00
and this quarter they estimated that 150,000 units w
required. The amendment was carried.

Bristol. — The representatives of the tramways c
attended at the Council House on Friday last to meet
committee of the Sanitary Committee with reference
Tramway Extension Bill and the Electrical Powers Bi
report containing the recommendations of the sub-committ
Council was read. The Chairman said that as far as the co
were concerned, there was a large proportion of the line i
there was less than 9ft. 6in. between the rails and the
and they would require the company to send in an
scheme. He enquired if the representatives of the comp
anything to say, and they asked to be furnished with
ticulars of the places at which the objections arose, but th
informed that these could not be given, as it was not for t
mittee to amend or suggest amendments in the company'
and that the company must bring up fresh proposals al
The representatives stated with regard to the new lines t
were ready for the committee to amend the plans in any
they might deem advisable, provided that the tramways as
could be reasonably and efficiently worked. Again the
were unsuccessful in eliciting any information as to the plac
it was considered there should be alteration. The company

ives also asked if they were to understand that the committee
solutely settled upon the report. The Chairman, although he
he report would be subject to modification, read a print of
port containing the statement that the committee had met
mpany's representatives, and had furnished them with par-
s of their objections, on which Mr. Low remarked that he
l take exception to that statement, and if he were able to be
Council on Tuesday he should be compelled to refute it, as
ticulars of the objections had been furnished. The com-
representatives then asked if the committee desired to
any other points of the Extensions Bill or of the Electrical
Bill. The Chairman said the committee were not autho-
discuss the Electrical Powers Bill, and did not intend to
-A quarterly meeting of the Council was held on the 8th
hen the report of the Sanitary Committee dealing with the
ays Bills was discussed. Two memorials, which were
ed by the Bedminster West Ward Ratepayers' Association
ners and occupiers in Redcliff-street, were read. These
objected to the proposed extensions on the ground that the
y space would not be left between the kerb and the nearest
y line. The Town Clerk added that he had received
f resolutions passed by the Bristol Trades Council Labour
l Association Executive Committee, Bristol Socialists'
ion, and an open-air meeting held on Bedminster Bridge.
solutions generally disapproved of the proposed schemes
rent grounds. The following amendment was carried:
the report of the Sanitary Committee and the two Bills of
ways company be referred to a joint committee, consisting
anitary Committee, with instructions to negotiate with the
y upon both Bills, without prejudice to the rights of the
tion, and that the joint committee be requested to report
earliest opportunity, and that meanwhile a petition be
d against the Electrical Powers Bill, and that the consent
orporation be given to the Extension Bill upon a proper
king to withdraw the Bill unless an agreement is concluded
the Bill reaches the committee stage." Mr. Alderman
octor had pointed out that there were difficulties in the
the consent which must be settled at once, but a parlia-
undertaking was often given, and could be enforced.
t of the report was adopted. It was resolved that the
ee should negotiate with the company for the insertion of
that no one employed in the service of the company should
ed more than 60 hours a week. The salary of Mr. Parkinson,
gineer's department, was increased by £50 per annum.

ie.—At the last monthly meeting of the Town Council,
ost reported that there had been a joint meeting of the
and Coatbridge Committee on Tuesday with regard to the
ion that was made by the British Electric Traction Com-
imited, to lay the tramway. As they were aware, the
mpany that proposed to make the line intended to do so
e Tramways Act. The present company wanted an order
e Light Railways Act, and to lay the line only as far west
lill Brae, and no farther east than Forsyth-street. But
mittee were determined not to give place to any such idea.
he company was prepared to go as far as the Carlisle-road
committee would not hear of taking into consideration any
art of the business. This was brought before the repre-
es of the company, and the committee endeavoured to
them that if they were to break up the connection at
-street and go no further east, it would destroy the idea of
ple of Airdrie, which was that they should be supplied to
as far as the Carlisle-road with the accommodation. The
was placed before the company's manager, engineer, and
ent, Mr. J. Milne Boyd, who was present at the meeting,
o asked the committee to formulate their objections, stating
y would be prepared to consult with the Airdrie Town
upon the advisability of taking over the Board of Trade
at the Council proposed getting for the electric lighting of
gh, so that the two might be worked together. The Provost
e thought that they had now made a step in the direction
g the foundation for the tramway, and he had no doubt that
uld be done in a very short period of time. It was said
they got the order to go on they would begin very early,
they did not require to wait upon an Act of Parliament.
mmittee had done all they could in the interests of both
and the minute of the meeting would be read. The
of the joint committee state that the joint committee,
nsidering the same, resolved that they would recommend
spective councils to agree to the light railway order being
l to that company provided (1) that a clause be embodied
order that the lines can be purchased at a valuation
greed upon at the end of 21 years and every seven years
er until the expiry of 42 years, when they can be taken
conformity with the provisions of the Tramways Act,
(2) that the gauge be made 4ft. 8½in. instead of
; (3) that the line be extended westwards in the burgh
ridge to Woodside-street, and eastwards in the burgh of
to the Carlisle-road; (4) that the fares within the towns of
and Coatbridge be at the rate of ½d. per half mile, and
f-mile stages be arranged for; that Section 38 of the
lway order be altered so as to provide that the railway
be used for conveying minerals without the consent of
orations, and that the carriage of goods shall be in a
to be approved of by them; (6) that Section 34, as to
wal of snow, etc., should be altered so as to provide
the company remove snow from their rails it must
ed off the street entirely; (7) that the company give
rtaking to the effect that so soon as the line
a paying one, they shall be bound when called upon
orporation of Coatbridge to construct a line from the Whitelaw Fountain along Sunnyside-road to the Red Bridge; (8) that Section 45 (2) be altered so as to provide that no mechanical power shall be used except with consent of and according to a system approved of by the Board of Trade after consultation with the two corporations; (9) that the line be a single one with passing stations, and that it be laid down in the track and in a manner as regard construction and placing of pillars and brackets to be approved of by the respective corporations. The corporations reserve power to themselves, if need be, to consult a parliamentary agent for the purpose of being advised as to whether or not their rights are sufficiently safeguarded by the light railway order as amended, which is now being applied for.

PROVISIONAL PATENTS, 1898.

JANUARY 31.

2433. An improved system of adapters to adapt all existing fittings for electric lighting to armoured, sheathed, or other concentric cables. Henry Fentum Phillips, Guildford Electrical Works, North-street, Guildford.

2455. Improvements in electric contacts suitable for railway signalling and other purposes, and apparatus for use in combination therewith. Robert Burn and Alfred Charles Brown, 50, Old Broad-street, London.

2479. Improvements in terminals for electrical connections especially adapted to incandescence lamp holders. Gustav Byng and Henry Bevis, 73, St. Stephen's-road, Upton Park, London.

2485. An improvement in electric arc lamps. Charles Oliver, 61, Wilson-street, Finsbury, London.

2487. Improvements in apparatus for distributing electricity. Henry Pengelly, 24, Southampton-buildings, Chancery-lane, London.

2495. Improved method of insulating electric apparatus and conductors. Jean Louis Berthet, Maurice Mollard, and Lucien Dulac, 111, Hatton-garden, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, July 2, 1897, being date of application in France.)

FEBRUARY 1.

2522. An improved electrical striking mechanism for bells. August Eckstein and Herbert John Coates, Peel Works, Adelphi, Salford, Manchester.

2551. An improved combined electrical dynamo and motor. Thomas Cooper, 77, Colmore-row, Birmingham.

2571. Improvements in electro-dynamic elements. Charles Vallot and Eugène Pauze, 8, Rue des Princes, Brussels.

2580. Improvements in electric lighting media. Henry Andrew Kent, The Limes, Brownlow-road, Bowes Park, London.

2584. Improvements in the manufacture of electric glow lamps. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Carl Pieper, Germany.)

2604. Improvements in systems and apparatus for electric time control. William Phillips Thompson, 6, Lord-street, Liverpool. (The Self-Winding Clock Company, United States.) (Complete specification.)

2618. Improvements in supports chiefly designed for electric incandescent lamps. Leonard Weldon, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

FEBRUARY 2.

2669. Improvements in electrical cut-outs. William McGeoch, jun., 24, Temple-row, Birmingham.

2670. Improvements in electrical keyholder and analogous switches. William McGeoch, jun., 24, Temple-row, Birmingham.

2684. Improvements in apparatus for the electro-deposition of metals. Frank Fisher, Benjamin John Round, Benjamin James Round, and Alexander Round, 5, Church-avenue, Water Orton, Birmingham.

2723. Improvements in electric arc lamps. Henry Crudgington, 11, Burlington-chambers, New-street, Birmingham.

2734. Improvements in or relating to electric incandescent lamps. Alfred Julius Boult, 111, Hatton-garden, London. (Carl Duvivier, Belgium.)

2735. Improvements in or relating to dynamo machines and electric motors. Montague Herbert Churchill Shann and Richard Ernest Churchill Shann, 111, Hatton-garden, London.

FEBRUARY 3.

18718A. Improvements in and relating to electric railways and tramways. Sidney Howe Short, 45, Southampton-buildings, Chancery-lane, London. (Date claimed under Patents Rule 19, August 12, 1897.) (Complete specification.)

2761. Improvements in high-tension electric switches. Edward Woodrowe Cowan and Alfred Still, Hart-hill, Woodville-road, Bowdon, Cheshire.

2770. Improvements in holders for incandescent electric lamps. Georg Jaeger and Hermann Bender, 10, Friedrichstrasse, Berlin. (Complete specification.)

2784. Improvements in electric switches. Otto Claude Immisch, 52, Chancery-lane, London.

2788. **Improvements in electric incandescent lamps.** Richard Bruno Roxby, 18, Featherstone-buildings, High Holborn, London.

2805. **Improvements in electrical tumbler switches.** Henry Crudgington, 11, Burlington-chambers, New-street, Birmingham.

2814. **A new or improved manufacture of insulated wire for electrical purposes generally.** Joseph Frederick Brennan, 19, Southampton-buildings, Chancery-lane, London.

2819. **Improvements in electric cigar lighters.** William Frederick Kessler, 45, Southampton-buildings, Chancery-lane, London.

FEBRUARY 4.

2849. **Improvements in electric switches.** Albert Edgar Tanner and Frederick Augustus Cortez Leigh, 70, Market-street, Manchester.

2871. **Improvements in electric furnaces.** William Henry Graham, 377, Norwood-road, London.

2876. **Improvements in electric lamp bulbs.** Jacob Atherton and Charles Manners Downie, 70, Palace-chambers, Westminster, London.

2904. **Improvements in electric heating and melting specially applicable to the metal pots of linotype machines and the like.** The Linotype Company, Limited, John Place, and Mark Barr, 22, Southampton-buildings, Chancery-lane, London.

FEBRUARY 5.

2967. **Improvements in electro-depositing anodes.** Harry Leopold Haas, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

2968. **Improvements in electric switches.** Reginald Belfield, 322, High Holborn, London. (Gilbert Wright, United States.)

2991. **Improved double arc lamp.** Wilhelm Mathiesen, 322, High Holborn, London. (Complete specification.)

2999. **Improvements in transmitters of Morse telegraphic apparatus for continuous and alternating currents.** Cesare Rossi and Pietro Forcieri, 4, South-street, Finsbury, London. (Complete specification.)

3003. **Improvements in and relating to lamps provided with electric igniting devices.** Paul Jenisch, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1897.

1734. **System of electrical signalling or communication between the occupant or occupants of a cab, carriage, or other road vehicle propelled by horse or other power and the driver or drivers thereof, and apparatus therefor.** Maycock.

2125. **Mean of economising electric energy in the heating of electrically heated apparatus and facilitating the use of such apparatus.** Edmunds.

2291. **Insulating frames for electrodes.** Engl.

2711. **Apparatus employed in the electro-deposition of copper and other metals.** Heys. (Dumoulin.)

2712. **Apparatus for the electro-deposition of copper and other metals.** Heys. (Dumoulin.)

3363. **Electric cables.** De Ferranti.

4417. **Electromotors and apparatus for the electric propulsion of tramcars, railway locomotives, or trains and other vehicles.** Ayrton and Allen.

5479. **Dynamo-electric machines.** Wade, Moores, and Farrell.

5805. **Improvements in and in the manufacture of elements for secondary batteries.** Fitz-Gerald.

6306. **Jacks for telephone exchanges.** Siemens Bros. and Co., Limited. (Siemens and Halske.)

6307. **Pegs and their cords for telephone exchanges.** Siemens Bros. and Co., Limited. (Siemens and Halske.)

6309. **Calling-off apparatus for telephone exchanges.** Siemens Bros. and Co., Limited. (Siemens and Halske.)

6351. **Electric incandescent lamp holders.** Hall and Clark.

6398. **Electricity meters.** Hookham.

9587. **Electric measuring instruments.** Evershed and Vignoles, Limited, and Evershed.

17597. **Conductors for electric railways.** Wise. (Krotz, Allen, and Kelly.)

20394. **Arrangement for strengthening electric currents.** Von Leon.

26656. **Electric accumulator plates.** Ribbe.

27345. **Holders for incandescent electric lamps.** Jaeger and Bender.

27346. **Holders for incandescent electric lamps.** Jaeger and Bender.

28225. **Electric railways on a road contact system.** Brown.

28853. **Electrical magazine fuse blocks.** Heys. (Ehrhardt, Thom, and Connor.)

29155. **Electric lamp holders.** Joseph.

29726. ***Electric heating devices.*** Le Roy.

TRAFFIC RECEIPTS.

Dover Tramways.—The traffic receipts for the w February 5 were £101. 0s. 5d. The total receipts f 1898 are £538. 0s. 8d. The mileage open at present is

Bristol Tramways.—The traffic returns for the w February 4 were £2,276. 0s. 8d., compared with £1,9 for the corresponding period of last year, being an £372. 9s. 5d.

Birmingham Tramways.—The traffic receipts for ending February 5 were £3,487. 19s. 1d., as com £2,977. 19s. 10d. in the corresponding week in 1897, increase of £509. 19s. 3d.

Liverpool Overhead Railway.—The traffic recei railway for the week ended February 6 amounted t compared with £1,241 in the corresponding week of t year, being an increase of £42.

City and South London Railway.—The returns f ended February 6 were £1,063, compared with £1,123 fo sponding period of last year, being a decrease of £60. receipts for the half-year amount to £6,456, comp £6,611 for the corresponding period last year, being of £155.

South Staffordshire Tramways.—The traffic retu week ending February 4 were £603. 15s. 9d., as com £521. 5s. 9d. in the corresponding week of the pre The aggregate receipts for the year are £2,957 12 against £2,728. 1s. 0d. in the corresponding peri previous year.

S.D. United Tramways.—The traffic receipts for ending January 28 were £436. 18s. 10d., as comp £360. 12s. 10d. in the corresponding week in the pre being an increase of £76. 6s. 9d. The number of carried was 73,523 in 1898 and 60,025 in 1897. The returns up to date are £1,720. 0s. 10d., as comp £1,640. 2s. 11d. last year, being an increase of £79. 17s. mileage open is the same as last year—viz., 8 miles.

COMPANIES' STOCK AND SHARE LI

Name.	Paid.
Birmingham Electric Supply Company	5
Brush Company, Ordinary	3
—— Non. Cum., 6 per cent. Pref.	2
—— 4½ per cent. Debenture Stock	100
—— 4½ per cent. 2nd Debenture Stock	100
Callender's Cable Company, Debentures	100
—— Ordinary	5
Central London Railway, Ordinary	10
—— "	6
—— Pref. Half-Shares	1
—— " "	5
Charing Cross and Strand	5
—— 4½ per cent. Cum. Pref.	5
Chelsea Electricity Company	5
—— 4½ per cent. Debentures	100
City of London, Ordinary	10
—— Prov. Cert.	15
—— 6 per cent. Cumulative Pref.	10
—— 5 per cent. Debenture Stock	100
City and South London Railway, Consolidated Ordinary	100
—— 4 per cent. Debenture Stock	100
—— 5 per cent. Pref. Shares	10
—— " " " '96	10
County of London and Brush Provincial Co., Ordinary	10
—— 6 per cent. Cum. Pref.	10
Crompton and Co., 7 per cent. Cum. Pref. Shares	5
—— 5 per cent. Debentures	—
Edison and Swan United Ordinary	3
—— 5 per cent. Debentures	3
—— 4 per cent. Deb. Stock, Red.	100
Electric Construction, Limited	2
—— 7 per cent. Cumulative Pref.	2
Elmore's Copper Depositing	1
Elmore's Wire Company	2
W. T. Henley's Telegraph Works, Ordinary	10
—— 7 per cent. Preference	10
—— 4½ per cent. Debentures	100
House-to-House Company, Ordinary	5
—— 7 per cent. Preference	5
India Rubber and Gutta Percha Works	10
—— 4½ per cent. Debentures	100
Kensington and Knightsbridge Ordinary	5
—— 6 per cent. Pref.	5
London Electric Supply, Ordinary	5
Metropolitan Electric Supply, Limited, Ord. No. 101-50,000	10
—— " " " 50,001-82,500	10
—— 4½ per cent. First Mortgage Debenture Stock	100
National Telephone, Ordinary	5
—— 6 per cent. Cum. First Pref.	10
—— 6 per cent. Cum. Second Pref.	10
—— 5 per cent. Non. Cum. Third Pref., No. 1-119,234	5
—— " " 119,235-250,000	[illegible]
—— 3½ per cent. Deb. Stock, Red.	100
Notting Hill Company	10
Oriental, Limited, £1 shares	1
—— £5 Shares	5
—— £4½ shares	4½
Oriental Telephone and Electric Company	1
Royal Electrical Company of Montreal	—
—— 4½ per cent. First Shares Mortgage Debentures	100
South London Electric Supply, Ordinary	2
St. James's and Pall Mall, Limited, Ordinary	5
—— 7 per cent. Pref.	5
—— 4 per cent. Deb. Stock, Red.	100
Telegraph Construction and Maintenance	12
—— 5 per cent. Bonds	100
Waterloo and City Railway, Ordinary	5
Westminster Electric Supply, Ordinary	5
Yorkshire House-to-House	5

NOTES.

ɛ.—We have received from Messrs. E. F. and
ɔy of "Magnets and Electric Currents," by
ɪming, F.R.S.

Power on Warships.—The Russian
ɩ decided upon the installation of electric
ɪrships for the purpose of raising ammunition,
ɪrking guns, etc., on the French system.

—We have received the February number
l, which is worthy of special notice. It is
ɪut contains a fully illustrated description of
hich certain kinds of timber are obtained,
ls of felling, shipping, etc. The letterpress
s make the paper most interesting reading.

Rays.—We are glad to note that the
Sciences, of Paris, has suitably acknowledged
by Prof. W. C. v. Röntgen. The acknow-
h special reference to the application of the
ɪdical work, and takes the form of the Caze
ther with £400 in cash. Prof. Lenard's
acknowledged at the same time.

-Mr. Henry C. Fischer, C.M.G., who has
of the Central Telegraph Office since 1870,
he responsibilities of his office on Tuesday
ɪs presents from the various divisions of the
h he has been connected so long have been
Fischer. These were displayed in the con-
on Thursday and Friday week, on the
which days informal farewell receptions

of Mechanical Engineers.—At the
held last week, the result of the ballot for
ɪe council was announced. Mr. S. W. Johnson
ident, and Mr. Arthur Keene and Sir William
ɪidents. Mr. Edgar Worthington, the newly-
ɪy, was introduced to the meeting. The
ɪates that at the end of last year the number
roll was 2,496, as compared with 2,359 at
revious year. During 1897, 227 names were
by death being 30, and by resignation or
t is proposed to hold this year's summer
nstitution at Derby.

Motors.—An important law case in
ɪulted in the decision by Judge Wheeler,
States Circuit Court, that the electric
ɪspension patent controlled by the General
stinghouse Companies is valid. An injunc-
d against the Union Railway Company, of
ɪe Walker Company, of Cleveland, to prevent
nging the patent in question. The patent
g suspension of the field-magnet frame of
for tramways. We understand from the
that, owing to peculiar legal arrange-
n will have to be again decided in other

am in 1870 and 1897.—One of the best
read before the American Society of
neers was presented by Mr. F. W. Dean,
in the cost of steam power between the
1897. This paper is briefly abstracted by
erican as follows: "The total decrease in
nearly 40 per cent. Seventeen per cent.
ted to the use of multiple-cylinder engines,
, higher steam pressure, and superheating
ɪ per cent. is due to the use of vertical
cent. to improved boilers, 7 per cent. to
l in heating the feed water, and 2 per cent.
is put down to the credit of improved construction of grates. Taking the best performance of the two periods named, the least consumption of steam per horse-power per hour in 1870 was 20lb., whereas the best for 1897 was 12½lb.

Royal Institution.—On Friday, the 11th inst., a lecture was delivered at the Royal Institution by Dr. J. H. Gladstone, on the "Metals used by the Great Nations of Antiquity," in which he traced the growth of the metal-working arts from the earliest periods of history. In connection with the occasion, a conversazione took place the same evening, which was well attended. At this a number of interesting samples of alloys and rare metals were on view, including aluminium from the British Aluminium Company, the well-known Atlas Anti-Friction Metal, Delta metal, and rare metals from the firm of Messrs. Johnson, Matthey and Co., including a specimen of uranium valued at £7,000.

A Fairy Electrician.—On the programme of Oscar Barrett's "Cinderella," now drawing to a close at the Garrick, is a fairy electrician, and as the song says, "she does her duty well." Electricity does much to enhance the brilliancy of the colours and changes in the dances and in the transformation scene. Cinderella contrives to dance in slippers bearing tiny incandescent lamps, and her chariot is dotted with a large number of the latter in all its outlines, wheels, etc., giving a very pretty effect. At the Empire the great quantity of electric light used is distributed amongst many lamps with variously tinted shades, thus softening the light to a remarkable extent. The Comedy is beautifully lit up, and the exceedingly natural moonlight scene in Mr. Hawtry's "One Summer's Day" shows what can be achieved with judicious use of this illuminant on the stage. At the Palace Theatre they rely so much upon the perfectness of their engines that they have not a single gas jet in the house.

Electro-Harmonic Society.—At the ladies' night concert on Friday evening next, Feb. 25, the following will be the programme:—Part I.: flute and pianoforte duet, "Sonata No. 5" (Handel), Mr. Frederic Griffiths and Mr. Alfred Izard; song, "Come, my beloved, come," Mr. Charles Chilley; new song, "The Dreamers," Miss Meredyth Elliott; pianoforte solo, "Wedding March," Op. 65 (Grieg), Mr. Alfred E. Izard; humorous recitation, "Our Revival," Mr. John Proctor; two gipsy songs (Dvorák), Miss Ethel Newcombe; flute solos, (*a*) "Le Cygne," (*b*) "Etude Sicilienne," Mr. Frederic Griffiths; humorous sketch, Mr. C. F. Frood. Part II.: Vocal duet, "It was a Lover and his Lass," Miss Ethel Newcombe and Mr. Charles Chilley; new song, "Trust and Believe," Miss Meredyth Elliott; humorous recitation, "The Roman Father," Mr. John Proctor; song, "The Garden by the Sea," Mr. Charles Chilley; piccolo solo, "Saltarello" (Edward German); song, "The Swallows," Miss Ethel Newcombe; humorous sketch, Mr. Charles F. Frood.

A Single-Rail Railway.—Mr. F. B. Behr informs us that the Belgian Government have named a commission composed of the following engineers in the service of the State railways: M. E. Gerard, engineer-in-chief and Chef du Cabinet of the Minister of Railways (president), M. A. Degraux and M. Flamasche, engineers-in-chief of the State railways, and M. Robert, engineer of the State railways (secretary), for the purpose of carrying out a series of experiments on Mr. Behr's lightning express railway constructed in the neighbourhood of Brussels. Mr. Behr informs us that in the event of the report of the commission being in every way satisfactory, the Government would permit the building of an important

line on his system. The experiments will begin towards the end of this month, and are expected to last about three months. It is desired that other Governments and important railway companies should send representatives to watch these trials, the commission being prepared to afford every facility for examining the work done.

Charges for Electricity.—The question arises as to what is the value of a system of electric light charges which is in operation as far as reduction goes to the great majority of consumers. The Brighton system, devised by Mr. Wright, is an excellent one, but some authorities in adopting it make modifications which practically nullify its use. This is done by extending the quantity of electrical energy which has to be taken before reduction is given in price. Thus, at Shoreditch the other day, Mr. H. E. Kershaw, the chairman of the Electric Light Committee, explained that, owing to the Vestry's success in generating electricity by steam obtained by means of the dust destructors, it was proposed to reduce the cost of the lighting from 6d. per unit the first two hours and 4d. other hours, to 6d. the first 2½ hours and 2d. succeeding hours, so that consumers can use light for, say, four hours a day at 4½d. a unit. The extra half-hour at the sixpenny rate nullifies the reduction to practically all the consumers. A reference to our "Question and Answers" column of the 4th inst. will be interesting in this respect.

Mean Horizontal Candle-Power. — The mean horizontal candle-power of an incandescent lamp is usually taken as the measure of the light emitted. This is perhaps the best measurement to take, but with certain of the new types of filaments will have to be replaced by the mean spherical candle-power. The mean horizontal candle-power can be obtained either by the laborious method of taking a large number of readings at different angles, or by spinning the lamp so as to obtain optically the mean candle-power. There have been doubts, though, on this spinning process as to whether it will give accurate results. Deformation of the filament due to centrifugal force would be the most likely cause of error, if any. Mr. C. P. Matthews contributes an article on the subject to the current number of the *Physical Review*. His experiments were carried out at the Purdue University, and show conclusively that no such error exists. Thus the whirling lamp gave a mean horizontal candle-power of 9·649, while the figures obtained by plotting the series of readings for different angles and integrating the curve was 9·655 c.p. This shows an error of ·06 per cent. only, which is very well within the limits of photometric accuracy.

Absurd Examinations.—We understand from the *Daily Mail* that the Transvaal Government have set up a standard of qualification for British mining agents and managers in the colony and will hold severe test examinations. It provides for a minute understanding of the Transvaal law, which is not easily available to the student, as well as a recondite knowledge of geology and an unsuspected theory of the origin and character of electricity. Failure in either one of these abstruse questions, although the candidate may be otherwise efficient in mining knowledge, constitutes a disability of which the penalty is as follows: Without a certificate of competency from the Transvaal Department of State Mines, no manager shall be suffered to retain his present employment, and any company so retaining an uncertificated manager shall be liable to have its mine "shut down" by Boer authority. What the origin and character of electricity have to do with mining no one knows, but we are sure that those managers would find no difficulty in answering questions as to the applicability of electric transmission of power to mining. The chief fault, however, arises in trying to discriminate between efficient and inefficient me[illegible] examination, and, worse still, in the consequent interfe[illegible] with the freedom of men to conduct their own busin[illegible] on their own lines.

Boilers.—The disastrous effects of many boiler e[illegible] sions make us more ready to notice any sets of rules l[illegible] to prevent such explosions occurring. In matters of [illegible] kind, reiteration of well-known facts cannot be carried [illegible] far. From the concise sheet of advice lately issued by [illegible] Manchester Steam Users' Association we note partic[illegible] the following as specially suitable for electric light sta[illegible] As regards raising steam it should be noted that su[illegible] changes of temperature may produce fractures or [illegible] leakages, therefore never raise steam hurriedly. The [illegible] and bottom of a boiler should grow warm together [illegible] convenient, fill the boiler with warm water through [illegible] economiser. If the boiler water is cold, allow fully [illegible] hours for raising steam. If pressed for time, fill the b[illegible] to the top of the water-gauge, fire slowly, and keep [illegible] safety valve open until steam blows off freely. [illegible] closing the safety valve blow out the bottom cold [illegible] till the working level is reached, and then the pressure [illegible] be raised more quickly. In the case of low water, du[illegible] faulty feeding, the fireman is advised to ease the s[illegible] valve so as to cause priming. The violent froth r[illegible] when this is done cools the exposed plates and sti[illegible] them. After this the feed can be resumed. It is na[illegible] stated at the end that when the furnaces are collap[illegible] due to low water, etc., the boiler attendant may pref[illegible] retire. We see no advice as to what should be done to [illegible] fireman who mistakes a full gauge-glass for an e[illegible] one, and fills the boiler and steam pipes with wat[illegible] consequence.

Incandescent Lamp Efficiency.—Mr. John [illegible] Randall read a paper on the present efficiency of in[illegible] descent lamps before the North-Western Electrical As[illegible] tion last month. He rightly lays special stress on [illegible] uniformity of the carbon filament. His argument i[illegible] follows: The quality of the filament is determined by [illegible] thread. The process of squirting threads is controllab[illegible] proper skill, experience, and appliances are employed. [illegible] the weather is more controllable than is the quality o[illegible] product when any of these requisites are lacking. [illegible] easier to shave down strips of bamboo to a uniform si[illegible] to weave braids of silk fibres that will appear to be [illegible] than it is to squirt a cellulose thread of uniform diam[illegible] but the bamboo strips and the silk braid will no[illegible] uniform in weight. They cannot, therefore, make uni[illegible] carbons. It is often supposed that the coating of ca[illegible] applied in treating the filaments fills up the pores [illegible] depressions, thereby correcting the defects due to irr[illegible] larities in texture and surface. This is not true. A [illegible] base carbon cannot make a good lamp. When one fila[illegible] is found to be better than another, its superiority ca[illegible] attributed to the base carbon. The author then pro[illegible] to give tests and figures, and winds up with the follo[illegible] characteristic remarks: There is still one condition [illegible] fulfilled in order that incandescent lighting may be [illegible] profitable—the voltage at the lamps must be [illegible] everlastingly and unceasingly steady. There has [illegible] improvement, but much more is possible and desir[illegible] Everything about lighting service is improved w[illegible] regulation is improved, even the customer's temper.

The By-Products of Electric Traction.—[illegible] American contemporary *Electricity* gives some amu[illegible] extracts tending to show a supposed additional sourc[illegible] electricity in St. Louis. To quote details: "Mr. Geo[illegible] Durant, manager of the Bell Telephone Company of [illegible] Louis, has ascertained that the ground under that

ted with electricity. The installation of the Bell
ione Company's new metallic system is said to have
the discovery, owing to a number of small signal
failing to work. A careful investigation was made,
vain, and as a last resort ground currents were
ht of. A voltmeter installed at a relay station showed
an escape current from the street car tracks was
ling along under the earth and entering the wires of
elephone company. This escape current was appa-
acting in opposition to that supplied from the com-
batteries, and neutralising the latter. Careful
evealed the fact that the waste current was 10 volts
er than that generated by the company's batteries." The
in question can see no reason why the current could
used to drive motors and dynamos in the same way.
actual current as it comes from the earth were not
nt, it could first be gathered into storage batteries
us intensified. The current can be handled exactly
were generated by a dynamo. A local paper, having
iewed Mr. Durant, writes under the impression that
citizens will have to do will be to drive a wire into
ound in their back yards and light their houses by
city. The facts discovered are a disgrace to the
ay company and St. Louis, and will result in endless
to the gas and water mains.

mways and their Municipalisation.—Sir
Leech read a paper recently on the above subject
the Statistical Society of Manchester. After a brief
of various systems of traction for tramways, the
turned to the question of municipalisation. He
ded that the leasehold system was calculated to
t improvement, blunt enterprise, and practically
monopoly. That was a great cause of the cry for
palisation of tramways. It was urged that if there
be a monopoly it should be in the hands of a
ation, who held it in trust for the benefit of the
. A corporation, he said, could borrow money at a
r rate, thus enabling a much better and cheaper
; could afford to treat its employés better as to
of service, and could at all times avail itself of every
rement. There was no halting place between
ipalisation and monopoly. Experience had made
Leech draw a line between ordinary trading
nies, where competition would soon rectify heavy
s or abuses, and companies protected by parlia-
ry powers, and which practically became monopolies
e the law would allow no opposition on the same
Among the latter he included railways, gas, water,
ones, tramways, markets, electricity, etc. The
cts of these were vital to the welfare and prosperity
ity, and he held it was the duty of every corporation
ter and protect the interests of its citizens. Another
t reason for municipalisation was that a corporation
the capital and the desire to keep pace with changed
rements and improvements. The author proceeded
vocate the municipalisation of the Manchester trams.

e Resistance of Thin Metallic Films.—Miss
Stone contributes to the *Physical Review* a thorough
xhaustive treatise on the resistance of thin films.
points out the discrepancy between the resistance
film of given thickness measured directly by the
tstone bridge as compared with the resistance calcu-
from its weight, density, and dimensions. As shown
bles and curves, the calculated resistance is but a
fraction of the initial resistance of the film, when
red directly. The process of experimenting, how-
revealed the fact that the initial resistance was not
t, but decreased with time, reaching its lowest
only after an infinite time. Films have not been preserved for longer intervals than three or four months; but the values of the resistance at the end of this length of time, while only approximately constant, nevertheless compare very favourably with the calculated values for the same thickness. From a series of experiments, of which dates are given, the authoress concludes as follows: "Heat accelerates the time effect. The greater the age of the film, the less the effect produced on it by heat. In general, the longer the heat is applied, the greater the fall in the resistance. A certain period of heating reduces the resistance of each film to its lowest value. This period of heating, necessary to produce the minimum resistance, is greater, the greater the initial value of the film. After the minimum value of the resistance is reached, further heating has no effect upon the film. When not reduced to its minimum resistance by heat, the film continues to decrease with time in the ordinary manner. When the lowest value of the resistance is produced by heating, there seems to be a certain increase in the resistance, when measured after a number of hours. In general, then, the decrease of resistance with time is caused by a gradual settling down of the silver molecules into a more and more compact mass. Heat accelerates this action, bringing in a few minutes the film into that condition which time acting alone accomplishes only after months. Preliminary experiments indicate that electric currents and shocks produce a similar effect upon a film as that produced by heat."

Mica Mining in Bengal.—The *Indian and Eastern Engineer* publishes an interesting article on the mica mining industry in Bengal. The Hazaribagh and Gya districts, where the produce is very plentifully distributed, does not present a happy prospect to the easy-going man. Owing to the lack of a railway system the nearest mines are from 35 to 70 miles from the nearest railway route, and this is in itself a disadvantage which has to be reckoned with. The whole of the soil simply bristles with mica and schist. Here the miner commences operations. Not much time is lost in discovering a "phook" or vent, or, perhaps, a small outcrop in quartz, which attracts attention, and in an hour or two hours the chiselmen are a few feet down, taking up small refuse mica, and come upon what appear to be "leaders" to a vein of mica. A defined vein once found is followed up carefully. These are generally only a few feet in thickness and run in a very ill-defined course, winding in and out and dipping downwards and sideways, as the case may be. All along a rich vein the mica is to be found embedded in the rock, which has, when very hard, to be blasted with powder, or dynamite when water occurs. The harder rocks having been removed, the chiselmen, who work in pairs, carve out the mica, which is found in "books." The best mica is found in rock, where it is clear owing to its encasement and protection against percolation and earthy movements. Where found in the softer soils its substance is weak, and its transparency sometimes partially or wholly destroyed by interlaminar inclusion or infiltrations of other mineral substances. The prices of mica vary according to its size and transparency, £100 per maund having been obtained for the larger sheets of 36 square inch and upwards.

Electric Sparks in Coal Mines.—We gather from the *Trade Journal Review* that Messrs. Siemens and Halske, of Berlin, and a committee representing the Westphalian collieries have been carrying out another series of tests on the danger which electric sparks from any electric apparatus to be used down in coal mines might introduce. The tests were conducted in the experimental gallery of the Consolidation Colliery at Gelsenkirchen, near Heise and Thiem. The experiments lead to the following conclusions: When the bulbs of incandescent lamps are broken, explosion may ensue at times. The carbon filaments do not always break

on such occasions; they are first cooled, then brighten up again. If a lamp is broken or damaged when not alight, and switched in after it has become charged with gaseous air, an explosion will not take place; but if such a lamp be then smashed, there will be ignition. On the whole, it may be said that high-voltage lamps (not above 150 volts, though) taking from 0·5 to 0·6 ampere are safe; stout, short filaments are not to be recommended. The bulbs should be of stout glass, so that the filament is sure to be smashed simultaneously with the bulb, and the platinum leads should not project much, less there be short-circuit between them. Illumination by properly protected incandescent lamps seems safer than any other illumination. Hot resistances are safe as such, but the different wire spirals may come into contact, and arc. Cut-outs, etc., fuses, switches, and electric motors should all be encased. Small electric motors are worse than large-sized ones, as they spark more readily. Polyphase motors, with closed-coil armatures, and even with contact rings and brushes for starting, are safe. Continuous-current motors should be enclosed in proper wire-gauze cages.

As Others See Us.—The following extract from the *Street Railway Journal* is interesting reading beside our report of the resumed discussion on Mr. Dawson's paper: "In the discussion of Philip Dawson's paper on 'Electric Traction' before the (London) Institution of Electric Engineers, one of the speakers is reported to have denounced with vigour and point 'American hap-hazard methods. Their standards are no standards at all; they go full speed ahead and then have to go astern.' There is possibly some basis for this criticism. Nearly the entire burden of experimentation in electric traction has fallen upon America, and it is inevitable that there should have been much duplication of plant in the progress of an industry from birth to what we might call now, perhaps, middle age. Nevertheless, there is one element in the case which is too frequently overlooked by the more conservative engineers and tramway managers both here and abroad, and that is that the pioneers in the industry who have gone ahead courageously, and put in the best apparatus known at the time, have frequently made enough money by doing so to purchase more improved apparatus as it has come out. This is true not only where there has been competition, and where the lines equipped with the better motive power have gained traffic at the expense of their more conservative competitors, but also in cities where there has been no competition, for the development of the 'riding habit' in American municipalities through the introduction of electric traction has been one of the marvels of the American financial world. Sooner or later this feature will, of course, be understood more generally abroad, but meanwhile 'conservatism' will, no doubt, plume itself upon its wisdom, while somewhat forgetful of certain advantages of 'progressiveness.'"

Acetylene.—The *Journal of Acetylene* says of an extract from *Engineering*: "Engineers quite commonly estimate the calorific value of a fuel from its chemical composition; and, speaking generally, the figures thus obtained are accurate within quite a small percentage. Exceptions, however, do occur, and acetylene is one of them. Its chemical composition is given by the formula C_2H_2, so that 13lb. of the gas consist of 12lb. of carbon and 1lb. of hydrogen. Now, 12lb. of carbon burnt to carbonic acid gas will give 174,600 British thermal units, and 1lb. of hydrogen, burnt to H_2O, will liberate 61,560 British thermal units, making a total of 236,160 units. Actual experiment, however, shows the heat set free on the complete combustion of acetylene to be much greater—viz., 281,250 heat units, or nearly one-fifth more than that
calculated from its chemical composition. Similarl
found that the actual heat of combustion of cyanogen
is nearly one-third more than that calculated fr
carbon content. The explanation of the discrepanc
course, to be found in the fact that a large quant
energy is absorbed in the production of these comp
which is liberated in the form of heat on burning
It is this fact which renders compressed acetyle
dangerous an explosive, as, quite apart from any qu
of combustion, there is a large store of energy availa
destructive purposes by the mere decomposition
body into its elements. Some French experiments, i
showed the explosive energy of liquefied acetylene
comparable to that of dynamite. It should, howe
the same time be stated that at pressures not exc
two atmospheres it was found impossible to produ
explosive decomposition of the gas, which, under suc
ditions, is as safe as lighting gas. It is interesting t
that many food stuffs, such as starch and sugar, exhib
same peculiarity as acetylene, their heat of comb
being greater than that estimated from their ch
composition.

The Consulting Engineer.—Mr. S. Dana G
read a paper before the New York Electrical Socie
the 12th of last month on the relations betwee
consumer, consulting engineer, and the electrical
facturer. He stated his opinion that the manufactur
electrical apparatus, and the companies or firms usin
apparatus, are dependent upon each other to a large e
and their relations should be close and friendly.
considered that the consulting engineer is a necessar
proper connecting link between the two. He state
functions of the consulting engineer were to see tha
client selects the system best suited to his local condi
that he buys the best apparatus for working that sy
and that in purchasing he gets good value for his m
The common sense of Mr. Greene's statements is be
dispute, but the large manufacturers in America do
care to be supervised in this way. Their object ap
to be rather to part with as many standard se
apparatus as possible and to let the purchaser adapt
to the unsuitable local conditions as best he may.
Greene's paper contains much useful matter which sh
redress the above fault, and not a few neatly po
ancedotes. The following is an example of these:
was less than a dozen years ago that the first fire
switchboard was installed in the Broadway Theatre.
specifications were drawn up by a consulting enginee
naval officer by the way—calling for a fireproof struc
and the manufacturer no doubt accepted the
thinking that he could use what had always been
before—viz., a wooden framework. In this he
mistaken, however, and after a year's wrangling a
board was installed, much to the manufacturer's dis
and at great expense to him. It is hardly necessa
say that this form of switchboard became sta
immediately, and several years after, the manufac
happening to meet the naval officer, said to him: "Som
was a d——d fool about that switchboard, and you
not the man."

Accumulator Traction.—The real commercial
of accumulator traction is the time test, together
the financial balance sheet. Still, efficiency trials a
interest, and those for the Englewood and Chicago acc
lator cars in America are to hand. This line has be
operation since June 20, 1897, running from 9 to 20 ca
about 12 miles of track. The complete tests of the effici
of the various parts of the equipment have been made
Mr. G. Herbert Condict, the tests being in charge of

A. Damon, assisted by Prof. T. P. Gaylord and a students from the Armour Institute. We notice illans engines are used to drive the Walker rs in the station. The cars are provided with battery boxes or trays with brass contacts, the eing hung from the truck frame between the axles. ries 72 cells in hard rubber jars, each fitted with oride negative plates and four Tudor positive plates, eries being connected up in four groups of 18 cells e terminals of which run to the controllers. The of the batteries and tray is 7,800lb., and the capacity peres at 145 volts. The trays are removed to the g table by a motor-driven derrick on a truck in the car-house pit. The batteries were supplied Electric Storage Battery Company, of Philadelphia. lowing figures obtained from the test are of interest. am pressure was 170lb. On a seven-hour trial the vaporated per pound of combustible from and at was 8·22lb., the percentage of the total calorific of the fuel utilised being 62·86. The indicated power varied from a maximum of 246 to a minimum the pounds of dry steam per indicated horse-power ing 18. The ratio of the electrical horse-power of the dynamo to the indicated horse-power of the was 79·3 per cent. The total station efficiency d pile to switchboard was 5·58 per cent. The tests atteries showed a charge of 36·757 kilowatt-hours, by a discharge of 19·715 kilowatt-hours and a harge of 31·631, giving an apparent efficiency of a der 60 per cent., it being difficult to obtain a more ure without a long series of charges and discharges, to the impossibility of determining the exact n of the battery at any time. The tests showed car used 1·41 kilowatt-hours per car mile at the g table, and ·87 kilowatt-hour per car mile at the giving about 10lb. of coal per car mile. Finally, told that the batteries have operated from 8,000 to miles and are standing the service remarkably well.

t Waves.—In a recent issue, we referred to some ents of Mr. Howard Swan on the interrelation of and light waves. The ideas then expressed seem been corroborated independently by American enters. Early in January last Mr. Swan gave an on the subject at the conference of the Society of s, from which address we take the following para thinking that it is best to give the author's own han to summarise what he says. Thus Mr. Swan "If in the dark you try to imagine some scene you erved, it can be brought before the vision as if it esent: often it comes and is soon succeeded by By a strong effort of will it can be kept, the light right, and the scene kept there for some moments. ocess needs somewhat of an effort, and evidently energy, as it is fatiguing. Now, as one can imagine ill close at hand or miles away, that same picture dently be pushed back in the imagination, as it were, er far away and much smaller: then still smaller: r distant and tiny: and eventually made to disappear. is then left is, or seems to be, a perfect blank, me and space, with no thought or scene present; and ckness, too, can be kept for some time with some f will. (It must be understood that sufficient control ight and will may only occur after some weeks of e in keeping the attention fixed in any direction l.) If the observer is in fair health and spirits—that fatigued, ill, worried, or depressed—then, in the t will be seen that this space is not perfectly blank, te black, but that various faint sheets of delicate lescent lights are being seen, perhaps with specks, spots, or spangles, often slowly in movement. It is these faint appearances of light that are in question in the investigation—the sensation of light within the brain. Scientific men attribute this dim appearance of light to the mechanical effect of the circulation of the blood, either within the eyelids or at the back of the eye on the retina; but there seems to be another and much more interesting and important cause—namely, the effect of the movement in the eyeball or optic nerve of the nervous force of the brain itself. . . . . Next, as regards electricity. This is regarded as the effect of a quiver or waving of this same ether, of much longer (sometimes shorter) wave-lengths, and therefore electric and magnetic waves are of the same nature as these of light; but the electric waves are noticed by other means: heat, light, attraction, and vibration of various material substances, and the quiverings of the human nerves, etc. Faraday showed how to produce electricity from magnetism by waving a closed coil of wire near a magnet, and the modern dynamo is little else but these coils, waved or rotated by means of a steam-engine. Now it was found that when these waves of electricity were sufficiently strong they would heat wires and so create light; that they would heat or destroy nerves and so kill a man. Tesla's great discovery was that if they were vibrated tens of thousands of times more rapidly still, they had not time (so to speak) to affect the nerves, and would be conducted at enormous pressures, if vibrated or quivered sufficiently rapidly, harmlessly through the human body. In the adjoining hotel, the Savoy, he explained this one evening to the present writer a few years ago, and related how he had worked out his theory mathematically and found it true, had made the machines, and then hesitated for two hours before risking his life on the experiment! Every scientific man knows now that his reasoning and calculations were accurate, that he was not killed, but that the current or vibration passed through his body and lighted lamp which he touched with the other hand with his finger. . . . When a scene is actually imagined, as in writing the account of a journey or of a scene, one has actual views kindred to those aroused by what is technically known as 'programme music'—that is, music supposed to describe the sun rising, the larks twittering, and the blacksmith blowing his bellows or clanging his anvil, etc. To picture scenes in this way for long vividly, uses up energy; and much of it, long continued, tends to weary the brain power by exhausting the light-forming power within. But when no scene is presented and emotion alone is felt, the process is not exhausting, but, on the contrary, exhilarating and elevating: the mind is stirred, harmonised, arranged, and the listener arises from hearing a beautiful piece of harmony strengthened in his soul and will. Is there any explanation of this effect? Can it be produced at will? Can musical emotion be imparted or developed by outward means? How far can this power be consciously employed? Does it follow laws which, if far higher than those of physical light, are yet capable of study and observation? These are the questions which arise in the mind in consideration of the foregoing facts. The present investigation is a first rough attempt to point out the possibility of an answer to these important and deep-searching questions." We have space only for one more paragraph: "It seems evident from this, therefore, that a succession of words moving all in the same direction would constantly send the nervous energy of the listener in one direction, and so in a certain time influence the brain and will-power of the individual. When musical tone is combined with that of the word in the living voice, with the spirit or soul-effect of the human will behind it, the influence will be still more powerful."

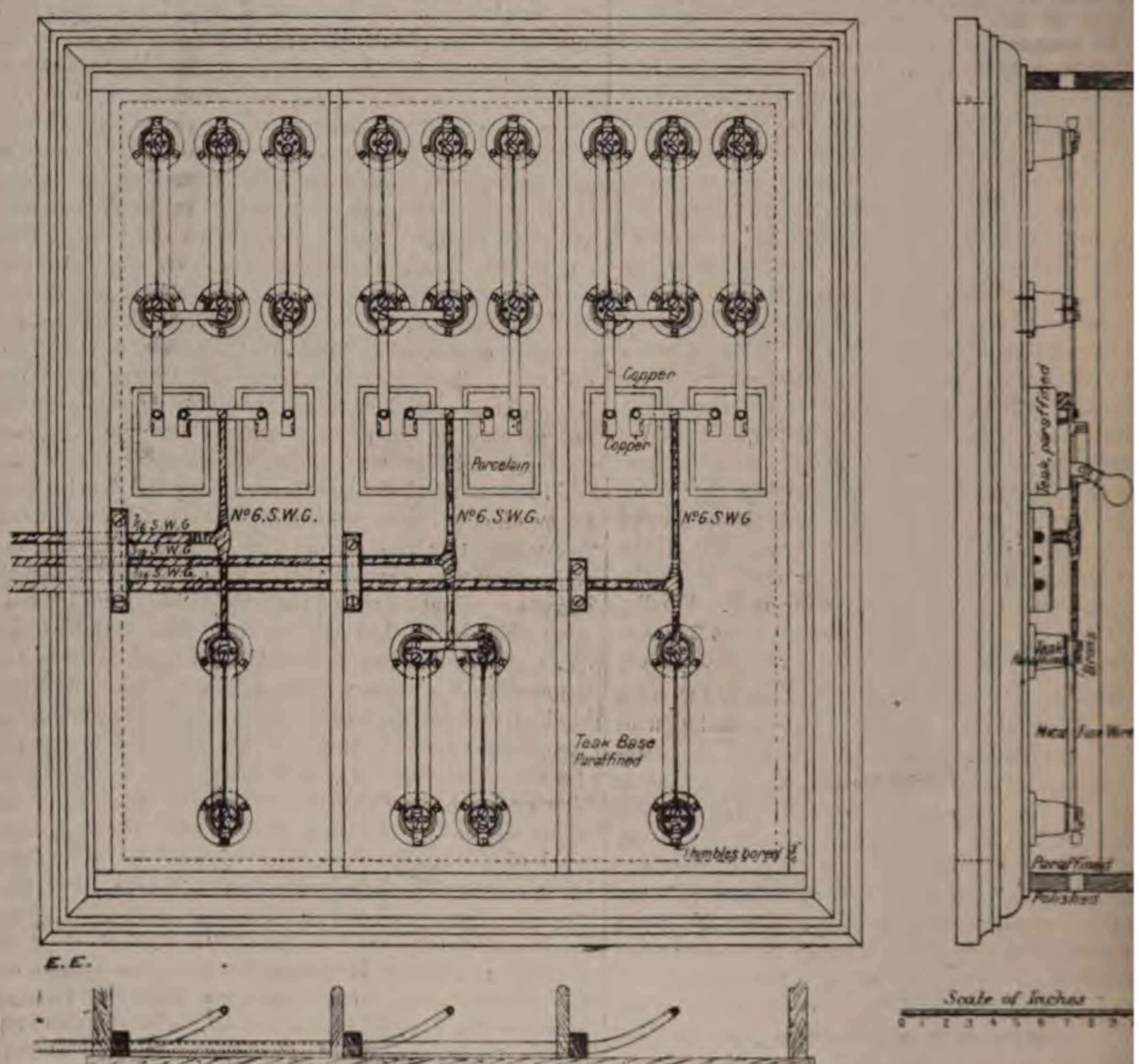
THE GLASGOW DISTRICT SUBWAY.

(Continued from page 173.)

The General Lighting of Power-House and Stations.

As previously mentioned, there are 15 passenger stations which had to be suitably lighted. These stations are generally of two kinds: (1) those that, with the passages leading to them, are entirely underground, and so need lighting all day long; and (2) those that are to a greater or less extent open to daylight, and so only require partially lighting during the daytime.

The general system of lighting is more or less the same in all the stations, and typical arrangements are shown in the illustration, St. Enoch Station being a good example of a



Glasgow District Subway—Typical Station Switchboard (Hillhead).

station that has a certain amount of daylight available, and St. George's Cross an example of an entirely underground station. The lights are arranged on separate circuits, all controlled from the main distributing board. This main distributing board is placed, as a rule, at the staircase end of the platform, and the three cables from the main junction box directly enter this.

On referring to the drawing of the station switchboard it will be noticed that each of the three wires splits into three circuits, two of which are fitted with switches, and are for the "day" and "night" lighting circuits, while the third circuit, without any switch, is for the signal lights. The dampness at first gave considerable trouble both with the wiring and also with the switchboards, and these latter were finally approved in the design shown. Special care has been taken to thoroughly insulate all the parts, and all the fittings are mounted upon paraffined teak, as a film of moisture cannot readily form on this

material when so treated; all the terminals, mounted on turned teak pedestals well paraffined. switches and fittings were made by the Edison-Sw pany. Various methods of running the wires we and the most satisfactory plan has been found carry them on small insulators overhead, fixed to of the stations; this is, perhaps, not of quite suc appearance as if they had been covered in, b installation of this kind it is of paramount impo secure the most trustworthy system. In some of stations, wood casing is still used to a considerabl however. The lights are arranged along the centr platforms in pairs of two together under an enamelled iron shade, and each lamp of every pair off opposite sides of the middle wire. The pas mostly lighted with single lamps, and suital

are arranged in the pay boxes, etc. The platfor are of 32 c.p. each, and the others are 16 c.p. Outside each station are two Brockie lamps on ornamental cast-iron brackets, which show plainly the entrance to the stations; wh stations, however, happen to be just off any of t thoroughfares a signal pillar is erected in the ma and two arc lamps are also hung from this, and globes, being so close together, forms a distinctive in the perspective of the street, and greatly facili finding of the stations to a stranger. Both the brackets and these signal pillars were made by Walter MacFarlane and Co., of the Saracen Glasgow. Outside St. Enoch's Station, however, two highly ornamental wrought-iron brackets, wh designed by the architect of the station itself. station a pair of wires are led directly from the swi to the signal lamps. The power station is well li

ome dozen Brockie-Pell arc lamps, and there are of 50-c.p. incandescent lamps arranged on brackets walls. The arcs in the power station are arranged ff the 440-volt mains. The wiring in the power run in wooden casing. There are also some arc the boiler-house, yard, and tension run. Incan-mps of various powers are fitted where necessary t the offices and engineer's dwelling-house; able culverts, etc., of course, being specially ed. At the cable cross-over both tunnels are r some 100 to 200 yards with 50-c.p. lamps on ttached to the sides of the tunnel. The power vitchboard is placed close alongside the main rd.

shed is also well lighted by both arc lamps and nts, and there are also a large number of plug s fitted for using hand-lamps in examining the gear of the cars, etc. It might be mentioned he connections at the various stations are of size to carry double the number of lamps, and it

Glasgow District Subway—St. Enoch Station, showing the Lamps.

ctors' idea to supply current to all their tenants p rate. This should be a good source of income npany.

(To be continued.)

S ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

[*Copyright.*]

LXXVII.

modification of the Marchenay process carried out Laurent-Cély, the fused mixture of lead and zinc is cast in the form of small buttons with rounded , when cool, are washed to remove the chloride d are thus rendered more or less porous. The tended for the manufacture of spongy-lead plates ted in this condition—viz., as porous lead ;—but those intended for peroxide plates are first spongy lead, and are then converted into oxide y heating them in contact with air. In either buttons are arranged in a mould so constructed a molten alloy of lead and antimony to be cast of a frame or grid enveloping the edges of of active material, according to the method patented in 1886, No. 10,502, by the present Sir Edward Frankland. The chloride buttons were afterwards reduced to spongy lead, and the oxidised buttons were converted into peroxide of lead. The Société pour le Travail Electrique des Métaux, created under the auspices of Messrs. de Rothschild, were the original owners of the Laurent-Cély patents for the manufacture of chloride of lead accumulators, which have been worked in this country by the Chloride Electrical Storage Syndicate, Limited.

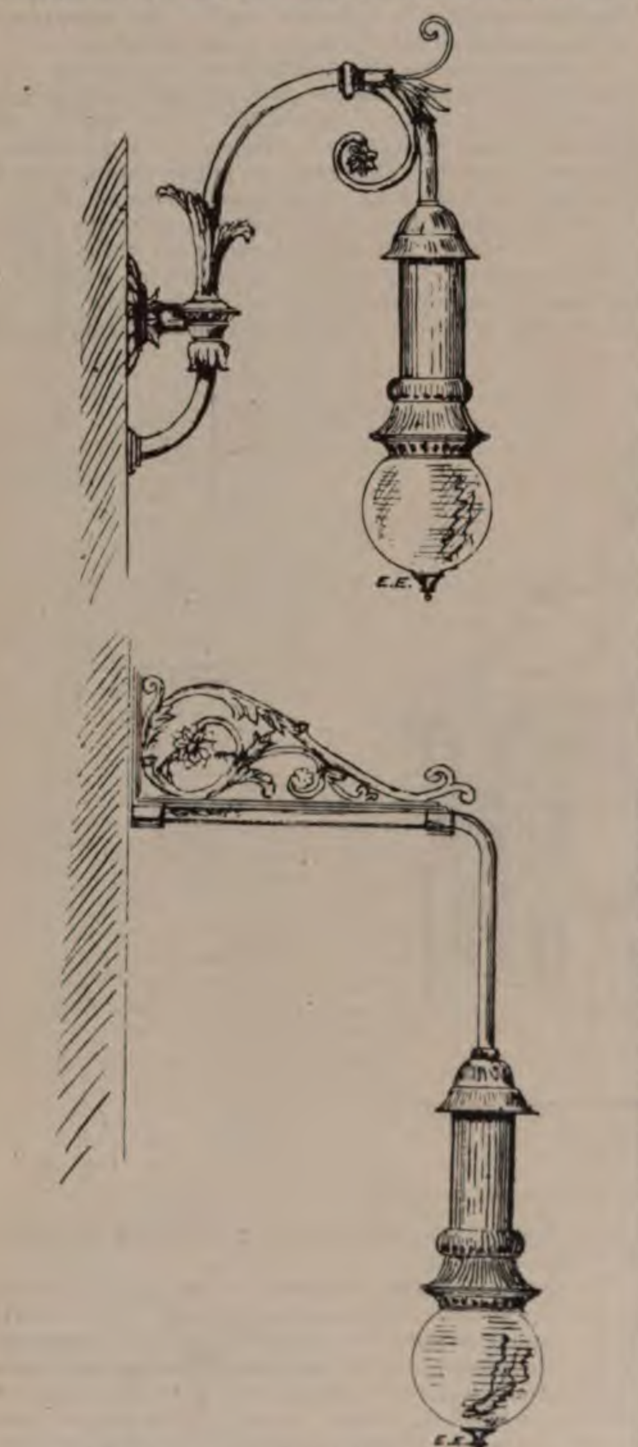
In 1893 the Société des Accumulateurs Electriques (the French Faure-Sellon-Volckmar, or E.P.S. Company, formed in 1889, with a capital of 1,100,000f.) were carrying on legal proceedings against all manufacturers of lead secondary batteries in France. They obtained judgments with heavy damages against the firms of Gadot and Rousseau. But the French Chloride of Lead Battery Company, having a long purse, compromised matters by the payment to the French E.P.S. Company of 1,350,000f., in return for which sum the latter company transferred all their assets to the Société pour le Travail Electrique des Métaux, and, by the vote of their shareholders at their last meeting in September, 1893, was wound up.

The first authoritative statement as to the constitution of the English Chloride Syndicate, registered Dec. 12, 1891, with a capital of £262,500, including 12,500 £1 founders' shares, was made in the following words at the conclusion of Mr. Herbert Lloyd's paper read before the Franklin Institute in October, 1893: "A company has recently been formed in England for manufacturing these (chloride) cells, which have just completed works near Manchester, capable of a very large output. That company is controlled by Messrs. Mather and Platt, probably one of the largest electrical engineers in Great Britain, and the business is to be managed by Dr. Hopkinson. Under such management there can be but very little doubt about the success of the business."

LXXVIII.

Possessed of every other requirement for success, the Chloride Electrical Storage Syndicate would appear from the commencement to have laboured under the disadvantage of being unacquainted with any chemist or electro-chemist who could have given them practical advice in regard to such points as the preparation of lead chloride or the character of the active material obtained by the peroxidation of spongy lead in a more or less oxidised condition. Lead chloride ($PbCl_2$) is soluble in 135 times its weight of

water at 54·5deg. F. (12·5deg. C.) and in 33 times its weight of boiling water. When the hot solution is allowed to cool, the salt is deposited in long acicular crystals, a circumstance which renders it easy, when necessary, to obtain this chloride in a condition of purity. On a large scale it is most economically prepared by boiling the principal ore of lead, *galena* (PbS), with hydrochloric acid



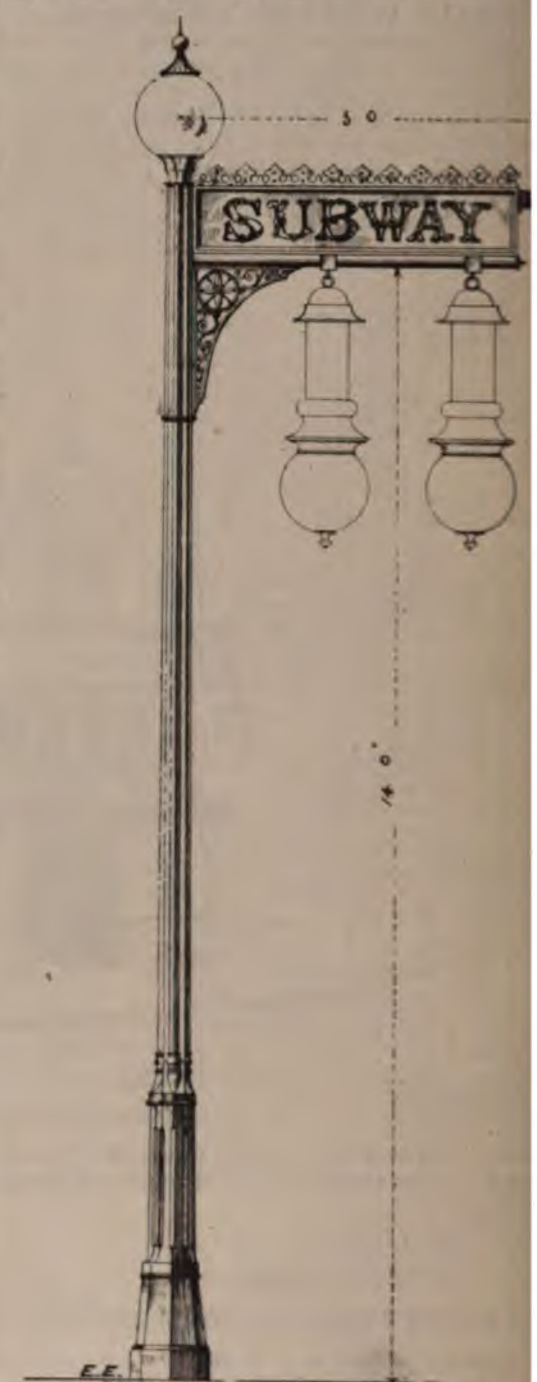
Glasgow District Subway—Types of Arc Lamp Brackets used outside the Passenger Stations.

(HCl). Sulphide of hydrogen, which can be utilised in various ways, is evolved according to the equation :

$$PbS + 2HCl = PbCl_2 + H_2S.$$

Being freely soluble in hot, strong, hydrochloric acid, and deposited therefrom when the acid cools, the chloride is easily obtained by this process in a state of purity. The deposited needles may be washed with cold water; but, since the salt is slightly soluble, long-continued washing is, of course, to be avoided; nor is it at all necessary when the salt is to be subjected to fusion. Another method is to digest litharge, with heat, in excess of hydrochloric acid; the latter being finally run off, with impurities in solution, and the white salt being washed with water. The resulting product is sufficiently pure for most purposes, if and acid have been carefully selected; but, by m circulatory apparatus, causing hot water to pas the salt, and subsequently to deposit crystals bef reheated, perfectly pure chloride may be obtained

In regard to the physical character of peroxid obtained from any known form of spongy lead (from a "set" compound of oxide and sulpha metal) it is now known that, unless such pe subjected to a special process of consolidation, it



Glasgow District Subway—Signal Arc Lamp Pillar

coherence and adherence renders it altogether ina for the purpose in view. It may be doubtful eight or ten years ago, a definite knowledge inapplicability of this form of peroxide, to say no the means of remedying it, was possessed by any chemist; but it seems incredible that, if a compe had been consulted and invited to make tests, b have allowed a battery to be put forward, with flourish of trumpets, as superior to every exist when the more important of its two elements was, defective.

LXXIX.

From Mr. H. Lloyd's paper above referred to, it that the different processes in the manufactur

of the Chloride Electrical Storage Syndicate were ws:

ub-dividing metallic lead by passing it in its molten ito a jet of dry steam.

issolving the finely-divided lead in dilute nitric acid a nitrate of lead, with production of nitrous acid) and some nitric oxide (NO).

dding hydrochloric acid to the solution of nitrate of precipitate chloride of lead.

fter mixing the chloride of lead with chloride of sting the buttons or tablets.

niting a number of these to form a plate by casting plate round them.

educing the buttons to metallic lead by placing them lution of chloride of zinc and using zinc plates as . The time occupied in this operation was from 14 hours, and considerably more than one equivalent : was consumed for each equivalent of lead reduced.

Vashing the plates in running water to remove le of zinc.

etting up the plates as cathodes in dilute sulphuric sing plain lead plates as anodes, and passing through ites a strong current during several hours to ensure mplete removal of chlorine.

'Forming" the plates in which spongy lead is to be ted into peroxide, using plain lead plates as negatives. operation is continued during several weeks. (It be preceded by the oxidation of the active material)

Charging and discharging the cells several times hey obtain the normal capacity.

a set-off against this complication of processes, it was d, and with some reason as regards the spongy-lead it, that greater uniformity in the porosity of the was obtained than in the ordinary red-lead or litharge g process. The available charge capacity of a plate ndent, within certain limits, on such porosity. But be shown that an equally good result may be obtained "dry-filling" process referred to in Section LXXV. use of metallic lead for obtaining the chloride has, ve, been long discontinued, and the peroxide plate actured by the Syndicate at Clifton Junction is now of the Planté type. The chloride is obtained by ssolving litharge in acetic acid, and then adding hydro- acid to the clear acetate solution. This is no doubt improvement, economically, on the original process; e use of acetic acid is both inconvenient and unneces- Great endeavours have been made to perfect the ide element, by inserting within the apertures of a roll of lead-foil suitably corrugated to allow of the ation of the electrolyte. It should be mentioned that stem of casting the antimonial lead framing under are is due to Mr. H. Lloyd.

e name of M. Clement Payen has been closely con- d with the invention of the "Chloride" accumulator; gentleman having indeed been awarded the John Scott y Premium and Medal, on that account, by the Com- e on Science and the Arts of the Franklin Institute. ve not, however, been able to ascertain the precise e of the invention arrived at by M. Payen. No a great inventor was required for so great an inven- and poor Mons. Marchenay hardly fitted the character. he holder of the great Scott Premium was in every orthy. "Money is a good soldier, sir, and will on!"

LXXX.

n elaborate pamphlet issued by the Chloride Electrical e Syndicate in April, 1894, the results obtained on ris and St. Denis electric tramway are referred to in tory sense. But the following reluctant admissions committee appointed by the Association Amicale des urs-Electriciens may, I think, be taken as a con- ion of the Laurent-Cély chloride battery in its tion to traction work: "The negative plates of ccumulators have exhibited great durability, having for over 150,000 car kilometres. The positive de) plates, on the contrary, became more quickly rated; the peroxide soon fell out, leaving a useless pport. To avoid this serious defect, the Society for tric Working of Metals have since adopted a new form of frame, similar to the old Faure model; it is formed of an unperforated plate, on which are cast slightly-inclined channels. By these the peroxide is retained for a longer period, and they can be repasted with great facility."*

On the other hand, some of the tests made with cells manufactured at Clifton Junction by the British Chloride Syndicate show results which, taken comparatively, are by no means unfavourable. This will be seen from the following table, compiled from my own notes. The "Chloride" cell mentioned was very solidly constructed, and evidently intended for long-continued use:

Designation of accumulator.		Safe rate of discharge (? maximum). Amperes. / Gross weight in lb.		Specific capacity. Ampere-hours. / Gross weight in lb.
E.P.S.	L. 23	·193	....	2·14
	T. 11	·66	....	2·2
	K. (cells lead lined).	·35	....	1·17
Epstein (Prof. Ayrton's tests).		1 (nearly)	....	2 (nearly)
Elieson's "Lamina"	A. 9...	·56	....	3·09
	C. 5...	·9	....	3·5
Chloride "T B." 17 (3 hours).		·87 (? ·98)	....	2·9
Ditto L. Cély (Sarcia's values)...		·58	....	3·77
E.P.S. "Afluidic" modification (Sept., 1896, 3 hours)...		1·11	....	3·36
I.E.S. (March, 1897)	9 hours...	·71	....	6·4
	3 ,, ...	1·52	....	4·57
E.P.S. (Faure-Tommasi)	1·86 hours ...	1·07	....	2*
	5 ,, ...	·9	....	4·5†
	8 ,, ...	·35	....	2·8*

* Bushbury car trial. † Price-list.

LXXXI.

In the above table the results obtained with an "afluidic" or so-called "dry" form of cell are noted. It may some day be regarded as very curious that these results should not have attracted more attention; for, according to them, not only is the safe rate of discharge, but also the capacity of a given accumulator greatly augmented. The latter effect appears somewhat incredible, and may perhaps be explained away; still, I cannot disregard experimental values on this hypothesis. The neglect of such results—unless extended publicity be obtained for them by various means—on the part of electrical engineers appears the more extraordinary when, as in the present case, some of them are casting about in possible and in impossible directions for the very desideratum which are shown by the results in question to have been already attained. Thus (XXXA.) the desideratum of allowing free access of electrolyte to the surface of a battery plate and at the same time giving a sufficiently elastic support to this surface is in certain directions fully recognised; whilst the means at hand to secure it are ignored, and futile suggestions are put forward in the direction of what has already been accomplished.

Mr. Barber-Starkey originated the idea of a solid accumulator cell, analogous to the "dry" cells which have been found so convenient for bell work, medical purposes, and laboratory experiments. He filled the space between the plates of an accumulator with a mixture of plaster of Paris one part, and non-resinous wood sawdust 2½ parts, and then saturated the mixture with the dilute sulphuric acid containing some sulphate of soda.† The mechanical properties of this mixture were initially excellent, but the same cannot be said of its chemical character. Plaster of Paris or sulphate of lime ($CaSO_4$) is a slightly soluble salt; at ordinary temperatures 150 grains of it are dissolved in a gallon, or 2·14 grammes in a litre, of water. Its solution is an electrolyte; and thus, in charging an accumulator, calcium (Ca), becoming calcium sulphate in presence of free sulphuric acid, would become deposited on the spongy-lead plates. The woody fibre or cellulin, becoming acted upon by the acid and oxidised by the ozonides liberated at the anode in charging, would give rise also to many compounds detrimental to the action of the battery. A trial, extending over a few months, was made on the Barking-road tramway with a set of E.P.S. traction cells mounted with the above absorbent mixture, which appears to have obviated the warping or buckling of the plates, and also the loss of pellets of active material. But ultimately, as might have been expected, the loss of efficiency was so

* *Comptes Rendus*, 1895, No. 4, p. 31.

† *Vide* Mr. Barber-Starkey's paper on "Secondary Cells," read before Section G of the British Association, Sept. 8, 1890.

great that the cells had to be condemned. It is characteristic of British want of enterprise that further experiments were not at once tried with some absorbent unattackable by acids and oxidants, and sufficiently porous to allow ready circulation of the electrolyte. This latter condition appears to be not only important but necessary, so that the expression *electrolytes immobilisées*, applied in France to the moist contents of what I have termed an *afluidic* cell, is in this case, like the term "dry," a misnomer.

INSTITUTION OF ELECTRICAL ENGINEERS, Feb. 9.

An Electrolytic Process for the Manufacture of Parabolic Reflectors.

BY SHERARD COWPER-COLES, MEMBER, A.M.I.C.E.

Glass mirrors at the present time are almost exclusively used for projectors for search-lights and similar purposes on account of the difficulty that has been experienced in producing a true metallic reflector that will not readily tarnish when exposed to the heat of an arc light. One advantage of a metallic reflector is that the rays from the carbon points are collected into a parallel beam by means of refraction only, and is not catadioptric, as most glass mirrors are. Spun reflectors are never true, as it is found in practice impossible to spin them quite true to the moulds. Experiments have been made with a view to substituting cast metal for glass, but the cost of grinding and polishing, and the unsatisfactory surface that is obtained, have resulted in the attempts being abandoned. Stamped reflectors have also been tried, but with no more satisfactory results. The present process I propose to describe to you is an electrolytic one, one of the chief features being that the surface produced requires no after polishing or trueing up. When once a true mould has been produced, any number of reflectors can be taken from it at a nominal cost. A glass mould is prepared, the convex side of which is accurately shaped and polished to form a true parabolic or other reflecting surface. As the mould only requires shaping and polishing on the convex side, it is comparatively cheap as compared to a glass reflector, which has to be ground on both sides. On the prepared surface is deposited a coating of metallic silver, which is thrown down chemically on the glass and then polished, so as to ensure the copper backing being adherent to the silver. The mould thus prepared is placed in a suitable ring and frame (which I will describe later on), and immersed in an electrolyte of copper sulphate, the mould being rotated in a horizontal position, the number of revolutions being about 15 per minute. The copper adheres firmly to the silver, and together they form the reflector, which is subsequently separated from the glass mould by placing the whole in cold or lukewarm water, and then gradually raising the temperature of the water to 120deg. F., when the metal reflector will leave the glass mould, due to the unequal expansion of the two. The concave surface of the reflector obtained is an exact reproduction of the surface of the mould, and has the same brilliant polish, and requires no further treatment to answer all the purposes of a reflector, with the exception that it must be coated with a film of some suitable metal to prevent tarnishing. Palladium is found to answer this purpose best, as a bright coating can be deposited rapidly to any desired thickness; the palladium resists tarnishing and the heat of the arc to a wonderful degree.

Palladium is a silver-white hard metal, and is sufficiently ductile to be rolled into thin sheets. Its specific gravity is about 12, being half that of platinum. The present price of palladium is about double that of platinum, but, its weight being only one-half, the same area can be covered at the same cost. It melts at an extremely high temperature—about the same as wrought iron. When only slightly heated in hydrogen gas it has an extraordinary power of absorbing mechanically large volumes of this gas. Graham investigated this very curious phenomenon, and found that a piece of palladium foil when heated below 212deg. F. takes 240 times its volumes of hydrogen, but that it had not the power of absorbing oxygen or nitrogen. At a moderately high temperature palladium assumes a blue colour, and the formation of a thin film of oxide, which it loses at a higher temperature, due to the decomposition of the oxide. Palladium is not readily attacked by sulphuric or hydrochloric acid.

In carrying out the manufacture of reflectors by this process, it is essential that the glass mould be perfectly clean and free from grease before the silver coating is applied. It has been found, however, that, if the cleaning is solely effected by chemical means, there is a great liability of the silver adhering too firmly to the glass, whereby the mould is in danger of being broken during the removal of the reflector. This difficulty has been overcome by cleaning the glass mould with a suitable paste or powder such as peroxide of iron, then removing such paste

or powder by washing the glass with a 50 per cent. so
of ammonia. It is necessary that this cleaning operati
repeated prior to the production of each reflector.
the convex side of the mould has been properly cl
as described, a thin coating of metallic silver is a
as follows: ammonia is added to a solution of nitr
silver until the precipitate that is first formed is rediss
then reprecipitating by caustic soda, again dissolved in am
then adding glucose to the solution. Excellent results hav
obtained with a silvering solution of the following compo
equal parts of each being used: silver nitrate, 0·5 per
caustic potash, 0·5 per cent.; glucose, 0·25 per cent.
surface of the mould to be coated is immediately dippe

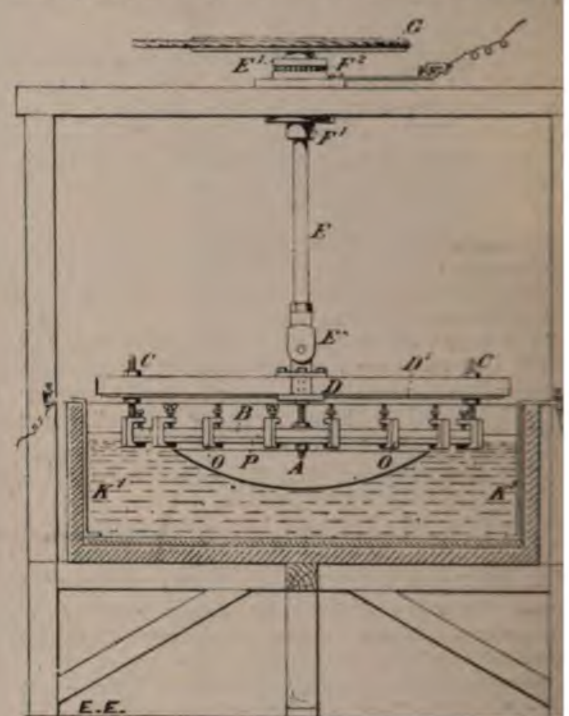


FIG. 1.

the solution, when it becomes coated with a film of silver.
silver coating is thoroughly washed and then allowed t
and the silver which has been deposited is burnished brigh
a piece of cotton wool and peroxide of iron, preferably p
tated by ammonia from a dilute solution of ferrous sul
The cost of the silvering is found to vary from 2d. to 4
inch diameter. I have here a film of the silver and c
stripped from a glass mould, which is quite transpare
transmitted light, having a green tinge, but is capable of refl
light.

During the several operations that have been described
glass mould (which in the case of large reflectors is of con
able weight) is handled by means of a sucker placed o
concave side of the mirror. The silver mould when silvere
burnished is placed in a ring, marked B in Figs. 1 and 3,
is attached to the frame, D; the ring serves to form an
trical connection with the silver coating. To determine th
of the reflector that is to be formed, and to ensure a clean
a ring, N (Figs. 2 and 3), is placed, having the proper in

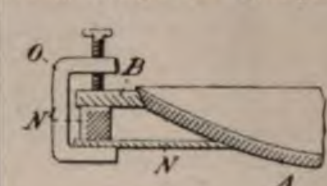


FIG. 2.

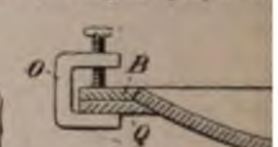


FIG. 3.

diameter, and bearing at its inner edge against the mou
shown in the figures. Wooden blocks, N, of the required
ness are inserted between the rings, B and N, and the ri
secured in place by clamps, O, as shown on Fig. 2. The r
may be made of insulating material, or it may be a
copper, or lead ring, having its lower face protected by su
varnish to prevent the deposition of metal upon it. The
B (Fig. 1), is suspended by bolts, C, and cross-bar
forming a frame which is connected to vertical shaft, E
said shaft is carried on the main frame, E, of the apparat
a bearing fitted with ball bearings marked F², which su
the shaft by means of a collar, and is allowed to rotate free
is a pulley through which shaft, E, and mould, A, may be r
by a belt or cord. The depositing tank is carried by a fran
which the mould is suspended, so as to be in contact wi

, which is a solution of copper sulphate ; the anode is t the bottom of the tank, and the current conveyed ans of copper strips. It is found advantageous to have iat, as it reduces the tendency for the copper to "tree" of the mould ; it also has the additional advantage ıg the reflector thicker in the centre. The electrical s between the negative terminal and the silver coating ector is made through the ring, B, bolts, C, strips of on the arms of the frame, D, the shaft, E, the ball ². Fig. 6 is a perspective view of the cross frame ıding the mould, and shows the metal strips for the electric current. The connection of the frame to ı made by a joint, E², that allows of the mould being

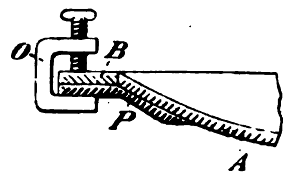


FIG. 4.

he reason that I will now describe to you. When first ıe mould into the solution, it is advisable to avoid ıe work of carrying the whole electric current on the , so the shaft, E, is raised by means of pulley blocks, e, to suspend the mould. The mould is then tilted ıaft gradually lowered, bringing the edge of the ontact with the electrolyte, the circuit being thus . A thin film of copper is deposited on the mould ı of contact near the edge of the mould. The shaft wered until it rests on the bearing ; at the same ıould is allowed to gradually assume its horizontal The operation I have just described occupies a interval of time, and the current for a few worked at a pressure of about nine volts, which is educed. It is very important that the silver be flashed opper immediately on immersion in the copper sulion. At this stage the ring N is not applied, and the ly rests on the ring B. The shaft is then rotated, and ıon of depositing the base metal continued with a ısity of about 19 amperes per square foot, and is proı until a sufficiently thick coating is obtained to act onductor to the electric current. The copper solution sed is of the following composition : copper sulphate, .; sulphuric acid, 3 per cent.; water, 83 per cent. , with the mould in it, is then lifted out of the bath, ng N applied to determine the size of the reflector e formed, after which the mould is again placed in nd the operation of depositing the backing proceeds quired thickness is obtained. During this stage the eposited on the mould up to the inner edge of the ich thus determines the diameter of the reflector, nsures a clean, even edge to the reflector, which further treatment. In place of the ring, N, shown and 5, a leaden ring, P (Fig. 4), may be employed. n ring is secured to the ring B by the clamps, O ; being soft and pliable, will bend to the angle of the l the ring, B, and therefore does not require to be as does the ring N. Fig. 3 shows a modification of aving its edges bevelled in the direction indicated— say, in the reverse direction to that shown in n such cases the mould is supported by a number of

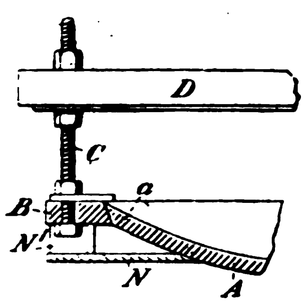
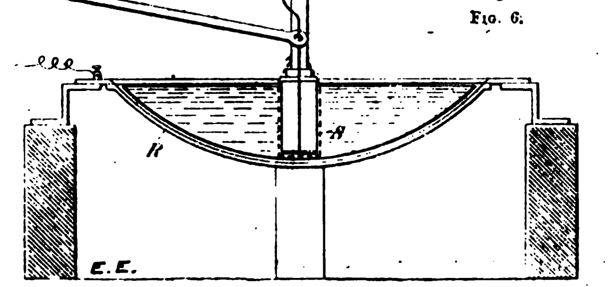


FIG. 5.

gid supports, Q, clamped to the ring by clamps, O. thin coating of copper has been applied to the mould ner already described, the ring, B, with the mould moved from the bath and turned over. The supports, Q, moved, and a ring such as P (Fig. 4) is applied to to determine the size of the reflector. Or, instead g the supports, Q, and applying the ring, P, if a ring N (Fig. 2) can be applied to the mould, it is then ı the bath and the depositing continued. As soon uisite thickness of metal has been deposited, the h the reflector attached to it, is removed from the d placed in a bath of cold or lukewarm water, which is then raised to a temperature of 120deg. F., whereupon, owing to the difference of the expansion of the glass mould and the metal backing, the latter separates from the mould. The only thing that requires to be done now is to coat the reflector with an untarnishable metal. This is accomplished by placing the



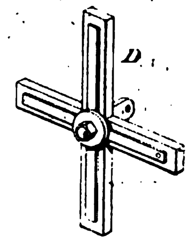


FIG. 6.

FIG. 7.

reflector in an earthenware pan (Fig. 7) containing a 0·62 per cent. solution of palladium ammonium chloride in about a 1 per cent. solution ammonium chloride. The solution is used at about 75deg. F., the current used for a 2ft. reflector being

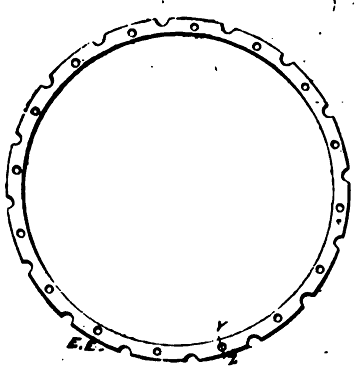


FIG. 8.

about 0·5 of an ampere, the E.M.F. at the terminals of the bath being four to five volts. An anode, S, made out of carbon, and curved approximately the shape of the reflector, is attached to a rod, marked T, which is connected by an arm to a rotating disc which causes the anode to swing to and fro, thereby ensuring an even coating of palladium, and agitating the solution and preventing the depositing upon the reflector of particles of foreign matter which may be present in the solution.

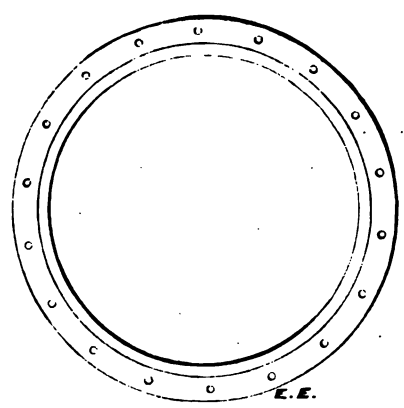


FIG. 9.

The back of the reflector is usually varnished before placing it in the bath, to prevent local action setting up between the copper and the silver or palladium. The reflector is removed from the bath and dipped in boiling water, and then placed in boxwood sawdust, which is kept hot by means of a steam jacket. The reflector is then ready to be mounted in a suitable ring, such as shown in Figs. 8, 9, 10, 11, and 12. The clamping ring shown in Fig. 8 is provided with a knife-edge, marked F, Figs. 10 and 12. The knife-edge forces the reflector against a ring of asbestos, marked G, and retains it in position after the

reflector has been carefully centred whilst resting on the asbestos ring.

Reflectors made by the process which has just been described have been subjected to a number of tests, and found to withstand excessive heat without tarnishing. Salt water has been thrown on the reflectors when they have been too hot to touch, the result being that the water was driven off as steam, and the salt left as a white deposit on the reflector, which was easily removed with a wet cloth. A reflector recently tested at Portsmouth had a number of rifle bullets passed through it, when the beam was found to be little affected. On the other hand, the first shot fired at a glass reflector splinted it to pieces.

FIG. 10.


FIG. 11.

FIG. 12.

Although palladium does not reflect light as well as a silver surface which is perfectly clean and bright, silver is found quite unsuitable, as after being in close proximity to an arc light for a short time the silver tarnishes, and the light is greatly reduced in intensity. With a palladium-faced reflector the intensity of light is found to remain practically constant, as little or no tarnishing takes place. Some of the reflectors have been tested optically by the process which has been extensively used by Thikolff. The method consists of photographing the image in a reflector of a white screen covered with black square network, as shown in Fig. 13.

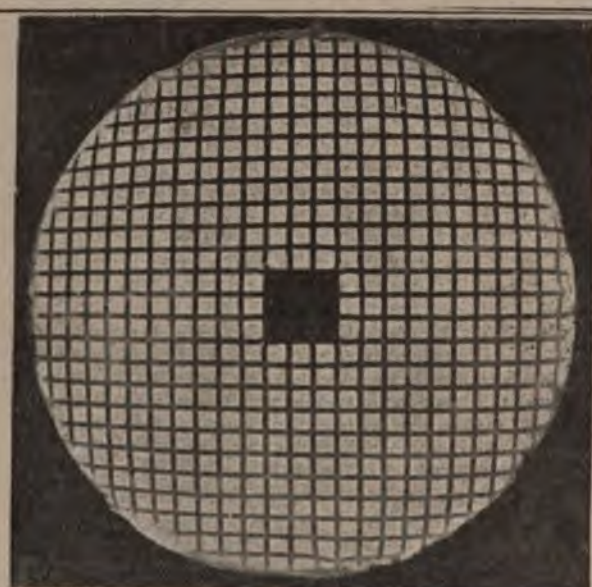


FIG. 13.

The screen is of white material having a black square network, the lines being 0·2in. thick and 0·6in. apart. In the centre of the screen a square opening is left, through which the photograph of the image of the network is taken. The first steps in the process are as follows: the reflector is placed at a distance of from 3ft. to 5ft. from the screen, which should exceed by at least 35 per cent. the height and breadth of the reflector so as to ensure the image of the network covering the whole surface of the mirror. The test of the reflector is carried out as follows: The surface of the mirror in all planes is tried by a template to ensure that the exterior curves of the surface are not far distant from the parabola. The image on the screen is then photographed, and the irregularity of the lines indicate any serious errors of the parabolic surface.

DISCUSSION.

Mr. Grove said he did not propose to criticise the method given. If it acted as well as the glass, it was of great value, because it did not require such careful handling. The mirrors made by this process were not quite so bright as those made of silvered glass, but when exposed to the heat of the arc these soon became coated with a film of white soot. Perhaps this coating would not take place with palladium. They had had a difficulty to find anything to reflect the
direct rays of the arc back on to the mirror owin
mirrors being unable to withstand the intense hea
palladium mirror would, he thought, answer this purpos

Major-General Webber said he had just been prot
this Institute should not have to consider the question c
he could foresee that this process would make a great
in the price of these mirrors, and in case of danger it w
such a heavy expense to have searchlights all round th
the United Kingdom. He would like to ask whether th
were very much lighter and less costly than the glass o

Mr. Spiers asked if it would be possible to make a cop
and use this instead of using the glass mould over and
It would be better, as the heavy glass was very difficult

Mr. Mordey said he would like to protest against the
that questions of cost had nothing to do with the Instit
thought they would all welcome anything that tend
such expensive things cheaper.

Mr. J. W. Swan said an important point had been b
by Mr. Spiers—viz., the question of distortion. This w
very much into effect by having the copper matrix sugg
had been tried, and had been found very unsatisfacto
Bagnold spoke to him on the subject some years ago,
agreed it was impossible to obtain good results. He
to ask what was the proportion of acid in the solutio
if Mr. Coles could tell them the comparative reflective
silver and palladium.

Mr. Spiers asked if Mr. Coles could separate the pla
copper matrix without destroying the mirror?

Mr. Cowper Coles, in replying, said that palladium
were as good as silvered ones. He had tried to se
curved metal matrix from the mirror, but had not
very well.

Examples of the working of the process were then thr
screen by means of a lantern.

SOCIETY OF ENGINEERS.

Inaugural Address.

BY W. WORBY BEAUMONT, M.I.C.E., M.I.MECH.E., PRESIDENT.

(Concluded from page 175.)

It is customary now for some roads and streets to ma
substratum of concrete, but the surface seems to be m
the supposition that the broken granite will pack i
that granite lumps approaching the size of cocoanuts c
compacted by the steam-roller. Nothing can be further
actual results. A good deal of crushing and pushin
simulation of a compact as well as a level surface
goes on during the rolling, but the road crust is
density, looseness, and tightness when the roller s
home. The pounding by horses' feet, and the pre
grinding by the narrow wheels of ordinary vehicles,
slow, then commences. The looser places are tight
harder, better-packed parts remain more or less obdu
the road surface soon becomes a dirt and rock repre
of a choppy sea. Every horse-vehicle that rattles over
in this condition increases the imperfection, and soon t
and hollows are enough to make themselves felt in a f
cab, or to throw a cyclist off his saddle if he moves at
two miles an hour. Destruction then is very rapid. Ev
descending at from six to ten miles an hour from a h
hit the hollow or the sides of adjacent humps with
of from ½cwt. upwards, wielded with a striking v
1,000ft. a second, which the recoil of the carriage spr
it. A road once made is left for a considerable time
care of itself. If our road authorities would spend a
save two, they would employ gangs of well-directed m
within a few days of the opening of a newly-made
inspect, pack, level, and make good every defect in th
its incipient evidence, breaking the big lumps in
raising and packing the soft hollows. In this way t
quick-travelling iron wheels would come to the aid of
maker, instead of doing nothing but destruction.
making of the road it is necessary in the first instance
rock-breaker should be given more work. The granit
be broken up to one-third the ordinary size used in a
London. It should then be packed in place by appar
can easily be devised, so that every piece approxim
against all the pieces surrounding it, as it does when s
metal such as that used in the Cambridgeshire road
The steam-roller then does better work from the first,
it more quickly. The attempt to compact the large r
often used by the steam-roller is about as successf
attempt would be to compact by the same means the lar
reaches of the Chesil beach, or that at Aldborough.
evidence of this is given by an examination of a Londo
macadam road when it is broken up for any purpose
to a depth of several inches it will be found that
sharply angular stones have all been more or less ro
the rubbing together of the adjacent pieces before they

y the crumbled and pressed material from the corners of ther surrounding piece. This process commences with im rolling of the large stuff tipped and levelled with the

If the progress of a heavy roller be watched, a wave road material immediately in front of the rollers will be wave which gradually lessens as the rolling approaches tion, but which is there to the end, and is formed in both ckward and forward travel. In this way not only does d metal get its corners rubbed off, but there is a more or gular recurrence of harder and softer places formed by the nt surmounting of the wave. The really good road cannot be made in this way, and an illustration of the may be given by a reference to what would happen if lar process were adopted with a heap of loaf sugar. If a ox of broken loaf sugar were put under a heavy roller to level hard surface, an irregular hard and soft surface be obtained, with a sub-surface of crushed lumps. If, r, every piece were carefully packed, very little or no would be necessary. Now, although packing by hand, ing of small bricks, cannot perhaps be indulged in in m roadmaking, the packing should be done, and I believe done by apparatus not at all difficult to devise.

e third very desirable improvement in our roads it is ble in this address to do more than call attention to the ing that might be made in work done and wasted, in t, and in avoidable accidents by the profitable employ- capital in reducing the hill gradients and in making-up ls across hollows. As an example of this class of work, e may be made to the proposed new road through the d pass from Borrowdale to Wasdale. Here a new road made according to the plans of Mr. G. J. Bell, which luce the gradient of 5¼ to 1 of the pony road hitherto 1 in 20 one side of the summit and 1 in 12 the most other—that is to say, the power of every pony or horse more than treble as between Wast Water and the Sty and more than doubled on the Borrowdale side. In e a certain summit 1,578·6ft. above datum has to be from starting point at 264ft., and the length of the to be increased from 4·3 to 7·88 miles, but the time ith the doubled or trebled load will only be about the The road is to be 18ft. wide, and the whole cost will £10,000, or about £1,260 per mile. This is an extreme rise of over 1,300ft. being made under five miles. In ases, however, the road improvement will be made by he top off the hill, going through it or round it, not ily surmounting it, and while the gradient will not often oved by so large a reduction, the length of the road will, other hand, not be increased. The capital expenditure Sty Head road will only represent a yearly charge of, 50, and for this a good safe road is obtained, the trans- power of every horse is doubled, and safety is exchanged ny dangers. Either less than half the horses will be ry, or more than double the passengers or baggage can ied. Assume that four one-horse journeys each way are er day for six months of the year, we have, for only six r week, 1,296 journeys. To this addition to the horse's s or to his load must be added the numerous profits arising e doubled power of transport, and when these are put r it will be obvious that the inhabitants will reap a me return for the money expended. This is only a small e of the kind of work which could be carried out in many nd secondary roads all over the country. Many of the ill roads, for example, might, with the greatest advan- the ratepayers, be put into the hands of the engineers; lays gone by, the roads of the North were put into those ord. Small detours and small cuttings and banks, which e days can be carried out by mechanical means at small would in many cases cheat gravity of half its natural aid h rates for cartage. The hills of the 100,000 miles of road country not only cost us an enormous sum every year to nt, but they put the most effective stop on the cheapen- road transit of goods between railway stations, villages, gricultural districts.

days are past when the natural highways were looked s only of importance to those who used them. Every- that can be done to make haulage on the roads easier and r, cheapens commodities partly by the reduced number of necessary or by the use of mechanical road vehicles, and by saving of time, which is equally valuable. We have d now at a time when it is seen that the great railway n which has done so much for us has its limits with regard tribution, and we see now that the common high road again receive the attention which for some years was to it in the early part of this century under Telford and . The extensive employment of engineers must again be ad to for the planning of new and the improvement of g roads; and the mechanical aid to road transport which urned when railways were growing up everywhere and ing everything, must now be taken into service.

we are to have the advantages of cheap and rapid transit n the hard-and-fast points of railway service, we must mechanical power on the roads. Already the importance of this is recognised, but it is necessary to point out that to secure the great possible advantages of this we must have not only the mechanically-propelled vehicles and the roads suitable for their working, but that these very road improvements are as desirable for the horse-propelled vehicles. Over many miles of suburban and country roads the construction of really well-made macadam roads, with wheelways at the sides, will make a splendid national investment. The better the road the longer it lasts, the less the time lost by stoppages of traffic for heavy repairs, the greater the average speed of travelling of goods and passengers. The haulage resistance on well-finished macadam roads is less than half that on a badly-made road of the same kind. This means more than the old fact that one horse would do the work now done by two, and do it quicker. With the improvement of the worst gradient, one horse could in many parts do the work now done by three, for it happens frequently that the full power of the two or three horses of a team is only required for a fraction of the whole road traversed. Further than this, it means that the mechanically-propelled vehicle could do with either less than half the steam-engine power now necessary, or could carry much greater loads, and the average speed would be greatly increased without making any addition to the full speed. In fact, the maximum speed could be reduced, and a higher average speed attained. With the improved roads, the cost of fuel, either as horse feed or as coal or oil, would be enormously reduced, especially in the case of horses, and the distance traversed by mechanical road vehicles with one supply of fuel and water would be proportionately increased. The reduction of cost in this respect is comparable with that of locomotives on the railways as against that by horses, but not equal to it in every respect.

When stage and mail coaches were employed, the allowance of horses was a horse per mile of double coach road. Now see what this means on the London and Birmingham road. The distance is 113 miles, which would require 56 horses per coach for the single journey. These horses would consume about 28lb. of food per day each, so that for the journey from London to Birmingham 14cwt. of food would be consumed in order to convey at most 14 passengers, or 1cwt. per passenger. This food at the present day would cost not less than 5s., so that the cost for food fuel alone for, say, the 500 passengers which a locomotive of to-day would take, would be £125, and it would weigh 25 tons. The locomotive takes the 500 passengers for about 1·8 tons of coal, or about 8lb. per passenger instead of 112lb. The coach carried a passenger for about 35s. of the then value, and the engine does it for 9s. 5d. present value. To take the 500 passengers to-day it would have required 35 or 36 coaches and 2,000 horses, and they would do the journey in 11 hours, while a 700-horse engine does the distance in 2½ hours. Thus the passenger does the journey in less than quarter the time and quarter the cost, and for a visit of a few hours he saves the cost of staying a night at an hotel, saves the cost of about nine hours' travelling refreshments, and saves the value of at least a day of his time. Thus one train carrying 500 passengers saves over a year and a half of working days. For each 20 travellers a ton of food had to be carted for the horses, while at the present time each passenger could carry the necessary coal in his pocket to take him the journey. The time saved is one of the greatest of all, and, although we do not always remember this, it is one of the several ways in which the steam-engine has more than doubled the money-earning capacity of men who do much travelling, and has increased the earning power of all.

Now I believe improvement of our common roads to suit the possibilities of mechanically-propelled vehicles, and the design of the vehicles to suit the possibilities of high roads, will in the future make a change almost as vast as that which has been wrought by the mechanical horse on iron roads. We have our roads leading from and to everywhere we want to go or send goods, to our houses and factories. We want to take advantage of the powers which the steam-engine will place in our hands, if we will but give a fraction of the ingenuity to the construction of roads which we have given to the construction of this world-changing motor. There are at work at the present time no less than 106,000 horses in London alone. These horses are not only destroying our streets and roads at double the rate at which even the iron-shod wheels would do it, but they are themselves the origin of an enormous quantity of street haulage. Nearly all the food and fodder has to be hauled over some parts of the roads and streets. Food and fodder alone represents 20,000 tons per week; the street refuse which employs an army of scavenging boys, and then scavenging carts and more horses, to carry away from the street boxes that which is not blown into the air we breathe or washed into the sewers, will represent another enormous quantity of street carting necessary to enable these horses to exist in London alone. All this will be avoided by the use of motor vehicles that are possible even to-day. This is not a statement of what is desirable; it is a statement bearing on changes which are becoming inevitable. If anyone is inclined to doubt it, let him go to any of the meeting places of our great lines of traffic, and see how nearly impossible has the movement of any vehicle become already. Oxford-street,

ng less economical methods, the steam car and the ine car must unhesitatingly be chosen as the best.

first qualifying condition which may be mentioned is the g of very steep inclines, and this favours the cable system. ry confined situations, as in tunnel lines, the products of stion of the fuel for steam raising or of the gas in gas- s may be disqualifying attendants of these two forms of on the cars. Under ordinary circumstances of level, or level street and suburban lines, the possibilities of the a small high-pressure superheated steam-engine and of s-engine appear to place the independent car propelled se motors in the most advantageous position. The elec- ystems are open to the objection, firstly, that the prime power must be converted into electricity, and that city must be converted back into mechanical power. : once raises the cost of the motive power on the rails m 15 to 30 per cent., without considering any inter- e losses. In past days, when the large engines used in generating stations could be shown to give an effective power for much less steam than the smaller engines d on the independent steam car, this loss might not only sidered as more than covered, but the small engines and available were also in many ways objectionable. This ice, however, has now been removed by the experience past few years with very high-pressure superheated steam, ns of which engines of less power than those required ncars are working with less steam per horse-power than ge engines of some of the large electricity generating s. Electricity is being generated now at a cost per unit, duction only, which is marvellously low as compared with t a few years ago, but however low the cost, the steam which generated it if put on the car direct would cost less cost of the electric generation, conveyance, and conversion. a, gas-engines are now made which give a brake horse- with not more than about 65 per cent. of the gas required ree or four years ago, and independent gas-engine cars ning which cost for power on the rails less than the current can be made and conveyed for. If judged, m the question of cost and profit-earning possibilities, am and the gas engine systems must be given the position, and electric systems when adopted must be d to offer some favouring conditions outside cost of g and profit-earning capacity, which places expediency r side.

objections to overhead wires carrying heavy currents spended points, crossings, and switches, may, it is able, be overstated, but only arguments of expediency urged in favour of such a system. It can only be upon as a makeshift, and one which would be a good ift where appearances and some danger are of no ance, as, for instance, in the grounds of large works, some country roads, where, however, any electrical ceases to have advantages over those employing prime direct. The underground conduit which employs a il is open to even greater objections, but a closed round conduit with a system of superficial contacts be valuable for towns if the superficial contacts offered pediments or obstructions in the road, or if they caused ue surrounding wear of the road surface.

he cost of working it is perhaps unnecessary to speak, e it is obvious that the systems which employ the prime upon the car directly must be more economical than those employ the power indirectly, and which require large of expensive machinery in central generating or power s, and further require extensive distributing systems of or of wires and supports or conduits. The cost of work- the different systems is, however, of interest in connec- with the main question of transport on common roads, se that which can be done on grooved tramlines very represents that which will in the future be possible on on well-made roads with horses and motor vehicles. verage cost of running a 42-passenger car by horses in a district, or in a town with no steep hills, is for all that s to propulsion and for driver about 8d. per car mile. ost by steam, like the Serpollet steam cars in Paris and in towns in France, including fuel, oil, sundries, mainten- and repairs, and driver, is 4·3d. per car mile for carrying ssengers, or at the rate of for 42-passenger cars of less 4d. The cost for fuel alone is only 1·13d., and this is less electricity, as fuel can be generated in the most economical ns. The cost of gas cars like those which are running he Blackpool, Lytham, and St. Annes line is, including oil, sundries, maintenance and repairs, and driver—every except directors' fees—only 4·5d. per car mile. The cost alone is only 1·1d. per car mile. The same cost for ly-propelled cars, including driver, is not less than ar mile. The cost on cable lines is not less than this. few electrical lines on which cost of maintenance of relates to the propulsion of the cars has yet been d or published, while, on the other hand, the total n many cases been kept apparently low by profits on other transactions of a financial nature.

In the future there can be no doubt that the tramways of this country will fall into the hands of much larger financial corporations than those at present owning them. Most of the companies owning the provincial and some of the London tramways make little or no profit at all on their working, and cannot do so as long as the lines are worked by horses. They have not got and cannot get the necessary capital to provide equipment for working the lines mechanically, even when they are not committed to the horse and fodder interests. To make the lines pay sufficiently they must be worked by powerful companies which will supply and work their own stock, and in some cases manufacture it too. This is being done so as to secure the extension of the electrical system of working, and although the steam and gas systems are cheaper in working, the same policy will have to be adopted. Only slow progress will be made if it depends on existing small companies to alter their methods of working; the change will have to be made by new and wealthy ownership. The public will then get the benefit of comprehensive management and the cheap working of the best plant and stock that modern engineering can provide.

I have thus far said nothing concerning our own society, but in drawing attention to some of the sources of profit from new works which require the best energies of the engineer, and to some of many directions in which money can be saved by improving old works (which is said to be as good as money earned, though this is not always true), I am reminded that, varied as are these future requirements, they can all be met by the Society of Engineers. It is a feature of the society that all branches of engineering are included in its scope, and the great growth in the number of specialist societies has increased the importance of this feature, especially to the younger members of the profession who have not yet had their practice developed in one particular direction. To the older members it is of great advantage that the society is able to receive papers and hold discussions on widely different subjects. All engineers are students so long as they practise, and the general character of the proceedings of the society gives to the young and the old students alike opportunities of gaining practical information, whatever branch he may be following. To all members the facility which the society affords for social intercourse at meetings, discussions, and visits is of great value and importance, and this intercourse is the more important, useful, and pleasant when each member can meet so many who are active in different fields. The old adage says that two of a trade never agree. This must be rather an inconvenient adage for the members of two or three of the special societies, but the inconvenience is avoided by the Society of Engineers. It is this social side of the purposes of a technical society which should be looked upon as of the highest value, for technical occupations tend to social neglect and difficulty. It may, therefore, be hoped that it may be found possible in the future to give even more attention to it than has yet been possible, and to provide for meetings which will have the social aspect of the visits and excursions, without occupying time difficult to spare.

In the past 44 years the life of the Society of Engineers has grown in usefulness, in importance, and in numbers, and at the present time its position, finances, and prospects are extremely satisfactory. I hope that my term of occupation of this chair may not be attended by any falling off in these respects, but that, on the contrary, my successor may be able to announce that the society's curve of membership and general progress is ascending.

NOTE.—There were at the end of 1896 in London alone 15,204 hackney and stage carriages under license. Of these, 7,585 were two-wheeled carriages, 3,449 four-wheeled carriages, 3,001 omnibuses, and 1,169 tramcars. To work these not less than 58,000 horses are employed, and the horses employed in the thousands of trade carts and vans and wagons and the private carriages will be more than this quantity, so that in the London area alone there are probably 120,000 horses. Each omnibus has on an average 10 horses to work it, and each hansom and cab two. For these, however, I allow in my estimate only three horses to two hansoms or cabs, to allow for small proprietors whose cabs are only worked part of a day.

In the United Kingdom there are of licensed vehicles the following in round numbers :

Hackney carriages	116,000
Other than hackney, with four or more wheels, for horse or mechanical haulage	48,000
With four wheels for one horse only	77,000
With less than four wheels..................................	305,000
Or a total of vehicles requiring license of	546,000

These represent at least 1,200,000 horses. I have no means of telling what the total number would be if all the agricultural horses and vehicles which do not need a license were added, but the total is probably considerably above a million and a half of horses.

THE

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TO CORRESPONDENTS.

 Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140, Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

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BOUND VOLUMES.

Vol. XX. of new series of "THE ELECTRICAL ENGINEER" *can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.*

THE RONTGEN RAY IN PRACTIC

Every day adds to the mass of evidence
prove the immense value of the Röntg
surgical operations. Not long since the
demand that such apparatus should be
among the surgical appliances of every
army. We have no hesitation in say
before long such supplies will be generall
and no army in the field will be without t
diagnose the position of bullets or splinte
human body. Many conditions of human
anatomy have been made clear by the a
X-rays, and operations have been successful
out that a few ago years were undreamt of.
monials of value are always welcome, but
be difficult to have better evidence than t
by the president of the Royal Southern
Liverpool, at the annual general me
the trustees on Monday last. He is
to have said: "Before concluding my
I must allude to the Röntgen rays,
tinued success of which is daily
more apparent, and the room and app
their hospital had been used for fifty-se
from March last to the end of December."
words show the appreciation in which
method of investigation is held by the
authorities. If, however, as we may well
to have been, the apparatus has been use
cases so sympathetically referred to by t
dent—namely, the straightening of spin
ture—the veriest tyro experienced with the
of humanity cannot but see its value.
one of a scientific man's experimental res
met with immediate application, and h
world at large to see the importance of
research. No one could possibly have fo
even, we think, have imagined that rays no
light rays could enable us to make visibl
photograph that which had hitherto been
The value of these rays is that many s
more or less opaque to ordinary rays a
parent to the X-rays, and thus we get
rential action upon a photographic pla
trust that the society founded specially
with all phases of the subject of the
will not restrict itself solely to the disc
details of experiments, quibbles as to what t
or that may mean, or to determine between
that man's opinions, but will endeavour
further practical application as well as
research. The mutual admiration societ
too much in evidence; it sets up a group o
demi-gods, and bows down in admiration to
say, while whatever any heterodox pers
say is anathema maranatha. Suffering h
will welcome everything that aids in d
suffering, and it will matter very little a hund
hence whether what A calls x is z, or wh
y is z. We are led to make these remark
in some directions the object seems to be t
everything done or said by some other bo
apparatus is even now so immensely valu
we can only wonder what will be thought o
improvements are made, as they will and

› with wider use and experience. It must r be forgotten that Liverpool has had from 'ery earliest time, in the application of X-ray ratus, the untiring and able assistance of Prof. odge, whose work in this direction can never verestimated.

AN ALL-BRITISH CABLE.

ne *St. James's Gazette* of Wednesday describes t it terms a new and important scheme in cable c. As a matter of fact, this scheme is merely alternative scheme put forward by certain exist- cable companies who have hitherto had the opoly of cables to the East. Another important or is that these companies have for years waged nergetic war against a British Pacific cable, it is largely due to their efforts that no cable exists at the present moment. If, they contend, Honolulu is the key to the fic problem, and the point is practically lost s and in the hands of the States, it is just more striking example of how "traders" will the throat of their own country to serve their ends. Gunmakers want to sell guns to anyone will buy, no matter if the said guns are to be a month hence against their own countrymen. irs is to trade, not to hold back in selling what increase their banker's account. Just so with the e companies. Theirs is not to discuss Imperial trategic questions, but merely to consider how their revenue would be affected. We have efore no doubt about the importance of the native scheme to them, but from the strategic t of view it is vastly inferior to the Pacific me. The question is not one of delays, put n to Australian land lines or cricket matches. question, again, is not so much what would pen after a declaration of war as that, during lous times before such declaration, messages, aps of supreme importance, should pass with lute certainty of secresy. So far as we can the Colonies in the East and West are not rested in this scheme—it is purely a speculation he part of the companies interested. They see t commercial success, and are prepared to find money and do the work, provided they obtain rtain concessions" and some "small subsidies." ar as we see, there is no reason why concessions ld not be given, provided such concessions do interfere with the Pacific scheme. As for sidies, as they are "small," no doubt the com- ies put in the request to gracefully abandon it n the concessions are granted. From our point view, then, this alternative scheme is purely mercial and not strategic, and it should be ted as such, and helped as much as possible, so g as it does not interpose any obstacle to the tegic scheme.

scribers Only.—*L'Energie Electrique*, the enter- French journal, has hit on a novel method of ing its influence. It undertakes to supply danger ds for high-tension poles at low prices to subscribers These are made of zinc, with the inscription, "Il y r a toucher les fils," over the Jolly Roger.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

LOAD FACTOR.

SIR,—I should be much obliged if you or your readers would let me know of any electrical plant running more or less continuously at or near full load. I am anxious to find out the cost of generation under these conditions, and should be glad to be put into communication with the owners of any such plant, whether used for electro-chemical or any other purpose. The plant need not be of large capacity necessarily, but the main features should be that it runs for long hours at or near full load. I imagine there must be cases where such plant is run more or less continuously all the year round, and if there is any such installation I should be very glad to know of its existence.—Yours, etc. ATLAS.

REVIEWS.

Elektromechanische Konstruktionen. By GISBERT KAPP. 20 marks. Julius Springer, Berlin, and R. Oldenbourg, Munich.

This book is arranged on practical lines, and goes very far beyond any similar treatise on the same subject. Its contents may be summed up briefly as follows: The first part of the text gives the necessary formulæ and directions for the design of all types of electrical generators, motors, and transformers. Following on this are 25 plates of actual designs, representing the practice of many prominent manufacturers. The working drawings on these 25 plates are supplemented by 160 pages of matter, in which the typical features and calculations of these machines are detailed. As the formulæ and general information for design are contained in the first 35 pages, much space is saved for working out the examples. The author has, in fact, given conclusions and formulæ in this first part rather than develop, as is done in his other books, these facts and formulæ from first principles. Coming to the designs themselves, we note several by the author himself, which are most valuable on account of the exceedingly full details given as to the process of design. The value of the book as a whole is, however, much enhanced by the fact that the other designs give the practice of other experts who have worked independently. This is seen from the following list of machines which make up the 25 plates: A 100-kw. three-phase generator by Gisbert Kapp, with radial-pole internal field and winding on each limb. A 100-kw. three-phase generator, by the same designer, with a claw system of field magnets and single exciting coils is the next design. We note in this example that the coil is not circular, but is a ten-sided figure, which will tend to prevent it moving due to the flywheel action when starting and stopping the alternator. In both these cases the characteristic curves are given, and also the curves connecting pressure and voltage between no load and short-circuit. The third design is of a 60-kw. single-phase alternator of the Kapp ring type. We then come to a 100-kw. railway generator for traction working by the Union Elektricitäts-Gesellschaft. This is a four-pole machine, and we fancy that the design is American. The Oerlikon tramway motor is the subject of the next plate. This motor is most fully detailed, numerous sections being given, as well as sketches of the brush gear, etc. The machine is designed for single-reduction gearing, and is of the four-pole type. Then follow a 72-kw. direct-current six-pole dynamo by Naglo Bros., of Berlin; a large two-phase alternator, designed by E. G. Fischinger for the Aktien-Gesellschaft Elektricitätswerke, of Dresden; and a four-pole dynamo by Schuckert, of Nuremberg. The 200-kw. railway generator by the same makers as the 100-kw. machine mentioned above is most fully illustrated, as two large plates are devoted to the machine and its details. This is dwarfed by a 624-kw. dynamo by the Allgemeine Company, of Berlin, on the next two plates. We then find a French design of a 210-kw. three-phase alternator, which is directly followed by an inductor type of three-phase

alternator of the same output by the Allegemeine Company, and a 75-kw. motor to work with it. Then comes an English alternator by Crompton and Co. After this there is a plate of a small direct-current machine by Messrs. Siemens and Halske, and then a 500-kw. alternator by Ganz and Co. The mechanical construction of this latter machine seems to us to be open to question, as insulation is introduced where it will be subjected to great stresses. The remaining plates illustrate another type of inductor alternator, two types of transformers, and an 800-ampere accumulator switch designed by Dr. Paul Meyer. The value of the plates is increased to us by the addition of a scale of inches in all cases. The text describing the machines gives most useful information as to the working of the types in question. On the whole, the volume is of a most practical nature, and although contemplated for use in a technical college, will be of great value to all designers. The only fault from the English point of view is that it is written in a foreign language, but this fault can be remedied, as we hope it will. The particulars of polyphase machines are urgently needed by English designers who are taking up this important branch of electrical engineering.

THE EMPIRE AND THE TELEGRAPH CABLES.

After references to the Canadian Pacific scheme, etc., the *St. James's Gazette* considers an alternative route *viâ* the Cape. But because the Canadian Pacific scheme presents serious obstacles in the way of its accomplishment, it must not be supposed that an alternative route cannot be found. A proposal is before the British Government, the merits of which can scarcely fail to commend it, and to ensure its acceptance. Three private commercial companies—the Eastern Telegraph Company, the Eastern Extension, Australasia, and China Telegraph Company, and the South African Telegraph Company—are concerned in this project. The plan which they suggest is that the British terminus of their cable should be in Cornwall, that it should touch at Gibraltar, at Bathurst or Sierra Leone in West Africa, the islands of Ascension and St. Helena (which would thus be brought into telegraphic communication for the first time), at Cape Town, and thence overland to Durban, in Natal, at Mauritius, the islands of Rodriguez and Keeling or Cocos, and reach the Australian continent at Perth. It will be seen that every one of the proposed stations mentioned is on British territory. The present single route passes through the Mediterranean, and in the event of warlike complications it is more than probable that it would be rendered nugatory by the severance of the cables. Even Mr. Rhodes's Trans-African telegraph would be subject to the same drawbacks so far as communication with England is concerned, supposing it is possible to construct and maintain it through such difficult countries as it would have to traverse. But it is to be presumed that if, under conditions such as have been suggested, the proposed cable *viâ* the Cape were in existence, the British Navy would be sufficiently powerful to ensure its safety against the depredations of foreign foes. In any case, the Cape cable would possess a striking advantage over the Canadian-Pacific scheme in one very essential particular. It would not only provide a third route (all-British) to the Cape and Mauritius, but it could easily be made to supply us with an additional means of communication with India. It is not a far cry from Mauritius to Colombo, and if the supplementary scheme were carried into effect, then for the first time India would be in telegraphic touch with England over an "all-red" route. Moreover, the Cape route is not encumbered by any excessive depths; for the great part of the distance it would be near the coast line, and its longest stretch of cable would be less than 2,400 miles, and would consequently be practicable.

These are some of the advantages that pertain to the proposal which the Government is considering. A Departmental Committee, upon which representatives from South Africa and the Australian colonies will sit, has been appointed, and will, it is hoped, shortly commence its investigations. As regards the financial aspect of the
scheme, we may state that the estimated cost of t
cable would be nearly £2,500,000. This expenditu
promoters—namely, the three telegraph companies r
to—are prepared to incur themselves, besides beari
cost of working and maintenance, provided they can
from the Imperial and Colonial Governments certa
cessions, including small subsidies for the mainten
stations such as those on the islands* of Ascensio
Helena, Rodriguex, and Keeling. This, it appears
is not a very serious obstacle to surmount, and it
hoped that the Governments will display a conci
attitude in regard to it.

We have dwelt at length upon the Imperial adva
which suggest themselves as likely to accrue fr
successful fulfilment of the scheme, because th
essentially more important than any others. But co
cially the proposal is an attractive one. Great
venience has resulted to business people both at hom
in Australia owing to the unsatisfactory working
Australian Government land lines and the preference
has been given to cricket telegrams, resulting on
occasions in the blocking of the lines against or
messages. Our commercial relations with the Coloni
to be stimulated, not impeded; and the constructio
new cable will facilitate commerce immeasurably. In
respect, therefore, an all-British Cape cable route wo
advantageous, and the sooner the scheme is put in ha
better.

FORTHCOMING EVENTS.

FRIDAY, FEB. 18.

Institution of Electrical Engineers.—At 6.30 p.m., st
visit to the generating stations of the St. Pancras Ves

North-East Coast Institution.—At 7 p.m., at South
ordinary meeting.

MONDAY, FEB. 21.

Presentation of testimonial to Mr. F. H. Webb, at 9.30
the Whitehall Rooms.

TUESDAY, FEB. 22.

Royal Institution, Albemarle-street.—At 3 p.m., Prof.
Lankester, M.A., LL.D., F.R.S., on "The Simplest
Things."

Institution of Civil Engineers.—At 8 p.m., "The
Design, and Practical Working of Alternate-Current
by Llewellyn B. Atkinson, Assoc.M.Inst.C.E.; and "
Electric Tramway," by H. F. Parshall, M.Inst.C.E.

THURSDAY, FEB. 24.

Institution of Electrical Engineers.—At the Civil Engin
8 p.m., "On the Manufacture of Lamps and other Ap
for 200-Volt Circuits," by G. Binswanger Byng, memb

FRIDAY, FEB. 25.

Royal Institution.—At 9 p.m., "The Theory of Colour
Applied to Modern Colour Photography," by Captain
C.B., D.C.L., F.R.S., M.R.I.

Institution of Civil Engineers.—Students' meeting, at
"The Problem of Train Resistance," by C. E. Wolff,
Stud.Inst.C.E.

Institution of Electrical Engineers.—At 6.30 p.m., St
visit to the Shoreditch Electricity Supply Station.

Electro-Harmonic Society.—At St. James's Hall, at
ladies' night.

SATURDAY, FEB. 26.

Physical Society.—Meeting at Windsor, 4 p.m., to vis
College. Train leaves Paddington at 2.25 p.m. Th
T. C. Porter will describe: (1) A new theory of g
(2) a new method of viewing Newton's rings; (3) expe
bearing on the sensation of light; (4) a method of
lantern projections in stereoscopic relief; (5) winter
tions on the shadow of El Teide, with a new met
measuring approximately the diameter of the earth;
perature of the water of Niagara.

Charing Cross and Strand Electricity Supply Corpora
The report of the directors of this Corporation for the yea
Dec. 31 last states that there has been connected to the
the Corporation during the past year the equivalent of
lamps, an increase of 53·7 per cent. on the lamps conne
1896. During the year 1897, 6½ miles have been added
mains laid in the combined areas. The combined output
from the stations of the Corporation has increased by ab
per cent. for the year 1897 over 1896.

QUESTIONS AND ANSWERS.

ır this heading we insert questions and answers ractical character relating to central-station work, y work, or construction work; and for each suitaestion offer *one shilling*, and for the best soluany question we offer *ten shillings*. We also o *shillings and sixpence* for every other answer we The answers to any question should be sent 10 days after the question has appeared, and be written on one side of the paper only. We all the attention of those sending in answers to the ıt the neatness of any sketches sent in is considered marking the relative values of these answers. ns may be sent at any time.

QUESTIONS.

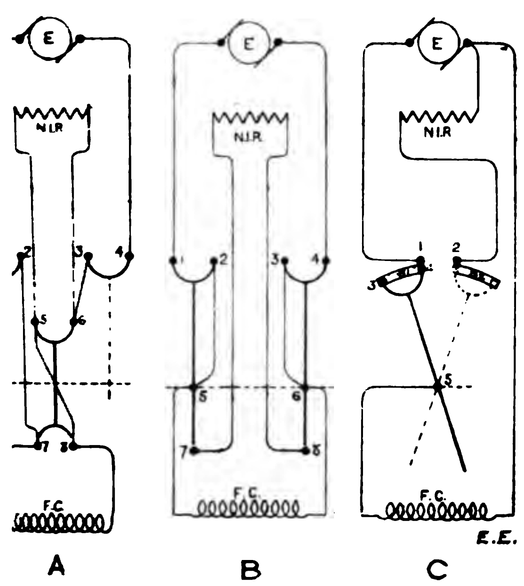
r is the efficiency of a gas-engine determined?—C. J. L.

nway motors are usually specified to have a certain tive effort at the periphery of the car wheels when the is travelling at a certain speed. How is this figure ved at, and what connection does it bear to the size of or?—X.

ANSWERS.

32.—Describe, with sketches, what you consider to be best type of switch to be used for opening the field iits of large separately excited dynamos or alternators.

Answer to No. 32 (*awarded* 10*s.*).—When the field of a separately excited dynamo or alternator is there is always a sudden rise of E.M.F. in the ls, due to their self-induction. The more sudden ak of the circuit, the greater will be the E.M.F., ing to several thousand volts, and breaking through lation of the coils. In order to obviate this diseffect on opening the fields, many switches have ised. All these switches work upon a common priniz., that of never actually breaking the field circuit, hunting it before the source of current is taken off. ccompanying figures, A, B, C, are shown in diagramorm three different types of switches. In all the s, E is an exciter, N I R is a non-inductive resistd F C the field coils.

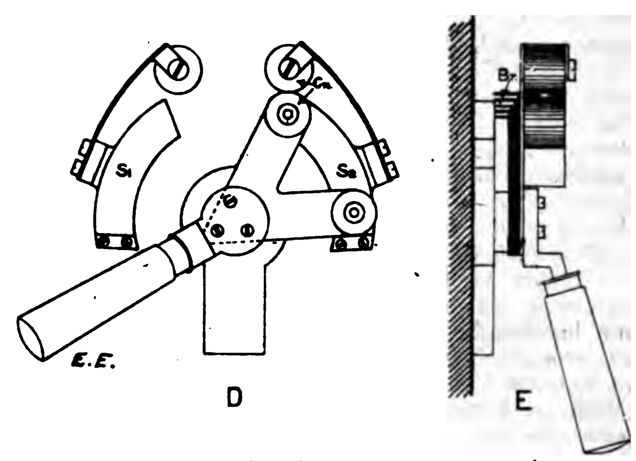


FIGS. A, B, AND C.

Fig. A, the action is as follows: Nos. 1 to 8 are between which the blades, represented by the semi, slide. All four blades are actuated by one lever, hile the three on the top side are in, the one on the side is out, as shown. In this position current is g from the exciter directly through the field coils, istance being short-circuited. The first action in g the switch is to open the contacts 5 and 6, leaving and 4 still closed. This puts the resistance in series he field, thus reducing its current to, say, about half. A further movement of the lever makes contact at 1, 2, 3, and 4 being still closed. This short-circuits the field coils, and sends all the current through the resistance. The next movement opens 1, 2, 3, and 4, thus finally cutting off the current from the resistance. The field circuit is not opened at all.

Referring to Fig. B, 1, 2, 3, 4, 7, and 8 are contacts, while 5 and 6 are the pivots of the switch. With the switch in the position shown, the current is flowing through the field coils from the exciter. The first movement of the lever closes contacts 7 and 8 before opening 1, 2, 3, and 4, thus putting the resistance as a shunt to the field. This resistance is most effective when about equal to that of the field, and therefore it takes an equal current to the field for a short time. The next movement of the lever opens 1, 2, 3, and 4, cutting off the exciter, and the current in the field coils gradually dies down without the fields being opened. It is generally found advantageous to first reduce the current in the field coils by means of an external resistance before opening the switch.

Fig. C is the diagram of a single-pole carbon break switch; 1, 2, 3, and 4 are carbon rollers, made of arc lamp carbons. The arc between carbon terminals is softer than between metal ones, and the carbons are easily renewed. In the position shown the exciter is sending current through the field coils. When the handle is moved to the left, roller 4 comes into contact with 2, whilst 3 is still in contact with 1, because of the brushes under 3 and 4, described later. This puts the resistance in parallel with the fields, and the next movement cuts off the exciter. The strips, S_1 and S_2, are connected with 1 and 2 respectively.



FIGS. D AND E.

Figs. D and E are drawings of this carbon break switch. Cn are the carbon rollers. Two are on the fork piece of the handle, and the other two are each connected by a spring to the strips, S_1 and S_2. The brushes which make contact with these strips are shown at Br. Things are so proportioned that the brushes leave the strips when moved in either direction before the carbons are separated, so that no arcing takes place between any metal parts. These three arrangements are very good, but C, besides being cheaper than the others, can be kept in better condition by renewing the carbons.—T. A. LOCKE.

Answer to No. 32 (*awarded* 2*s.* 6*d.*).—The principal points which switches for this class of work must embody are (1) immunity from danger of the field-magnet coils by reason of their big self-induction on breaking the circuit; (2) preservation of the switch contacts from destructive sparking.

There are a number of excellent methods of obtaining these results. The one sketched below would fulfil the conditions very well. It consists of two brushes rigidly fixed together and capable of being swivelled round on to two contacts, E and F, which have at their extremities carbon rollers playing against corresponding rollers on the brushes, the object of these being to remove the spark from the metal contacts to a place where it is comparatively harmless. Fig. 2 gives a diagram of the connections. On making the circuit the switch would be in the position indicated in Fig. 1. On breaking, the action is to short-circuit the field-magnet coils on themselves through a non-inductive resistance; this happens when the switch is in its

middle position, as shown by the dotted lines, A B and C D. On turning the handle a little farther round, the right-hand brush would leave its contact while the two carbon rollers on the right are still touching one another, and thus the damaging spark which would ordinarily occur is diverted on to the two carbon rollers, preserving all the metallic

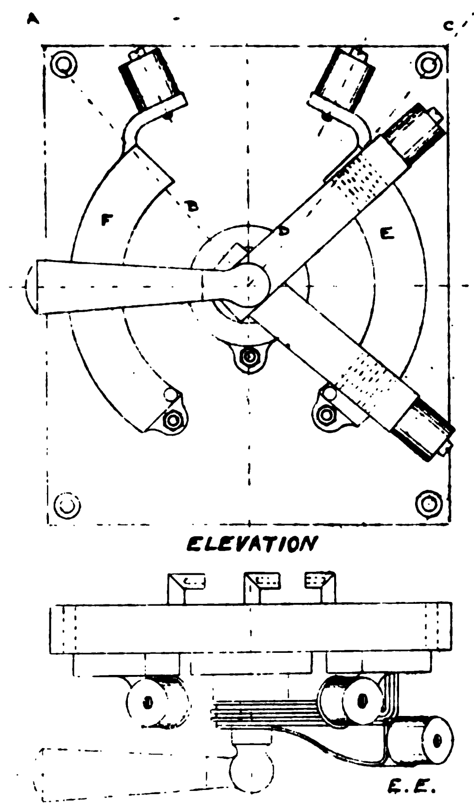


Fig. 1.

contacts. The object of short-circuiting the field coils is to reduce the big self-induced current which would occur were the circuit suddenly broken. If this were not done, probably the high induced current would break down the insulation of the magnet coils at some weak spot, and eventually cause a short in them. It also tends to materially reduce the big flash at the carbon contacts on breaking the circuit.

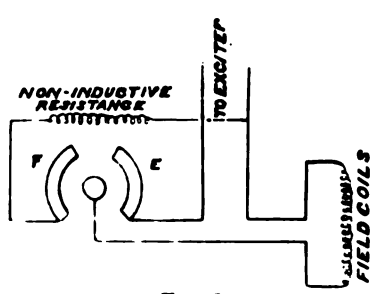


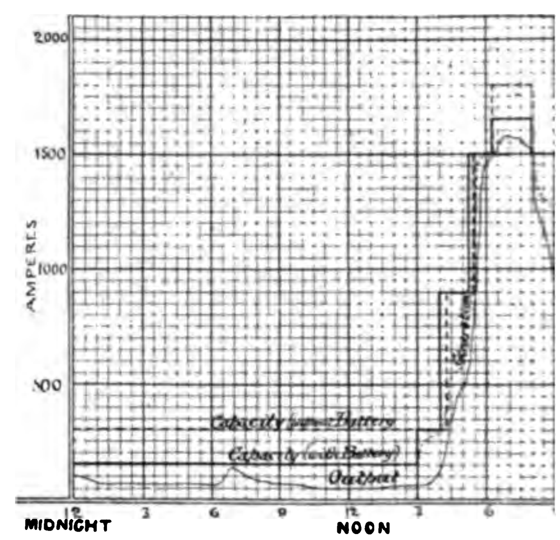
Fig. 2.

There are many other switches in use for attaining these results, but generally the same principle—namely, that of short-circuiting the field—is employed in them, as in the one in the sketch. Another method of protecting contacts from sparking is by having a small fuse in parallel with the switch. The main current, which would tend to flash across from the contacts to the brush at break, flows through this auxiliary fuse and eventually melts it. A bobbin of fuse wire is conveniently placed for replenishing after has melted. This method has not simplicity and cl to the same extent to recommend it as the one the sketch.—Herbert Bell.

Question 33.—Discuss the financial and other advantage from the use of accumulators in a moderate-size station.

Best Answer to No. 33 (*awarded* 10*s*.).—The ad are: (1) The battery supplies the small demand fo during the day and latter part of the night, a moderate-sized station, such as that of a small p town, means on the average 18 hours of the 24, th ing a great saving in attendance and coal, water, et would otherwise be required for running during t of this time, and during the greater part of w engines would be working under their very wor tions, whereas the battery is at its best with a lo discharge for a long period. The reduction in at is an important item, since it enables the stati worked with only one shift of men during the he of the evening. The financial side of the questio answered if this saving can be proved to be large e pay for the outlay on accumulators, notwithstan loss in efficiency and cost of maintenance, which is heavy item. The following figures, which are fou actual costs, those for a system without accumulat obtained at a time when the battery was disconn repairs, show this. (See Table A below.)

The saving is £456 per annum, and the batter paid for in a little over two years taking initial £800, which interest at 5 per cent. and a 4 per cer ance for maintenance brings up to £944.



(2) The charging of the battery during the ev helps to broaden the load curve, and improves factor of engines without much increase in consu fuel and steam; and (3) at the time of maximu the engines running are fully loaded, the peak of can be taken by a discharge on the battery instead o up another set. This not only helps to flatten lo but adds to the capacity of the plant without an of the boiler or engine power. This can be seen paring in diagram (1) the capacity curves of systems, and (2) the load factors for the sam taking this to be 900 units, the load factor of th which uses accumulators works out at 75 per ce that of the other is only 65 per cent.

TABLE A.

System.	Coal.	Water.	Oil.	Stores and wages and materials on repairs.	Labour and superintendence	Total works cost.	Units generated.
1. Low tension without accumulators	1·93	·055	·035	·47	·77	3·26	150,000
2. Low tension with accumulators ...	1·03	·05	·03	·46	·73	2·3	165,000*

* Allowing 10 per cent. loss in battery.

The battery steadies the voltage, sudden increases ıcreases in the load being taken up momentarily as rges or charges giving the attendant time to regulate hunt resistance, or at the stop-valve till the engines the load again; this is no small advantage, especially es of light load.

The use of a battery does away with the chance of terruption in the supply, for should there be a break- in engines or dynamos the cells supply the current repairs are being effected or another set being run nd (6) on three and five wire systems it acts as a ing device.—F. H.

wer to No. 33 (awarded 2s. 6d.).—In order to esti- he effect of storage in electric supply, we will in the se assume that we have to put down a station to an equivalent of 8,000 35-watt lamps—that is to total load of 280 kw. The usual maximum load at e time may be taken as 75 per cent. of this, say v. The initial cost of such a station without storage, timating from catalogue prices, would be:

irect-coupled engines and dynamos, capable of an ıt of 50 units each	£2,800
boilers, 26ft. by 7ft., including mountings and gs	1,800
ipes, feed pump, etc.	1,500
ritchboard, etc.	300
Total	£6,400

let us arrange to have sufficient storage to supply e load. The cost will now be:

gines and dynamos as above	1,400
oilers 20ft. by 6ft. as above	1,200
lators, including racks, etc.	1,600
ipes, etc.	1,000
oard, etc.	300
	300
	£5,800

aving of £600 in favour of storage. It will be that no reserve is provided. The cost of buildings about the same in each case. We find, then, ference in first cost between the two systems is not rable, and need not be taken into account when encies are provided for.

, turning to the working expenses of such a station, kly wage per shift in the first case may be taken at hereas with storage the watch from 12 midnight to nd Sunday work may be omitted, thus effecting a of at least £5 per week, or £260 per annum. The l would be affected, other things being the same, in of storage, owing to the boilers under steam being ; and worked at a more uniform rate. This saving estimated at some 20 per cent., which would mean g of about £100 per annum in an average case. r manufacturers will now undertake to keep a in repair, and renew the plates when required, at al rate of 8 per cent. on the first cost. This would 128 per annum in the case we have assumed. Again, and cleaning to machinery and boilers may be taken 0 per annum in the first case and £50 in the second. put aside 7 per cent. on first cost for deprecia- c, we have £448 in the first case and £380 in the , since the battery need not be taken into account. s find we have a total annual saving of £350 per in favour of storage.

a, considering the case of an existing station which fed at its maximum output. The question arises r we shall increase the capacity of the plant by of engines and boilers, or by storage. The fore- considerations appear at first sight to settle this s so far as working expenses are concerned. But st remember that the feeders are now in all bility at their maximum economical load; hence, if t our battery in the station, the losses in the feeding s will be greatly increased. To get over this difficulty, consider what would result if we were to place our y at the extremity of a feeder and charge it during s of light load. Assuming the original plant to be of sending a current C_s into this feeder, and the is to be increased by an amount C_B either by g plant in the station or by placing a battery as above stated, the loss in the feeder if the extra plant is put in the station is increased in the ratio $\frac{\{C_s + C_B\}^2}{C_s{}^2}$ per hour, assuming the leads to be constant for one hour. But if the battery were placed at the extremity of the feeder, and, say, charged during the time of light load at the rate of $\frac{C_B}{4}$ amperes for four hours, the loss now is only increased in the ratio $\frac{C_s{}^2 + \frac{C_B{}^2}{4}}{C_s{}^2}$. Whence the ratio of the losses in the first method of increasing the capacity to those in the second method is $\frac{\{C_s + C_B\}^2}{C_s{}^2 + \frac{C_B{}^2}{4}}$, or if we assume that $C_B = \frac{C_s}{n}$, the ratio becomes $\frac{\left\{1 + \frac{1}{n}\right\}^2}{1 + \frac{1}{4n^2}}$, or $\frac{n^2 + 2n + 1}{n^2 + \frac{1}{4}}$

If $n = 4$, then the value of this ratio is $\frac{100}{65}$.

We may, to emphasise the matter, assume $n = 1$—that is, the output is to be doubled—then the ratio of the losses is greater than 3 to 1. Now, assuming a feeder one mile long, one square inch section, carrying 500 amperes, with a total resistance of ·1 ohm, the loss along the conductor is $\frac{500^2}{10^4} = 25$ B.T.U. as originally installed; and assuming the above conditions of charging and discharging for a battery at the end of the feeder, we have a further loss during charging of 6¼ B.T.U., or a total loss of 31·25 B.T.U. In the case of the battery being placed in the station the whole current would have to be sent through the feeder, incurring a loss three times as great, or a difference in the losses, in favour of the battery at the end of the feeder, of 62·5 B.T.U. per hour of maximum load. Assuming the total cost of generation to be 2d. per unit, and the maximum discharge to take place for 100 hours per annum, the difference in the cost of the energy wasted will amount to over £50 for this one feeder for only 100 hours out of the year. Of course, the sectional area of the feeder could be increased, but this would mean a great expense, and the only item to set off against it is the cost of a building to contain the battery, which need not be a fraction of the cost of the copper in the feeder.

We have thus fairly considered the battery question, and have come to the conclusions that the saving to be attained by their use is not in first cost, but in the wage sheet, coal bill, and provisions for extensions, and a certain amount of security against breakdown in the machinery.—E. W. R.

INSTITUTION OF MECHANICAL ENGINEERS.

The fifty-first annual general meeting of this institution was held on Thursday evening, Feb. 10, when the chair was taken by the retiring president, E. Windsor Richards, Esq., until succeeded by the president-elect, Samuel W. Johnson, Esq. The discussion was then continued on a paper read by Mr. Dawson last November on "The Mechanical Features of Electric Traction."

Mr. Mark Robinson said that when foreign models were held up to them for recommendation they were apt to belittle their own country. The English engine builders were quite capable of holding their own with the American. There was a paragraph on p. 21 which he thought was entirely out of place in an English audience. He referred to the great diversity of opinion said to exist as to whether generators should be driven by ropes or coupled direct. This question had been decided in England for a great number of years in favour of direct coupling. On p. 22 there was a statement that different engines were required for lighting and for traction purposes, and a table was also given. It seemed to him, however, that the difference should not be in the engines, but in the flywheels. With a rather heavier flywheel they could do quite as well as if they had different engines. As regarded flywheel accidents, there was not so much danger of the English small flywheel bursting as of the larger American wheel. The paper said that the angular velocity should not vary more than three-quarters of 1 per cent. In the three-crank Willans engines it was only one-third of 1 per cent. without flywheels. As to varia-

tion of load being injurious to the engines, the English practice was to test the engines by throwing the full load suddenly on and off several times. No greater strains than this would be met with in traction work. Mr. Dawson, on p. 21, said that low-speed engines were preferable, but the Liverpool Corporation did not think so, as they had just ordered 1,500-h.p. high-speed engines for their trams. As an example, three small high-speed engines had been sent out to Hobart, Tasmania, and although they had the disadvantage of light flywheels, they were giving great satisfaction. The engines of this type at Liège were also very satisfactory. They should not accept the facts which Mr. Dawson gave.

Mr. Jeremiah Head said he thought the discussion had been a little too hard on the paper. Mr. Crompton had said that the work might be done quite as well by English engineers, and we could manufacture better engines and dynamos. With regard to the greater number of miles of electrical tramway which had been used abroad, it was because the conditions were very different in America. The United States were vastly larger than England; their towns were not compact, like the English, but very straggling, and consequently a great distance from one end to the other. The English too, had the advantage of splendid roads, which made communication easy, but in the States the roads were very bad, or even wanting. As regarded the best methods of traction, in 1890, when he was first in the States, there were five modes of electric traction. These had now all practically disappeared, except the trolley car, this showing which the United States engineers thought the best after trial. The question was not yet settled in England. In Newcastle their engineer had recommended cable cars, but he could not, he thought, have compared the statistics of the two, or he would not do this. The Boston cars ran at 36 miles per hour. They were composed of two bogie cars with pneumatic brakes. They carried 60 passengers, and ran on rails of 60lb. weight per yard. These cars went round any corner, no matter how sharp. Everything on them was worked by electricity. He did not advocate putting these cars on the London streets. If they were to be brought into the City, they would have to be made to run underground; but they might be used with advantage in the suburban towns. A 32ft. car on a wheel-base of 7ft. would carry a large load of people. The noise made by them was a great objection. The system did not answer well at first, because they argued that if it took two horses to pull a car, it would only take a 2 h.p. motor. Now, however, they used 25-h.p. motors. The power was easily obtained at the central stations. It was a very good system. What he wanted to know was, why could the States do all this, while we could not?

Mr. Worby Beaumont said that if the paper had been American it could not have had a more decided tendency that way. They did not want to be told that *this* was recommended and *that* was advised. English engineers did not want that. They did not in England want tramways so much as they did in the States. Several flywheel accidents happened there every week. Regarding the successful running of the tramways in the States, if the Americans liked to run their trams through the streets at a rate of 15 or 16 miles an hour by using two 25-h.p. motors on a car requiring not half as much, they might. As to their superior engines, etc., there were some engines in use now which were in use 20 years or so ago. He considered that the case of the flywheel accident to be due to the factor of safety being taken too low. Mr. Dawson's remarks on this subject had led him to this conclusion; 80ft. per minute was the maximum rim velocity we allowed.

Sir Frederick Bramwell said that Mr. Head had asked why they had not made as much advance in traction as the Americans. In the States they were not handicapped by silly laws which checked private enterprises by confiscating their lines after a limited number of years.

Prof. W. C. Unwin said that the reason we did not get along so fast as the Americans was because we had not so much experience as they. The conditions were very different in America. They also had habits there which did not exist in England. Many people went on the cars for a trip at 11 o'clock at night to get the air. The system was to be seen at its best in Ottawa, where they had only a single trolley line, and their power was derived from the river. The cars were excellently lighted, 20 16-c.p. lamps being used in one car, and these were also heated by electricity. In Boston the conditions were different, and the service was not so well liked. They even looked forward to having some other system, as the overhead trolley wires were objected to in narrow streets. It was reported that 200 horses were killed in the streets of Boston by falling trolley lines during the recent blizzard. In New York they were laying down a conduit system. As to the question of engines, if the flywheel question were the principal one, then he thought short-stroke engines with light flywheels the best. It was in the long-stroke engines that they had the heavy flywheels. The longest list of flywheel accidents he had yet met with was not American, but came from Germany. There was no reason why the heavy flywheel should not be as safe as the light one, as the rim velocity, and not the weight, gave the trouble. A question yet to be settled was whether the long or short stroke engine is the best. He was rather inclined to favour the long-stroke type; and, at any rate, automatic expansion governing must be used.

Prof. A. W. B. Kennedy said it was only right to say that engineers would have to treat the subject in the same way as every other mechanical problem. The Americans would have us believe that only their system would be successful, and anything else would be a failure. There was no fetish about electric traction, as these gentlemen would have us believe, but careful attention to the mechanical problems involved was required. Thus the American method would be supplanted by others equally good. The strains on the engine due to fluctuating load had bee exaggerated. With the high-speed engines used in Engl load could be thrown on and off as rapidly as one liked injuring the engine or varying the voltage to any extent.

Mr. Archibald Sharpe said that he would like to brin their notice a new type of flywheel which was absolutely fr bursting. This was a wheel with 24 spokes set at a tange to lessen the bending strain on the rim, which at high v and with few spokes was more dangerous than the tensio A diagram was explained in full.

Mr. Holroyd Smith said that he concurred with Mr. Be that one reason why the United States used electric tra much was the bad state of the roads. They were obliged to have the best-quality rails. In Philadelphia once found on measuring that the rails were in some plac 6in. above the road. He would like to ask whether in th on p. 3, on the cost of tramways in small towns, did the ite struction and equipment" mean the electrical equipment whole equipment; also, why did the wires fall in Boston the 200 horses?

Mr. Gadsby said he thought that the Tramway Act of which a corporation was able after 21 years to practically co the tramways, had a lot to do with retarding progress. Th described as S S S should be called, he thought, G.A.S was an appropriate term, as a hot and a cold tube could welded together. He had noticed that in America the were not keyed on to the axles, which, he thought, advantage, as it facilitated their removal when required.

Mr. C. Day said that the author had compared the required for traction to those used for working rolling m had not, however, given particulars of English types of mill engines, which were heavier, as far as the speaker co than those listed by the author. All the deputations (exc Birmingham one) sent from England to examine the d methods of electric traction did not notice the unsightlines overhead wires after a few days. There was no objectio conduit system such as that at New York, except the cost.

Mr. Lomas, in replying for Mr. Dawson, said that with to the horses in Boston, the paragraph was cut from the unt New York Press, and said that 200 horses were killed by e and falling trolley wires.

ELECTRIC LIGHTING AND HACKNEY.

The Hackney Vestry has not made much progress u present with regard to the provision of electric light in the Although a consulting engineer was appointed some ye nothing was done, and now the position of the matter is as

A special meeting of the Vestry was called for We evening last to rescind the resolution of the late Board of dated October 12, 1892, so far as the same relates to the p Hackney—viz., "That having carefully considered the su the reference made to them, they are of opinion that it desirable that the electric lighting of the district should into the hands of private persons." Also to rescind resolu the Hackney Vestry, dated January 28, 1896, upon the r the Sanitary Committee—viz.: (*a*) "That the Vestry do un the work of collection and disposal of house refuse in the p (*b*) "That the Sanitary Committee be instructed to submi Vestry a scheme for the collection and disposal of house If the foregoing was carried, Mr. Hulland was to move the a of the following important report: "Report of the Joint Co composed of the members of the Public Health and the Lighting Committees of the Hackney Vestry, presented in ance with the following resolution of the Vestry passed on 1897: 'That it be referred to the Joint Committee of the Health and Electric Lighting Committees to consider the ability of the Hackney Vestry transferring the electric order or retaining the same, and to report fully on the question, submitting schemes.'

"We have, in accordance with the above resolution careful consideration to the question of how best to utilise interests of the ratepayers of Hackney, the provisional o electric lighting. The main question before us was whet Vestry should itself do the work of generating and su electrical energy under the order. This would have invol raising of a large sum of money—probably £250,000—on lo engagement of electrical engineers, and the making of nu contracts for buildings, machinery, plant, cables, etc. T through all this successfully would have demanded technical knowledge on the part of some members of a mittee appointed for the purpose, and the taking of a responsibility on the part of the Vestry, which, in the exp of the London local authorities acting under their electric orders, has not been so far financially to the interests of th payers. On the other hand, various offers have been made Vestry which show a considerable financial benefit, and rel Vestry of all risk. The committee, therefore, almost unan decided to recommend that the Vestry should not the work the order, but should transfer it to skilled contractor adequate provisions for efficient working and probable rep The committee further decided that the destruction of re conjunction with the generating of the light, should be an e part of the scheme. The advantages of this system are and we may add that the Vestry has unanimously app dust destructors. The refuse provides to some extent the the engines, and consequently the light can be produc cheaper rate.

committee felt it desirable to advertise for schemes by ›rs for taking over and working the provisional order. In we received seven proposals. We also received particu- ust destructors from Messrs. Willoughby, of Plymouth, Horsfall Furnace Syndicate, of Leeds, but not accom- y any provision for dealing with electric light. One other Adamson and Co., Dukinfield) wrote for particulars, but submit a scheme. The scheme submitted by Mr. H. Kingsland-road, appeared to your committee to be calculation at what rate the work should be done than a ›ffer to undertake the responsibility of the order. The submitted by Messrs. Crossfield, Son, and Cushing, on Messrs. C. and A. Sax, of 53, Charterhouse-street, offered take the dust destruction at 1s. 3d. per ton; the price to ed for electric energy was 5d. per Board of Trade unit; ric current for 25 public arc lamps to be supplied free of ınd the repurchase was to be upon the following terms: ler may be repurchased at any time by giving 12 months' n the following terms: up to a period of 10 years ıent of 15 per cent. over and above the sum fixed proper valuation, such valuation to be made by a ıppointed by either party, and in case of dispute the respective valuers the matter to be settled by ›ire appointed by the Board of Trade, or other nutually agreed to. The umpire's decision shall be binding on all parties. Between 10 and 21 years by of 10 per cent. on the same lines. At the expiration of and up to 32 years by payment of 5 per cent. on the same l at the expiration of 32 years, the applicants agreed to r the compulsory clause as provided by Clause 2 of the ınt to the Electric Lighting Act, 1882, Clause 27. The ıubmitted by the Imperial Electric Lighting Company, y House, Norfolk-street, offered to do the dust destruction , but the representatives declined to do the dust collec- the price to be charged was on the basis of the maximum The committee felt that this scheme did not offer the ı benefit to the ratepayers. The scheme submitted by iemens Bros. dealt only with a portion of the area, and reover, accompanied by the proposal to do the dust on at 2s. 5½d. per ton. The scheme submitted by the f London and Brush Provincial Company did not include ision for a dust destructor. Moreover, their generating situated outside the district, and therefore if the Vestry wished to exercise its power of taking over the supply vould have to build new works In the meantime, the ould have to build a destructor at considerable expense. me submitted by Messrs. Laing, Wharton, and Down e satisfactory in itself, except that the prices quoted so favourable to the Vestry as those in some of the other he scheme submitted by the Electric Extension Company, covered all the points which the committee desired to see

They offer to collect, destroy, and dispose of the dust ton, to supply public and private lighting at 3½d. and nit respectively, and for power purposes only at 2½d.

They satisfied us, on searching and careful questioning, y were able to undertake the work and carry it out . They are practically manufacturing firms of the standing (the British Insulated Wire Company and Limited); and they were able to show us, from contracts carried out by them for more than 100 public bodies and companies, that their experience in dealing with such is of a very wide and satisfactory character. No other tendering impressed us with anything like the same ce as the representatives of this company did. They ıe to deposit £5,000 with the Vestry—a guarantee for the out of the work at 2½ per cent. per annum. They further ke to pay the Vestry £500 towards their expenses in g and transferring the order.

financial benefit to the parish by accepting this offer is from the collection and disposal of the dust. During the hs ended Dec. 24, 1897, the collection and disposal cost the N division, 22,766 cart loads at 5s. 3d. and 5s. 2d., 18s. 6d.; S division, 27,972 cart loads at 5s. 2d. and 5s. 1d., 5s.; wages of dustmen, paid by Vestry, £2,152. 3s. 7d.— 15,195. 7s. 1d. Assuming each load one ton, the cost under r would have been, at 4s. per ton, £10,147. 12s., leaving a the parish per annum of £5,047. 15s. 1d.

ur committee, therefore, unanimously recommend the to accept the proposal of the Electric Extension Company, d, conditional upon all the advantages outlined in the al being embodied in the most binding contract that can be up on the matter. Your committee further unanimously end that the solicitor be granted (subject to the control of nt Committee) power to obtain legal and technical assist- preparing the necessary contracts and deed of transfer."

ELECTRIC LIGHTING FOR LUTON.

y report on the Luton Corporation's electric lighting as been presented by Mr. Albion T. Snell, A.M.I.C.E.,

port Mr. Snell says: "I am of opinion that a low- e-wire system at 460 volts with 230-volt lamps would d for the requirements of your town, both in the nt and in the future. The scheme I propose would, e additions, serve an area bounded by a circle of at iles radius from St. Mary's Church, and so would meet the probable extensions of your town. Should the town extend beyond these limits in any one direction (say the Dunstable-road), it would be easy to combine a high-tension service if found to be necessary. The compulsory area and adjacent streets are compact and well suited for an electricity supply. The compulsory area comprises 1,897 yards, the suggested additional area is 1,143 yards more, making a total of 3 040 yards. For the first year, the estimates are based on a lamp connection of only 5,000 lamps of 8 c.p., exclusive of street-lighting. Experience shows that only about two-thirds of the lamps connected to the supply mains are ever in use at the same time. Hence 5 000 lamps connected are equivalent to a station demand of about 3 400 lamps. For public street-lighting I have suggested elsewhere, in the first instance, the use of nine arc lamps and incandescent lamps, equivalent to 100 of 8 c.p. This is equal to a station demand of approximately 1,630 lamps of 8 c.p. each. For motors, I should estimate that power would be required during the first year equal to a station load of 750 lamps of 8 c.p. each. For heating, I should estimate that a demand equal to 500 lamps of 8 c.p. might be required during the winter months of the first year. On these assumptions, the estimated station demand at full load for the first year may be given in terms of lamps of 8 c.p. each thus: private lighting, 3,400 lamps; public lighting, 1,630 lamps; motors, 750 lamps; heating, 500 lamps—or, say, a total of 6 300 lamps of 8 c.p. each."

Mr. Snell recommends putting down three Lancashire boilers with an economiser, each of sufficient capacity to deal with the first year's load so as to have one in actual work, one in complete reserve, and one being cleaned or repaired. A battery of accumulators should be provided to deal with the night load from 11 p.m. until 7 a.m., and also mechanical stokers. In the engine-room there should be three sets of direct-coupled compound condensing engines, each of about 135 i.h.p. at its most economic load. There should also be a small balancing set of about half that power for running the day load. The River Lea would supply the circulating water. The distribution network would be by lead-covered cables drawn into stoneware conduits laid direct under the pavements. The ultimate private demand in the area would probably be not less than 18,000 lamps. Only one feeder, near the town hall, would at first be required. Provision is made for extensions in the direction of Dunstable-road, Castle-street, and High Town, and the use of only first-class plant is urged. The following are the alternative estimates:

ESTIMATE A.—INCLUDING PUBLIC LIGHTING.—*Capital Account.* The items are: generating plant, £8,430; mains and 50 connections, £4,518; public street lighting, £500; buildings, £4,500; sundries and fees, £2,000—total, £19,948. Of this amount probably not more than £16,000 need be spent during the first year.

Revenue Account. — First year's consumption estimated at 143,000 units at an average price of 4·6d. per unit. Private lighting with 5,000 lamps at 5·92d. will produce £1,850; public lighting, nine 10-ampere arcs, £120; ditto incandescent lamps, £140; motors at 4d., £453; heating at 1·5d., £140—total first year's earnings, £2,734

Maintenance Account.—Works cost, including £357 coal and £415 wages, is put at £1,041; general costs, management, rates, etc., £567; capital charges, sinking fund and interest on £16,000, £960; depreciation, £320—total, £2,888. The cost per unit is 4·85d.

ESTIMATE B.—PRIVATE SUPPLY ONLY.—*Capital.*—Substantially as in A, but probably not more than £15,000 need be spent in first year.

Revenue —As in A, deducting street-lighting, £2,473.

Maintenance.—For a consumption of 126,500 units, £2,722. Cost per unit, 5·14d.

Mr. Snell says his estimates have been carefully prepared to meet the special features of Luton. He proceeds: "The selling price for units for all work, except public lighting and heating, is based on a charge of 7d. for the first hour and 3d. afterwards. Heating is charged preferentially at 1·5d. per unit, public lighting at 3d. per unit. The importance of public lighting and of a motor and heating load is manifest. The estimates show that a small loss is probable during the first year's working, which would, in my opinion, be more than compensated during the second year. If the estimated motor load were not fully realised during the first year the loss might be slightly greater, and it might be found advisable to charge a preferential rate for motors as well as for heating. The estimated average price, including public lighting, is 4 6d. per unit. The average price for public lighting is 5·92d., being taken on a basis of 15 units per annum per lamp connected—*i.e.*, each lamp running for an average of 500 hours per annum. This is a low estimate, and it is probable that the average time of running would be greater. If this were so, the price to the consumer would be proportionately decreased and the earnings of the station increased."

Mr. Snell gives the cost of lighting Park-square, Market-hill, and George-street by gas at £130. 19s. 8d., and by electricity at £132. 9s. 4d. "This will compare very favourably with gas when the increased (treble) illumination is taken into account." In the chief side streets he would recommend incandescent lamps at a cost of £90, as against gas at £83. The total charge for street-lighting in the compulsory area would be £260. 19s. 8d., as against £232. 8s. 5d. for gas as at present.

Mr. Snell urges the importance of a regular demand, and says this is the test of a consumer's desirability. The tradesman who lives over his shop is in the best class of consumers, but a large shop which closes early is not so desirable. Factories and private

houses offer points of different maximum demand. Brighton's example shows the success of the demand meter system, and he recommends this for Luton, the basis being 7d. for the first hour and 3d. afterwards. Under his suggested scale, the bills for electricity and gas would be about the same when the lamps were run three hours daily.

The report states that the staple trade requires a warm dry atmosphere in the workrooms, and this can be fully secured by electric radiators. But the only obstacle is the cost, and in few places is electric heating generally possible. A charge of 1·5d. per unit on the estimated consumption is suggested. As to motors, Mr. Snell feels sure they will be largely used as soon as properly appreciated. Motors would compare favourably with gas-engines, besides having other advantages. As much difficulty is experienced in providing a useful day load for the station, motors should help to a slight extent, but Mr. Snell recommends encouraging the continuous use of the light in basements, staircases, etc. In conclusion, Mr. Snell mentions methods of popularising electricity, and recommends the Corporation to give free connections to consumers.

LEGAL INTELLIGENCE.

POSTMASTER-GENERAL v. CORPORATION OF LONDON.

On Thursday last week the case of the Postmaster-General *v.* the Corporation of London came before Mr. Justice Wright, Viscount Cobden, and Sir F. Peel, sitting as Railway and Canal Commissioners. The Solicitor-General (Sir R. Finlay) and Mr. Cassely appeared for the appellants, while Mr. Cripps and Mr. Lyttleton Chubb were for the respondents. We are indebted to the *Morning Post* for the following report:

Mr. Cripps said the substance of the difference between the litigants was this: Her Majesty's Postmaster-General applied for permission to place his wires under certain roads situated within the City of London. He applied to the Commissioners of Sewers, who had since been succeeded by the Corporation of London. For some time there had been a discussion between the National Telephone Company and the Commissioners of Sewers. So far as the National Telephone Company were concerned, they did not dispute that the Corporation of London had the right of absolute veto, and when the National Telephone Company applied for leave to lay junction wires connecting the exchanges with the Post Office, the Corporation refused their consent. Subsequently an application was made—not in respect of the same wires, but that did not affect the question—by the Postmaster-General. He claimed that he could lay down these wires for the use of the Telephone Company under his rights as Postmaster-General, without the consent of the Corporation, but the Corporation contended that they had the power of veto on such laying down of wires for the National Telephone Company, which was a private company. The matter was brought before Commissioner Kerr, who decided in favour of the Postmaster-General. What the Corporation sought from the National Telephone Company were better terms, because they were not satisfied with the service provided by the company in the City. He, on behalf of the Corporation, contended that there was nothing in the Acts of Parliament or elsewhere that enabled the Postmaster-General to override the veto of the Corporation with respect to the National Telephone Company. They were perfectly willing to consent to lay down wires for the use of the Postmaster-General, but not to those laid down for a private company. The National Telephone Company had, it was alleged, not done its duty in the City, and the Corporation, having the right to withhold their consent, submitted that the Postmaster-General had no greater right nor the power to lay these wires for the Telephone Company.

The **Solicitor-General**, in reply, submitted that the condition laid down by the Corporation was entirely unreasonable. The trunk lines would be useless were they not in communication with the local branches, that were served in the majority of cases by companies such as the Telephone Company. What he wished to draw attention to was that such communication between the trunk lines and the local systems of the Telephone Company, who acted under the license of the Postmaster General, was essential for the working of the system that was contemplated by the Act of Parliament of 1892, under which the Postmaster-General acquired the trunk lines. It was not disputed that the Postmaster-General was entitled to lay these down, but it involved the breaking up of streets, for which the consent of the road authority had to be obtained. It was in their capacity as the road authority that the Commissioners of Sewers had any jurisdiction in the matter. It had been said that the road authority had the right of absolute veto. As a matter of fact, the road authority was invested with power in order to see to the safety of the roads and the convenience of the public.

Mr. Justice Wright: You say that the road authority can only object as a road authority?

The **Solicitor-General:** Yes. Continuing, counsel submitted that the condition imposed by the Corporation was preposterous. They were seeking to determine that the conditions under which the telephone system was to be carried on were proper, and the consent of the road authority to the opening up of the streets was to be made the lever for entrusting the authority with functions which, he submitted, were absolutely alien to its constitution.

Mr. Justice Wright, in giving judgment, stated that the objection of the Corporation was not raised in an unfriendly or captious spirit. They thought that as the supreme road authority it was their duty to see, as far as they could, that companies trying to use
public streets for private purposes should be made to
reasonable terms. The question was whether such a
been conceded by the Legislature. Speaking for h
thought the objection made was not one it was intended
authority should be enabled to raise. The objection
entitled to raise must be of a kind that concerned them
authority, whereas the one in question had another int
did not concern them as a road authority. Even outsi
was clearly an unreasonable objection, and ought not t
tioned by the Court.

Judgment was accordingly given for the Postmaste
without costs the President stating that there were no co
Court, save where it was thought something had been pr
resisted in a vexatious manner.

TELEPHONE AND ELECTRIC TRAMWAY WI

At the Walsall County Court on Wednesday, his Hon
Griffith being on the bench, a case was heard of co
interest to telephone and electric tramway compa
plaintiffs were Messrs. Bedworth and Son, merchants, o
street, Great Bridge, and they claimed £37. 4s. from the
Telephone Company, Oxford-court, London, this being
of a horse which died in consequence of the telephone wi
it a fatal shock.

Mr. Ensor appeared for the company, and claimed
South Staffordshire Tramway Company should be jo
them as defendants, as they were jointly liable. Mr.
appeared for the tramway company, and Mr. Parfitt re
the plaintiffs. The facts of the case are these: A serv
telephone company was engaged in repairing one of
when it fell across another wire, the latter being the p
the tramway company. This sent through it a curr
made the man drop the wire, and after it had fallen
horse became entangled in it, and was fatally shocked.

Mr. Ensor urged that the tramway company were
insulate their wires, and as they had failed to do this
really responsible for the accident.

Mr. Disturnal submitted that to make a third party
such a case liability to indemnify must be shown.

His **Honour** held that the falling of the telephone wi
tramway wire was a trespass, and that the tramway comp
not be held liable for that. He therefore dismissed t
against that company with costs.

Mr. Parfitt said that after Mr. Ensor's argument ther
no defence against the plaintiff's claim, as the parties h
that the damages were £35. 4s. 6d. He asked his H
judgment for that sum.

Mr. Ensor said his only defence was that it was the
passing from the tramway wire to the telephone wire
caused the man to drop it, and it was in that wire that
was entangled.

His **Honour** said the telephone company had no ri
their wire rest on the tramway company's wire. An
made for £35. 4s. 6d. and the costs.

EXPORTING ELECTRICAL GOODS.

Lyell and Co. v. Davis.

In the Westminster County Court on Friday last, h
Judge Lumley Smith, Q.C., gave judgment in this cas
of which appeared in the *Electrical Engineer* a fortnight

The plaintiffs were Messrs. John Clarence Lyell,
Lyell and Co., at Victoria-street, Westminster, and
was brought against the defendants, a firm of carriers,
damages for the loss of sale of a quantity of electr
entrusted to them for exportation to Stockholm for the
the decorations in connection with the jubilee of King
Sweden. The plaintiffs' case was that the defendants
to send the goods by a certain ship, but failed to d
the consequence was that they arrived at Stockholm a
and were rejected by the consignees.

In giving judgment, his **Honour** said he was satisfi
evidence placed before him that the defendants did un
deliver the goods at Stockholm in time for the jubil
was equally satisfied that they had failed to carry out
tract. He had no doubt that the goods would have bee
if they had been delivered by the proper ship, and the
plaintiffs were entitled to damages for the loss of sale,
being so, there would be judgment for the plaintiffs fo
costs, but he would give the defendants leave to app
question involved was one of some importance to carrie

COMPANIES' MEETINGS AND REPO

INDIA RUBBER, GUTTA PERCHA, AND TELE WORKS COMPANY, LIMITED.

Directors: Matthew Gray, Esq., managing directo
Silver, Esq.; Abraham Scott, Esq.; the Hon. Henry
A. Weston Jarvis, Esq; Major Leonard Darwin.

Report of the directors for the year ending Dec. 3
be presented at the thirty-fourth ordinary general meet
shareholders, to be held at the Cannon-street Hotel,
Wednesday, Feb. 23, at 12 noon.

annexed accounts show, after provision for doubtful debts, profit for the past year of £41,044. 14s. 9d. Adding £22,128. . brought forward, and deducting £12,500 interim dividend in July, there remains a disposable balance of £50,673. l. The directors recommend the distribution of a dividend s. a share, free of income tax, amounting to £37,500, g, with the interim dividend paid in July, a total payment per cent. for the year, and leaving £13,173. 1s. 1d. to rried forward. There has been little cable work during ar. The Company's general business has steadily increased, e steamships have been moderately employed. The factories rertown and Persan are in a high state of efficiency. There six months' strike in the engineering departments at Silver- which caused some inconvenience and expense, but did not y affect the Company's business. The block of buildings in the Melbourne agency was situated was burnt out on 21. Other premises have been taken and new stock has sent out. Major Darwin retires by rotation, but offers f for re-election as a director.

BALANCE-SHEET, DEC. 31, 1897.

Capital and Liabilities.		£ s. d.
rised share capital		812,000 0 0
capital—amount paid on issue of 50,000 s of £10 each		500,000 0 0
ge debentures		300,000 0 0
fund		450,000 0 0
nd loans owing by the Company		37,355 3 8
med dividends		52 0 0
and loss account—balance c. 31, 1896	£59,628 6 4	
dividend paid Feb., 1897	37,500 0 0	
	22,128 6 4	
or the year 1897 (as below)	41,044 14 9	
	63,173 1 1	
interim dividend paid July	12,500 0 0	
		50,673 1 1
ent liability—bills receivable nted ... £9,774 8 11		£1,338,080 4 9

Assets and Expenditure.	£ s. d.
d and leasehold premises (Silvertown, n, London, and Liverpool), machinery, teamships	495,866 18 0
wing to the Company	175,519 5 0
ith bankers in current account and in	18,089 4 6
n-trade, including 150 miles of cable laid	233,681 17 10
ures and shares in other companies	216,236 6 0
tock, debts, etc., at Persan and agencies, deducting liabilities	198,186 13 5
ure stamps (balance)	500 0 0
	£1,338,080 4 9

OFIT AND LOSS ACCOUNT, YEAR ENDING DEC. 31, 1897.

	£ s. d.
s, commission, rent, rates and taxes, rs, and general expenses	60,170 11 10
ge debenture interest	12,000 0 0
bts	1,030 7 1
tax	1,906 9 4
ure stamps (one-third of cost of new nture issue)	500 0 0
iation written off buildings and machinery	16,329 6 6
rs' remuneration	2,000 0 0
e—profit for the year	41,044 14 9
	£134,981 9 6

	£ s. d.
rofit for the year after making provision oubtful debts	134,981 9 6
	£134,981 9 6

WESTMINSTER ELECTRIC SUPPLY COMPANY.

ordinary general meeting of this Company was held on the st. at the offices, Eccleston-place.

. **Suffield** presided, and congratulated the shareholders. d the payment of a dividend which was an addition of cent. on that of the preceding year was recommended. extensions had been made in the centres at Millbank- Eccleston-street, and Davies-street, and the cost of supply nerating might have been far less if they had not had to l with difficulties in consequence of the necessity for those ildings. The supply of current still showed an increase tisfactory rate, and, so far as the directors could judge, vas no present likelihood of a decrease in the number ications received. As many of the older houses where tricity was used were pulled down, they were replaced e blocks of flats where electric fittings were put in. revenue of the year amounted to £49,461, and an interim d at the rate of 8 per cent. per annum for the June half- ad been distributed. The balance to the credit of the was £34,013. The Board therefore recommended the payment of a dividend at the rate of 16 per cent. per annum, less income tax, for the past half-year, making 12 per cent. for 1897, and carrying forward a balance of £3,119. He concluded by moving the adoption of the report and accounts.

This was seconded by **Mr. E. Boulnois, M.P.**, and agreed to.

A resolution that the directors should be paid out of the funds of the Company by way of remuneration for their services, the sum of £3,000 per annum was also agreed to with two dissentients.

LIVERPOOL OVERHEAD RAILWAY COMPANY.

Directors: Sir William Bower Forwood, J.P., Ramleh, Blundellsands, chairman; James Barrow, Esq., J.P., 7, Beach-lawn, Waterloo; John Brancker, Esq., J.P., Green Bank, Wavertree; Harold Brocklebank, Esq., 20, Bixteth-street, Liverpool; Richard Hobson, Esq., J.P., 54, Brown's-buildings, Liverpool; Edward Lawrence, Esq., J.P., The Grange, St. Michael's Hamlet; George H. Robertson, Esq., F24, Exchange-buildings, Liverpool. Engineer and manager: S. B. Cottrell, Esq., M.I.C.E., 31, James-street, Liverpool. Secretary: William H. Alexander, Esq., C.A., 24, North John-street, Liverpool.

Report of the directors (with revenue account) for the half-year ending Dec. 31, 1897:

In presenting the half-yearly statement of capital and revenue accounts to Dec. 31, 1897, the directors have to report that the gross revenue receipts amount to £37,583, and the working expenses to £20,240. 4s. 1d. The number of passengers carried during the last two years is as follows:

	Half-year ending June 30, 1896.	Half-year ending Dec. 31, 1896.	Half-year ending June 30, 1897.	Half-year ending Dec. 31, 1897.
First class	455,561	476,817	608,278	621,392
Second-class	2,284,823	2,473,828	2,618,844	2,790,768
Workmen (special) return tickets	999,191	968,489	1,042,138	1,055,330
Total	3,739,575	3,919,134	4,269,260	4,467,490

Revenue Account.

	£ s. d.
Receipts from passenger traffic amount to	£36,994 12 0
Miscellaneous receipts and interest	588 8 0
	37,503 0 0
Less working expenses	24,240 4 1
	13,342 15 11
Deduct interest on mortgage debentures	3,400 0 0
	9,942 15 11
Add balance brought forward June 30, 1897	3,810 6 0
Leaving available for dividend	13,753 1 11

Out of this balance the directors recommend the declaration of dividends at the following rates (less income tax), payable on and after Feb. 11 next: 5 per cent. per annum on preference shares, £3,000; 3½ per cent. per annum on ordinary shares, £7,875; leaving a balance of £2,878. 1s. 11d. to be carried forward to next half-year. The directors retiring by rotation are Mr. Edward Lawrence and Mr. George Hunter Robertson, who, being eligible, offer themselves for re-election. The auditor retiring by rotation is Mr. George Nicholson, who is eligible for re-election.

The passenger train mileage at Dec. 31, 1897, was 371,773.

REVENUE ACCOUNT, HALF-YEAR ENDED DEC. 31, 1897.

Expenditure.	£ s. d.
Maintenance of way, works, and stations	4,645 9 9
Locomotive power	5,746 17 4
Repairs and renewals of carriages	586 13 7
Traffic expenses	7,936 18 2
General charges	3,237 4 10
Law charges	168 9 11
Compensation	95 8 6
Rents, rates, and taxes	1,749 2 0
Government duty	74 0 0
	24,240 4 1
Balance carried to net revenue account	13,318 7 7
	£37,558 11 8

Receipts.	£ s. d.
Passenger traffic	36,994 12 0
Parcels, etc.	42 0 9
Rents	505 3 11
Transfer fees	16 15 0
	£37,558 11 8

COVENTRY ELECTRIC TRAMWAY COMPANY.

The half-yearly meeting of the Coventry Electric Tramway Company was held on the 16th inst. at the offices, Bank-buildings, London, the chairman (Captain Francis Pavy) presiding.

The **Chairman** stated that the nominal capital of the Company was £112,000, of which £96,000 had been subscribed and 50 per cent. paid thereon. The existing company was in liquidation, for the purpose of being amalgamated with and taken over by the Company, for which the Act was obtained in 1897. The contract for the construction of the new portion of the tramway had been given to Messrs. Pauling and Co., Victoria-street, and the work

was to be completed as rapidly as possible. The traffic receipts on the existing electric tramway lines showed an improvement as compared with the previous year.

SCARBOROUGH ELECTRIC SUPPLY COMPANY.

The Scarborough Electric Supply Company report that during the past year 32 new customers, and the equivalent of 2,340 8-c.p. additional lamps, have been connected to the Company's mains, making a total of 330 customers and 20,067 8-c.p. lamps connected at the present time. The Company has made a profit on the year's working of £2,044. 13s. 0½d., as against £1,617. 8s. 8d. in 1896. Adding the balance of £191. 19s. 5d. carried from the previous year, there is, after paying income tax, £23. 2s. 8d., bank interest £18. 8s., and writing off the sum of £100, being the balance of the preliminary expenses account, and putting £250 to depreciation, a sum of £1,845. 1s. 9½d. available for distribution. The directors recommend that this should be applied in paying a dividend of 5 per cent. (less income tax), which will absorb £1,656. 10s., leaving a balance of £188. 11s. 9½d. to be carried forward.

TRAMWAYS UNION COMPANY, LIMITED.

The twenty-fourth annual general meeting was held on Feb. 15 at Winchester House. **Mr. E. M. Underdown, Q.C.**, presided, and, in moving the adoption of the report, asked them to consider it more as describing the doings of the Company during a period of transition. The step they had taken in regard to one of their tramways was extremely important. It would be satisfactory to them to know that in all probability that portion of their system which was intended to be worked by electricity would be in full operation in June. If, as they had not the slightest doubt, the results of this mode of traction proved to be more efficient and profitable, the receipts which would provide the means of covering the outlay they had incurred for this purpose would come into account during the remaining half of the coming six months. There had been increases in their expenditure at both Bremen and Bucharest, and the expenditure had not been lessened by the fact that forage had ruled comparatively high in those cities. At Bremen they had practically relaid the system and otherwise improved it, with results eminently satisfactory. During the current year they would reap the benefit of the improved earnings. They had run an increased mileage both at Bremen and Bucharest. At the latter place they had studied in every way the possibility of improving the service. The improvement of the lines in some portions of the city would, as in the case of Bremen, immensely encourage traffic. The progress of the works at Madrid had been extremely rapid, and the appliances they were putting down there might be confidently said to be of the best and most modern kind. Their colleague, Mr. Concanon, had bestowed the greatest attention on this matter. Among other things, he went to the United States, and had satisfied himself that in the arrangements they had made they had got the very best materials and appliances that could be procured. They all knew the great profit which was obtained by overcoming the mechanical difficulties which arose in the earlier stages of the progress of electricity, and he believed they would be able to work the traffic in Madrid in a very profitable manner. Having referred to the great financial success which had attended the introduction of electric traction in Montreal, Rouen, Brisbane, and Hamburg, he stated that the capital of the Company, by the resolution passed by the shareholders last August, had been increased by £150,000 by the issue of 5 per cent. registered B debentures.

Mr. George Richardson seconded the motion, which was unanimously adopted, and a dividend was afterwards declared, making 5 per cent. for the year, tax free.—*The Times.*

DOUGLAS HEAD MARINE DRIVE COMPANY, LIMITED.

According to the annual report of the Douglas Head Marine Drive Company, Limited, a portion of the drive abandoned by the previous company has been completed, and the electric tramway continued to Port Soderick. The past season was unsatisfactory, and the support received did not equal anticipations. A concession had been granted to construct a tramway to Douglas Head, which would prove of benefit to the Company. The directors acknowledged the forbearance of the debenture holders, and stated that the property was being well maintained. Eight hundred and seventy-four pounds were taken in tolls during the season.

PAISLEY TRAMWAY COMPANY.

The Paisley Tramway Company, Limited, held their twenty-sixth ordinary general meeting last Tuesday at Paisley. After the usual business meeting, at which a dividend of 1½ per cent. was declared, an extraordinary general meeting was held in private to confirm an arrangement entered into with the British Electric Traction Company. This looks as if there is some prospect of this line being equipped for electrical traction in the near future, but, unfortunately, there is many a slip between the cup and the lip in such matters, and in view of the near completion of the Corporation's station, it would have seemed likely that they would have had something to say on the subject, and a proposal to buy up the line would have seemed the most natural course to be adopted. There are rumours, however, of an arrangement on lines that have been suggested—viz., that the company undertake to buy all their current from the Corporation.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Tadcaster.—Tenders are invited for dynamo and wiring to light Old Brewery, Tadcaster, maltings, offices, etc. For information apply there.

Glasgow.—The Corporation invite tenders for the hire or purchase from makers of dynamos and engines, direct-coupled or belt driven. Tenders by Aug. 1. Full particulars will be found in our advertisement columns.

St. Chamond (France).—Tenders are invited for lighting the town by electricity or otherwise. Particulars are to be obtained from, and tenders addressed to, Municipal Authorities at above place (Department Loire) by March 31.

Braila (Roumania).—Tenders are invited for the electric lighting of the town. The deposit required is £600. Specifications are to be obtained from, and tenders addressed to, the Municipal Authorities at Braila by Feb. 20 (March 4), at 4 p.m.

Madras.—The Secretary of State for India in Council announces that the time allowed for the receipt of tenders by the Chief Engineer for Irrigation, Madras, for the utilisation of water power of the Periyar Lake has been extended from Oct. 31, 1897, to July 1, 1898.

Melbourne (Victoria).—The Telegraph Department of the Victorian Government Railways are inviting tenders for the supply of alternating-current transformers and one main switchboard. Tenders to the Telegraph Superintendent's Office, Spencer-street, Melbourne, by March 21.

Kolding (Denmark).—For complete establishment of electric lighting works, etc. Specifications are to be obtained from Byraadets Udvalg for Electricitätsvaerket, Sugförer Edv. Las, for 50 kroner (£3. 3s.) to be returned on receipt of bona fide tender, and tenders addressed the same at Kolding by March 24.

Segorbe (Spain).—Tenders are advertised for electric lighting of the town for five years. The estimated cost is 9,000 pesetas per annum, and the deposit required is 2,250 pesetas. Specifications are to be obtained from, and tenders addressed to, the Municipal Authorities, Segorbe, province of Castellon, by Feb. 25.

Bristol.—The Electrical Committee require tenders for 214 arc lamp-posts. Specifications can be obtained from Mr. H. Faraday Proctor, city electrical engineer, Temple Back, Bristol, by depositing £2. 2s. on or before 21st inst., which will be returned on receipt of a bona fide tender. Only founders are permitted to tender.

Burgo di Osma (Spain).—Tenders are invited for the electric lighting of the town for four years. The estimated cost is 2,500 pesetas per annum, and the deposit required is 500 pesetas. Specifications are to be obtained from, and tenders addressed to Municipal Authorities, Burgo di Osma (Province of Sovia), by Feb. 20.

Sunderland.—The Corporation invite tenders for the supply of the undermentioned requirements for the ensuing year: (1) india-rubber-covered cables; (2) armoured and unarmoured concentric cables; (3) cast and wrought iron pipes and service boxes; (4) stoneware casings. Tenders by Feb. 25. Full particulars will be found in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply of (1) lead-covered cables and accessories for a period of 12 months from date of acceptance of offer, and (2) accumulators, equalisers or balancing motor-transformers, motor-driven boosters, and relative switching apparatus. Tenders by Feb. 28. Full particulars will be found in our advertisement columns.

Copenhagen.—Tenders are invited for the supply of dynamos, accumulators, etc., for the central station at Frederiksberg. Specifications are to be obtained from, and tenders addressed to Frederiksberg Sporveis-og Electricitets-Aktieselskab, Gammel Kongerei No. 140, in Kopenhagen V. Tenders to be endorsed "Tilbud paa del electriske Anlaeg til Frederiksberg Central station," and sent in by March 12.

Madrid.—The Secretary of State for Foreign Affairs has received a despatch from her Majesty's Chargé d'Affaires at Madrid, enclosing copy of a Royal decree announcing that public auction for the contract for repairing the national submarine telegraph cables during the next five years will be held at Madrid on Feb. 22. Further particulars as to the cables in question may be inspected at the Commercial Department of the Foreign Office any time between 11 and 5.

Belfast.—The Corporation invite tenders for the wiring of the new police cells, Chichester-street. Specification, with schedule of lights and form of tender, may be obtained on application to Mr. Victor A. H. M'Cowen, electrical engineer, Marquis-street, Belfast, on payment of £1. 1s., which will be returned on receipt of a bona fide tender accompanied by the specification. Sealed tenders, endorsed "Tenders for Wiring of Police Cells," to be delivered at the offices of Sir Samuel Black, town clerk, by 10 a.m. on March 9.

Rochdale.—The Corporation invite tenders for the following (Contract No. 1) steam dynamos, balancer and boosters, etc. Specifications, conditions of contract, and form of tender may be obtained at the offices of the engineers, Messrs. Lacey, Clirehugh and Sillar, 10, Delahay-street, Westminster, on payment of £5. 5s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed and endorsed "Electricity Works," must be delivered at the office of Mr. Jas. Leach, town clerk, Town Hall, Rochdale, by Feb. 19.

West Ham.—The Council invite tenders for wiring and fitting the following buildings, situated in the county borough of West Ham: (1) town hall and fire station, Stratford, E.; (2) police court, West Ham-lane, E.; (3) Corporation stables, Abbey-road, E.; (4) fire station, mortuary, and weights and measures offices, Barking-road, Canning Town, E.; (5) public conveniences, Broadway, Stratford, E.; (6) fire brigade watchbox, Woodgrange-road, Forest Gate, E. Tenders by March 8. Full particulars will be found in our advertisement columns.

London, S.W.—The Secretary of State for War is prepared to receive offers, in writing, accompanied by competitive designs and specifications, for the supply of portable electric search-light apparatus. General particulars as to requirements can be obtained on application, either by letter or personally, to A. Major, director of army contracts, War Office, Pall-mall, S.W. The offers and designs must be delivered at the War Office, Pall-mall, London, S.W., by April 27, addressed to the Director of Army Contracts, and marked on the outside "Designs for Search-Light Apparatus."

Canterbury.—The Town Council are prepared to receive tenders for the electric wiring and fittings for the Beaney Institute, Canterbury, according to plans, specifications, and conditions of contract, which may be seen at the office of the City Surveyor, 28, St. Margaret's-street, from whom also specifications, with form of tender, may be obtained on deposit of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders to be lodged with Mr. Henry Fielding, town clerk, sealed and endorsed "Tender for Wiring the Beaney Institute," by Feb. 23, at 10 a.m.

Guipuzcoa (Spain).—The Secretary of State for Foreign Affairs has received a despatch from her Majesty's Consul at Bilbao, reporting that the Provisional Board appointed in connection with the electric tramway which it is proposed to lay from Zumarraga to Zumaya, in the province of Guipuzcoa, invite plans and tender, to be received by February 28, for the construction and equipment of the line. Further particulars of the conditions of the tenders for the above-named tramline and branch, which together measure 20 miles, may be inspected at the Commercial Department of the Foreign Office between 11 and 6.

London, N.W.—The Vestry of St. Pancras invite tenders for the supply of dry-back marine boilers, 11ft. diameter, 13ft. 6in. long, with superheaters and brickwork seatings. Copies of specification, conditions of contract, and form of tender to be obtained on application at the Electricity Department Offices, 57, Pratt-street, Camden Town, N.W., on payment of a deposit of £1, which will be returnable on receipt of the specification, accompanied by a bona fide tender. Tenders to be sent to Mr. C. H. F. Barrett, vestry clerk, Vestry Hall, Pancras-road, London, N.W., endorsed "Tender for Boilers, etc.," by 12 noon on Feb. 22.

West Derby.—The Guardians invite tenders for the following work in connection with the lighting of the Mill-road Infirmary: (Contract No. 1) two dry-back return-tube boilers, each to evaporate 4,000lb. of water per hour; (No. 2) three 50-b.h.p. coupled engines and dynamos, one booster, two feed pumps, one feed-water heater, one switchboard, steam, etc., piping, tanks, etc.; (No. 3) one secondary battery of 900 ampere-hours' capacity; (No. 4) wiring of infirmary, administrative buildings, and nurses' home, and cable connections from main switchboards to above buildings. Tenders by March 8. Full particulars will be found in our advertisement columns.

Coventry.—The Electric Lighting Committee of the Corporation will receive tenders for the supply and erection of the following plant for the extensions of the municipal electricity works: (Section A) engine-house plant—300-kw. steam alternator and exciter; (B) separate exciting plant—25-kw. steam dynamo and accumulators; (C) surface-condensing plant—condenser, air-pump, circulating pump, and footplates, etc.; (D) pipework—steam, exhaust, suction, and discharge pipes, valves, oil separator, etc.; (E) switchboards and instruments—main H.T. switchboard, exciter and accumulator switchboards, step-switches, etc. Tenders by March 8. Full particulars will be found in our advertisement columns.

Carlisle.—The Corporation are prepared to receive tenders for the erection of a central electric lighting station, consisting of engine-house, boiler-house, office, stores, chimney, etc., in James-street. Persons desirous of tendering for the above works may inspect the drawings, stipulations, and conditions of contract, and obtain a copy of the specification, bill of quantities and form of tender, at the office of Mr. Henry C. Marks, A.M.I.C.E., city engineer and surveyor, 36, Fisher-street, Carlisle, on deposit of £1. 1s. for each trade, or £3. 3s. for the full set, returnable on receipt of a bona fide tender, and the return of the specification and bill of quantities. Sealed tenders, endorsed "Tender for Electric Lighting Station," to be delivered at the City Engineer's Office by 10 a.m. on Feb. 25.

St. Helens.—The Corporation invite tenders for the following work in connection with the supply of electricity for electric traction: engines, condensers, dynamos, switchboards, battery, overhead conductors, poles, and other appurtenances. Copies of the specification may be obtained from Mr. W. J. Jeeves, town clerk, on payment of £25 (to be returned on receipt by the Corporation of a bona fide tender). Specifications and drawings may be seen at the temporary offices of Dr. J. Hopkinson, F.R.S., 5, Victoria-street, London, and at 29, Princess-street, Manchester, and at the Town Hall, St. Helens. The Corporation will also be prepared to consider any tenders providing for any alterations or other arrangement or system that a contractor may desire to specify. Tenders, on the prescribed form, must be delivered at the office of the Town Clerk not later than Feb. 21, 1898.

Egremont (Cheshire).—The Wallasey Urban District Council invite tenders for the following works—viz., (*a*) engine, alternator, and exciter; (*b*) two Lancashire steam-boilers and one water-tube steam-boiler; (*c*) condensing apparatus. Copies of the specifications may be obtained on application to the engineer, Mr. J. H. Crowther, Gas and Water Works, Great Float, near Birkenhead. A charge of £2. 2s. will be made for copy of each specification, to be returned on receipt of a bona fide tender. Sealed tenders, on the form provided for the purpose, addressed to the Chairman of the Gas, Water, and Electricity Committee, and endorsed "Tender for Engine and Alternator," or any other contract, as the case may be, to be delivered at the office of Mr. H. W. Cook, clerk, Public Offices, Church-street, Egremont, Cheshire, by 4 p.m. on March 17. Contractors will be required to enter into a bond with approved sureties for the performance of contract.

Northwich.—The Weaver Navigation Trustees invite tenders for the construction and erection of the necessary electric power plant for lighting and working the new swingbridges at Northwich. The current will be supplied by the Northwich Electric Supply Company, and while the machinery will have to be constructed on the general lines laid down in the specification, and shown on the drawings, the details will be left largely to the discretion of the contractor, who will be expected to supply sufficient information and drawings to enable a decision to be arrived at as to the suitability of his proposals. The specification and drawings may be seen, and all further information obtained, from Mr. J. A. Saner, Engineer's Office Weaver Navigation, Northwich, on and after Feb. 14. Tenders and plans will have to be sent in, marked "Tender for Electric Plant," and addressed to the Clerk, Weaver Navigation Offices, Northwich, on or before March 5.

Shoreditch.—The Vestry are prepared to receive tenders for the following works for one year from March 26 next to March 25, 1899, inclusive—viz., electricity works department—(A) electric cables and sundries, (B) engineers' stores, and (C) ironmongery, tools, etc. Samples may be seen at the Electric Lighting Station, Coronet-street, Hoxton, N. Forms of tender for all the above-mentioned articles can be obtained on application to Mr. H. Mansfield Robinson, clerk, Town Hall, Old-street, E.C. Tenders must be sent to the Clerk before 4 p.m. on March 8. Contractors or their agents must attend at the Vestry meeting at the Town Hall, Old-street, on March 8, at 6.30 p.m., and must agree to pay the trades union rate of wages observed at the date of the contract, and to observe the usual hours of labour recognised by the trade. Forms of tender, with any further information, may be obtained from the various departments of the Vestry or from the Clerk.

Portsmouth.—The Corporation invite tenders for the supply and erection of additional Lancashire boilers, feed pumps, mechanical stokers, coal conveyor and elevator, economiser, steam, feed, condensing water, and other pipes, chequer plating and sundry ironwork. Specifications and forms of tender can be obtained from the Superintendent of the electric light station, Gunwharf-road, or at the offices of the engineers, Messrs. Kincaid, Waller, and Manville, of 29, Great George-street, London, S.W., on payment of a fee of £3. 3s., which sum will be returned on receipt of a bona fide tender. The contractor whose tender shall be accepted shall enter into a formal agreement under seal, with sufficient sureties, for the fulfilment of contract. Trade union rates of wages and hours to be observed. Sealed tenders must be sent in to Mr. Alexander Hellard, town clerk, Town Hall, Portsmouth, endorsed "Electricity Supply Extensions, Contract No. 6," by 4 p.m. on Feb. 22.

Sophia (Bulgaria).—Her Majesty's Secretary of State for Foreign Affairs has received a despatch from her Majesty's Agent and Consul-General at Sophia to the effect that the Municipality of Sophia have issued a notice inviting tenders (*a*) for electric lighting of the town, town hall, and fire brigade barracks; (*b*) for an electric tramway for the town and surroundings. Only bona fide electrical firms are allowed to tender. Tenders must be in by March 5-17, at 11 a.m. A deposit certificate of the National Bank of Bulgaria of £6,000 must accompany each tender; also documents showing that the contracting firm has already successfully carried out similar works. If up to the 10th-22nd of March, at 10.30 a.m., a proposal of a reduction of at least 5 per cent. per kilowatt-hour of the lowest tender is received, a new adjudication will take place on the same day at 11 a.m. Specifications are to be obtained from the Mayor of the above town (8s. prepaid), where tenders are to be addressed. Further particulars may be obtained, and a copy of the specification and other papers may be inspected, on application at the Commercial Department of the Foreign Office, between the hours of 11 and 5.

Pembroke (Ireland).—The Lighting Committee are prepared to receive tenders for the supply and erection of the following plant: (Section A) boiler-house plant—Lancashire boilers and accessories, mechanical stokers, feed pump, injector, economiser, electric motor; (B) engine-house plant—high-speed steam dynamos and accessories, oil-filter, steam, exhaust, feed, blow-off, and sundry pipes, valves, feed-water and storage tanks, etc.; (C) overhead travelling crane; (D) Switchboard and instruments; (E) accumulators; (F) underground work—trenching, cables, etc.; (G) public lamps—arc and incandescent street lamps and lamp-posts; (H) meters. The whole bound up in one specification. Tenderers are at liberty to tender for any one section, but not part of a section. Specification, with terms and conditions and forms of tender, may be obtained at the offices of Mr. Robert Hammond, M.I.E.E., the consulting engineer to the township, Ormond House, Great Trinity-lane, London, E.C., on payment of £5. 5s., which sum will be refunded on the return of the specification filled up with a bona fide tender. Duplicate copies of the

specification, £1. 1s. each, not returnable. Tenders, sealed, and marked "Tender for Electricity Works," must be addressed to Mr. J. C. Manley, secretary, Pembroke, and be delivered by March 5.

RESULTS OF TENDERS.

Hull.—The tender of Messrs. Siemens Bros. has been accepted, at £44,228. 1s. 5d., subject to the provisional approval of the scheme, and of a suitable central site for the power station, by the Board of Trade.

Aberdeen.—The Town Council have accepted the tender of Messrs. Mather, Platt, and Co., Salford, Manchester, at £4,147, for the supply of a new 650 h.p. engine and dynamo, the firm to be paid an additional £60 to adapt the engine for the supply of electricity for traction.

Belfast.—The Harbour Commissioners have accepted the following tenders for the supply of electrical plant, or portions thereof (which must be of the very best of their respective kinds), in connection with the extension of the electric lighting of the quays at Belfast Harbour: W. Hartnell, Leeds, two dynamos; Williamson and Joseph, Limited, London, one switchboard and 100 isolating switches; C. A Müller, Bradford, 100 arc lamps; T. Scott Anderson, Sheffield, 100 lamp masts; British Insulated Wire Company, Limited, Prescot, mains and junction boxes.

Bootle.—The Corporation have accepted the following tenders for boilers, machinery, plant, mains, and other works required in connection with the supply of electrical energy, in accordance with plans and specifications prepared by Mr. Thomas Lodwick Miller: (Contract No. 1) Thos. Parker, Limited, Wolverhampton, boilers and economiser, (No. 2) engines, dynamos, and other plant—£11,791, with allowance by contractor for present engines, dynamos, and switchboards, £650. (No. 4) British Insulated Wire Company, Limited, Prescot, feeders, distributing mains, potential and service lines, and maintenance of same for 10 years—£10,096. 6s. 9d., subject to measurement and schedule of prices, including earthenware in lieu of iron troughs, and lead-sheathed instead of vulcanised cables, the digging of trenches, and making good the streets. (No. 5) Thomas Parker, Limited, running of electricity supply works and supply of current for public and private purposes, as follows: for each 10-ampere arc lamp, run from one hour after sunset to one hour before sunrise (3,620 hours per annum), £24 per annum; for each 10-ampere arc lamp, run from one hour after sunset to midnight (1,810 hours per annum), £12 per annum; for each lamp-hour added or deducted from above, 1·55d.; for each incandescent lamp used for public lighting, 3d. per unit; for remainder of current up to guarantee of 100,000 units per annum for public and private purposes, 3·75d. per unit; for first 25,000 units above guaranteee, 1·75d. per unit; for second 25,000 units above guarantee, 1·25d. per unit; for every unit in excess of 150,000 units, 1d. per unit.

BUSINESS NOTES.

Lynn.—We understand that Prof. Robinson has been engaged to report and advise on the electric lighting of the town.

Wolverhampton.—The Local Government Board have sanctioned the borrowing of £9,000 for the purposes of electric lighting.

Ealing.—The Electric Lighting Committee will shortly submit a report to the District Council on the subject of the proposed application of incandescent lamps to the arc lamp-posts.

Southall-Norwood.—The District Council have decided to support the claims for licenses made by the New Mutual Telephone Company, Limited, of Manchester, and by the Corporation of Glasgow.

Hucknall Torkard.—At the last monthly meeting of the Urban District Council a letter of the New Mutual Telephone Syndicate, Limited, appealing to the Council for support, was referred to a committee.

Ramsgate.—The committee of the whole Council have reported that they have resolved to send the Board of Trade notice of opposition to the application of the Electric Supply Corporation to supply electricity in Ramsgate.

Auction.—The Societé Deneayrouze in Brussels, rue des douze Apôtres No. 28, will on March 2 sell by auction the electric installation of the Grand Hotel in Brussels. The accumulators and the dynamos are not included in this sale.

Kirkcaldy.—At Kirkcaldy Police Commission on Monday night a letter was read from the secretary of the British Electric Traction Company stating his company would be willing to take up the question of building and equipping an electric tramway.

Dudley.—We are informed that the Electric Traction Company have accepted a tender for converting the steam-tram line from Dudley to Stourbridge into an electric line, and the work is to be executed within six months from the date of its commencement.

Yarmouth.—The Yarmouth and Gorleston Tramway Company have entered into provisional agreements for the purchase of the Yarmouth 'Bus Company's undertaking. It is intended to transform the stables into a station for the generation of electric power.

Ayr.—The Harbour Trustees have resolved to take a supply for 10 arc lamps (18 amperes) from the town. A committee has been appointed to make the necessary arrangements. Mr. Fuller is to consult with the trustees as to the plant and superintend the work.

Plumstead.—At the meeting of the Vestry last week a motion "That in the opinion of this Vestry the time has arrived for the Vestry to take the necessary steps to obtain a provisional order for the purpose of electric lighting," was discussed, but was poned until October.

Great Northern Telegraph Company.—The system of ke the traffic accounts of this Company having been alter appears to be very difficult to make up the monthly traffic re in the same way as hitherto, and consequently no monthly re will be published in future.

Morley.—The electric lighting of the town has been sta It is the intention of the Electric Lighting Committee to s electricity free of charge from the 14th inst. to March 1 to premises where the wiring is complete and the installation p the test specified by the Corporation.

Eastern Telegraph Company.—At an extraordinary ge meeting of the Eastern Telegraph Company, Limited, hel the 15th inst. at Winchester House, the Marquis of Twee presiding, the following article of association was added: " tinuing directors may act notwithstanding any vacancy in body."

Colwyn Bay.—The following resolution has been agreed the District Council: "That the surveyor prepare an altern scheme in connection with the electric lighting of the prome that will provide for the engine-room being placed on promenade itself, in order to expedite the work in view of season."

Bangor.—The Council have appointed a sub-committee co ing of six members (three representing the electric light and representing the gas party) to consider and make recomm tions upon the report of the special Gas and Electric Comm with power to call in expert and other evidence if the necessary.

Hull.—The Council have decided to apply to the Board of T to sanction the borrowing of £270,000 for the purposes o the tramways. Hull has now definitely adopted the over electric system, and probably within a couple of months the p of Hessle-road with wood and the laying down of the el system will be started.

Brush Electrical Engineering Company, Limited.—W informed that the directors of the Brush Electrical Engine Company, Limited, have declared an interim dividend at the of 6 per cent. per annum on the preference shares for the year ended Dec. 31 last. The transfer books will be closed March 2 to 16, 1898, inclusive.

Appointments Vacant.—The borough of Tunbridge Wel advertising for a shift engineer, and the Corporation of South are about to appoint an electrician-in-charge for their elect station.—The London School Board require for the training "Shaftesbury," off Grays, Essex, a stoker mechanic havi practical knowledge of electric lighting apparatus and s boilers.

Londonderry.—At the monthly meeting of the Port and Ha Commissioners last week a letter from Mr. J. Christie, elec engineer to the Corporation, proposing a scheme for the illu tion of the quays with electricity, at the rate of 2¼d. per unit discussed. It was decided to ascertain from the gas compa they could improve the lighting, and at what cost, before t other steps.

Melbourne (Victoria).—A telegram to the *Times* states Messrs. Horn and Bakewell, two leading colonists of S Australia, have left by the "Orizaba" for London to plac Great Western Railway and Electric Power Company b English capitalists. The company possesses valuable conces of land, together with the right to construct a railway conne Hobart with the Mount Lyell and Zeehan district, in Tasmar

Smoking Concert.—Messrs. Drake and Gorham's empl smoking concert took place at the Grosvenor Hall on F evening. A very large audience enjoyed an excellent progra and also liquid refreshments of various kinds, the supply of w was cut short at 10 o'clock. Mr. Bernard Drake, who took chair, mentioned that during the past year £1,000 had been to the staff for bonuses under the profit-sharing scheme ad by the firm some years ago.

Free Wiring Company.—We understand that the Right Lord Wantage, V.C., K.C.B., F.R.G.S., has given the order t National Electric Free Wiring Company, Limited, for supp and erecting a complete installation for electrically lig Downs House, near Wantage. The wiring is all to be on company's patent twin system. The installation com steam-engine, boiler, dynamo, storage batteries, switchbo mains, house wiring, and fittings.

Lowestoft.—At the last meeting of the Town Council a s committee reported in favour of the Horsfall destructor with temperature and forced draught. The cost was about £ Smiths' Marsh had been practically decided on as the site o electric station, and there would be plenty of room there f destructor. It was resolved to refer the question to the San Committee to obtain tenders and apply for a loan, with a vi combining this with the electric light scheme.

Poplar.—The report of the Electric Lighting Committee r mends that the Board on 21st inst. consider the following r mendation of the committee—viz.: "That the Board proc once to act upon its provisional order, and to supply elect within the compulsory area at the earliest practicable mo and that the Electric Lighting Committee be instructed t the necessary steps to carry this resolution into effect, rep its action from time to time for the approval of the Board."

Whitehaven.—In moving the confirmation of the minutes Water and Electric Lighting Committee at the last Town C

Alderman Musgrave said the opportunity had offered for ase of the properties on the West-strand mentioned in tes, and the committee felt that, with a view to being in of their requirements, the opportunity should not be lost. er was in negotiation, and they hoped and expected that urse of a very short time the property would be secured.

ea.—The Gas and Electric Lighting Committee of the uncil have had a conference with Prof. Kennedy, London, g engineer to the Corporation, in regard to the extension ctric lighting system to the west end of the city. The of utilising the city refuse in the generation of electricity ntroducing electric traction for the tramways was also under the notice of Prof. Kennedy, who stated that he al with both these points in a report he would present to Council.

t.—The Belfast Wholesale Merchants and Manufacturers' ion, Limited, propose to organise a deputation to wait on Council on an early date with the object of urging Corporation the necessity of taking steps to organise a al telephone service in the interests of the citizens of —A committee has been appointed to consider the ques- lectric traction for tram service, and generally with regard and rental, and the alternative of the purchase of the company's property by the Council, and report thereon.

r.—At the last meeting of the Council, the Electric Committee recommended that, in consequence of the d demand for the light, the proposed loan be increased ,000 to £6,000, to enable them to lay down extra plant. to Mr. Finch, Mr. Wreford said the question of making he refuse for obtaining power to generate the light, as it n tried in other places, had not been lost sight of. The as adopted. It was stated that the greater number of the ps for street lighting had now been delivered, and they e tested at once.

agnie Francaise des Cables Telegraphiques.—This y was entrusted with the laying of a second cable from New York, in consideration of which the State gives an subvention of £32,000. On the strength of this, two years er cent. debentures were issued. The Company has under- o lay the cable by the end of March, 1898, and the Société éphones was to do the work. Difficulties have arisen which en overcome by the formation of a new company. the Société e Française des Télégraphes, with a capital of £400,000, as taken over the contract.

re's French Copper Company.—A circular which has ed to the first mortgage debenture-holders of Elmore's Patent Copper Depositing Company, Limited, states that ectors have received a proposal for the purchase of the n' shares of the Société Française d'Electro-Metallurgie, onstitute practically the main asset of the Company. The these shares will enable the sum of 6s. in the £ to be paid irst mortgage debenture-holders in discharge of their debt. ing of the latter will be held at Winchester House on day, 23rd inst., to consider the proposal.

f London Electric Lighting Company, Limited.—We are d that the directors of this Company have decided to recom- the shareholders the payment of the following dividends, o the completion of the audit: on the preference shares, hare for the six months ended Dec. 31, 1897, making, with im dividend already paid, a total distribution of 6 per the year; on ordinary shares Nos. 40,001 to 80,000 £1 s for the year, and on ordinary shares Nos. 80 001 to s. 7d. per share for the year, being a distribution at the rate cent. for the year ended Dec 31. Both dividends will be n March 3, 1898.

—At the last meeting of the Port and Docks Board, a s received from the law agent forwarding a print of the nd Hill of Howth Tramroad Bill, and advising that a e presented against it. In his letter the law agent the various clauses and powers of the Bill, and pointed these powers for the use of the roadways, etc., would interfere with the control of the quays, bridges, and ents under the control and jurisdiction of the Board. l approved of the report.—At a special meeting of the Council on the 16th inst., a report of the sub-committee traction was discussed

field.—The Electric Lighting Committee's revenue for December shows a balance of £1,184 income over re. The balance of the revenue account at the end of , amounting to £1,618 9s. 4d., has been transferred to a on and contingencies account to meet future expendi- onference has been arranged between representatives of ation and the National Telephone Company for the 28th ras proposed at the last Council meeting to renew the s for a license to the Postmaster-General. The Mayor was no objection to another application being made, atter would be dealt with in committee.

y.—The Park and Electric Lighting Committee have ied the appointment of Mr. Thos. L Miller to report on of electrical supply to be adopted under the Barnsley ghting Order of 1890, and to design and superintend ection of the works, exclusive of the buildings. The l specification of the works are to be subject to the f Mr. A. Burnley Holmes, M I.C.E., and a commission t. is to be paid to Mr. Miller and Mr. Holmes upon the electrical works, exclusive of buildings. The further stipulate the appointment of a resident electrical d the required visits by Mr. Miller and Mr. Holmes.

Swansea.—The Swansea Tramway Company, who have been negotiating for some years with the Swansea Corporation, have now practically come to terms with another customer for the undertaking. Advertisements now appearing in the London Press and circulars sent to shareholders call a meeting of the shareholders in London on 25th inst., at noon, for the purpose of considering, and, if thought advisable, of approving, so far as the same affects the holders of the Swansea Tramways' capital, the terms of agreement, dated 9th inst., between the Swansea Improvements and Tramways Company and the British Electric Traction Company, for the sale of the undertaking, property, and assets of the Swansea Company to the Traction Company.

South Australia.—We are asked to insert the following: "During the last session of Parliament in the colony of South Australia an Act was passed in favour of the South Australian Electric Light and Motive Power Company, which gives to this company practically a monopoly of the electric light and motive power business throughout the colony. One of the promoters of the Bill was Mr. W. W. Crawford, M.I.M.E., C.H.E., A.I.E.E., the representative in Australia of Messrs. Johnson and Phillips, to whom orders for the Port Adelaide plant have already been transmitted. Mr. Crawford is a large stockholder as well as a director of and consulting engineer to the company. Messrs. Johnson and Phillips have now depôts at 91, Pitt-street, Sydney, and Brookman's-buildings, Adelaide."

Hounslow.—At the last meeting of the Hounslow District Council Mr. Clifton Robinson, the manager of the tramway company, attended. The Works Committee recommended that the passage of the line through Brentford should be assured; that the company deposit enough money to pay one-third of the cost of purchasing the frontage of Treaty House and altering the roadway to be widened there; that a double line be laid throughout; and a clause be inserted as to the use of proper material. The Council gave their consent to the company's proposal, and an agreement embodying the above conditions was signed. From the remarks of members it appeared that the Council favoured the extension of the lines through the Staines and Bath roads, and from Isleworth-corner through to Twickenham.

Taunton.—At the last quarterly meeting of the Town Council the Electric Lighting Committee reported that they were receiving applications for the electric light in various parts of the borough, and particularly in the districts of the Nursery Estate and Rowbarton. A considerable addition to the plant was absolutely necessary for the present supply and demands, and, the committee being of opinion that the questions of meeting the present necessity and providing for extensions should be at once considered, they had prepared and sent to each member of the Council an estimate of the total amount which would be required—viz., £10,000. An animated discussion followed, and in the end the report of the committee was adopted, and it was decided that application should be made to the Local Government Board for their sanction to the borrowing of £10,000, repayable in 30 years by means of a sinking fund.

Shrewsbury.—At the quarterly meeting of the Town Council the report of the Water and Lighting Committee was adopted. It stated that the Shrewsbury electric lighting provisional order had passed the standing orders of the Board of Trade, but a memorial had been deposited, signed by six persons, nearly, if not all, of whom are largely interested in the gas company, objecting to the purchase by the Corporation of the undertaking of the Shropshire Electric Light and Power Company. The agreement between that company and the Corporation was laid on the table, and the committee recommended that the corporate seal be affixed. The committee have been advised that it will be necessary in a short time to increase the works, so as to meet, not only the demands of private customers, but also to provide for the lighting of the streets and public buildings, and negotiations had been entered into with a view to the purchase of additional ground for new works at a cost of £800.

Islington.—The report from the Electric Lighting Committee, adopted by the Vestry states that, in consequence of the great demand in the district for electrical energy, the new machinery is rapidly becoming loaded, and that in order to satisfy the requirements of intending consumers it is necessary that additional machinery should be placed on order without delay, it being probable that, even if ordered at once, it will only just be ready to meet the increased demand during the coming winter; and recommending that the additional plant referred to in the engineer's estimate given below be placed on order, and that the cost be raised by loan as heretofore. The engineer's estimate is as follows: two boilers, 1,500-h.p. engine, 1,300-kw. alternator, £7,180; steam and exhaust pipes, feed pipes, heater, pump, and injector, £818; foundations, settings, flooring, excavations, etc, and contingencies, £1,282; battery, instruments, regulators, boosters, exciter board, cable, meters, etc., £2,720—total, £12,000.

Chester.—The question of discount or rebate to consumers was considered at a recent meeting of the Electric Lighting Committee, and after a long discussion it was resolved that discounts on the following scale be allowed—viz., from 300 to 1,000 units 5 per cent., number of customers, 69; 1,000 to 5,000 units 7½ per cent., 34; 5,000 to 10,000 units 10 per cent., 4; 10,000 to 15,000 units 15 per cent., 1; over 15,000 units 20 per cent., 2; total, 110 customers; and that it be notified that a reduction to consumers all round will be made for the current year to 5d. a unit, and for motive power to 3d. per unit, consumers with two or more shops or premises served with the current to be treated as one consumer, and the city accountant to send a credit note to the consumers for the amount of the discount allowed. The appointment of resident

engineer and manager was considered, and terms were arranged with Mr. Thursfield for undertaking the duty, the engagement to be terminable by either party giving to the other three calendar months' notice.

Chelsea.—At the last meeting of the Vestry Works Committee, the vestry clerk and the surveyor reported at length upon the Metropolitan Electric Supply Company's Bill. By Section 3 the company sought power to lay the necessary cable under the roadway of Harrow-road, together with the necessary conduits, pipes, tubes, or coverings, and other conveniences and appliances in connection therewith. The surveyor reported that these "conveniences" to the company were generally the cause of much inconvenience to the public when they were placed in the public streets, and he therefore thought the Vestry should oppose the laying of any mains in Harrow-road, unless the company would undertake to supply electricity for public and private purposes at Kensal Town, at a cost of not more than 4½d. per unit. The Vestry agreed to oppose the scheme altogether if they could not get a better understanding than 4½d. per unit. The committee also agreed to recommend the Vestry to consider the question of purchasing the Chelsea Electricity Supply Company.

Cardiff.—At a meeting of the Electric Tramways Committee of the Cardiff Corporation held last week, the Chairman mentioned that at Blackpool Colonel Cardew, who held a local enquiry, had reported against overhead wires. It was pointed out to him that conduit wires were not so satisfactory, but he stated that if the members of the Council wanted any information they should visit Bremen, Hamburg, or other towns on the Continent. A deputation had been appointed at Blackpool to visit certain places on the Continent, and he put it to the meeting whether a similar step should be taken at Cardiff. The following resolution was passed: "That the following gentlemen, appointed by the Council on May 10, 1897—viz., the Mayor, Alderman Carey, Mr. J. H. Hallett, the borough engineer, and the electrical engineer—be directed to make further enquiries, and to visit such place or places as may be reasonably necessary to ascertain the best measures for providing energy for working the proposed electric tramways and the best system of traction, and report to the committee thereon."

Lewisham.—At the last meeting of the District Board a letter was received from the Great Western Electric Light and Power Company consolidating their proposals as follows: "If the consent of the Board be given to the grant of a provisional order, on the terms of the draft deposited—with such modifications as may be agreed upon to bring it into harmony with the arrangements suggested—the company will be prepared to undertake the dust destruction at cost price, guaranteed not to exceed 1s. 6d. per ton; and in connection therewith to take over the dust destructor recently erected, at the price paid by the Board to the makers for it, and work it at once, pending the erection of electric supply works, when the combined operations would be carried on. The company offer to insert a clause in the order giving to the Board the right of taking over the order when granted, on payment of cost incurred, in which event, of course, the arrangement as to the destructor would not take effect. The company also propose to introduce the Brighton system of supply, with the same method of charge for current—viz., to private consumers 3d. per unit after the first hour at 7d., and for the public lighting 2d. per unit after the first hour at 7d. Under this arrangement the public lamps would be supplied with 16-c.p. lamps at a cost of about 33s. 4d. per annum." The matter was referred to the Works Committee—for this purpose to consist of the whole Board—for consideration.

Newington.—At a meeting of the Vestry of St. Mary on the 16th inst. a report was received from the Electric Lighting Committee recommending (*a*) that the plans and specification as submitted by Messrs. Kincaid, Waller, and Manville for the erection of the buildings for the electric lighting station in Penrose-street, Walworth-road, be approved, and tenders invited for the execution of the work; (*b*) that application be made to the London County Council for a loan of £40,000 to enable the Vestry to comply with the provisions of the Newington Electric Lighting Order, 1897, such loan to be receivable in four instalments of £10,000 as the work proceeds, and repaid within a period of 50 years with interest, the first of such annual instalments to be deferred for a period of five years from the date of the loan; (*c*) that the clerk be instructed to notify to the parishioners by advertisement in the *South London Press*, and by circular, of the intention of the Vestry forthwith to proceed with the erection of an electric lighting station in Penrose-street, Walworth-road, in order that the lighting of the main roads of the parish may be improved, and shopkeepers and private householders enabled to obtain electric energy during the ensuing winter at the lowest possible price, and urging the parishioners to support their own municipal undertaking by declining to take a supply of electric energy from any other persons or company working in competition with the Vestry.

Barrow.—The Electric Committee reported at the last meeting of the Council that they had written to Messrs. Vickers, Sons, and Maxim, Limited, stating that having now accepted tenders for the necessary electric lighting plant, and being anxious to arrange for a motor load if possible, so as to utilise their plant during the daytime, they would, therefore, be in a position to supply the company on very special terms for this purpose. The secretary of the company replied that they had now under consideration the question of laying down an electric power plant of their own, but that they would lay the town clerk's letter before the Board on the first opportunity. The Local Government Board have sanctioned the borrowing of £29,000 for electric lighting purposes, at the same time stating that they were not prepared to sanction the borrowing under the Electric Lighting Act and the Public Health Act, 1875, of the sum of £1,000 included in the estimate for the provision of the site of the central station, but would give their approval under Article 7 of the Barrow-in-Furness Order, 1894, to the appropriation of the land intended to be used for the purposes of the electric light undertaking, on being furnished with a plan showing the land, and distinguishing by colour the part proposed to be appropriated. It was resolved that consideration of the matter be deferred, and that the town clerk be directed to see the Board thereon when next he is in London. The report was agreed to.

Sheffield.—The Corporation have awarded Mr. John Spencer, Globe Tube Works, Wednesbury, a premium for the design submitted to them for the poles for their electric trams. They have also decided to order a large number of the poles from the same firm. The design selected is of ornamental character.—A meeting of the Parliamentary Committee was held on the 1[illegible] inst. for the purpose of considering the letter received by the Council from Messrs. Broomhead, Wightman, and Moore, suspending the negotiations for the sale of the undertaking of the Sheffield Electric Light and Power Company, on account of certain reflections made on the good faith of the directors of the company by several members of the Council at the last meeting. Considerable discussion took place, and eventually the following resolution was passed: "That this committee has heard with regret that the negotiations with the Sheffield Electric Light and Power Company, Limited, for the purchase of its undertaking by the Corporation have been suspended in consequence of certain statements and insinuations having been made in the Council against the directors of the company, and this committee hereby expresses its opinion that the directors are fully acquitted of any improper secrecy or conduct in connection with the negotiations between the company and the Corporation, and trusts that the terms as agreed to by the Council will be accepted by the directors and shareholders of the said company; and that a copy of this resolution be forwarded to the directors of the company."

Southport.—The Electricity Committee have presented the following report of Mr. C. D. Taite, the borough electrical engineer, on the proposed extensions of the mains, etc., at a cost of £1,578. The practical results of the completion of this scheme will be: In case of one feeder failing the other three are not affected, and in most cases it would only be necessary to switch over to another feeder at one of the sub-stations in order to supply the district whose feeder has failed. At present a failure on one of the feeders means a complete cessation of supply until the fault is removed, or at any rate located. Work could be carried out on the high-tension mains without disturbing the low-tension supply. This can only partially be done at present. Each feeder would be able to supply a distinct low-tension network, but in case of necessity these networks could be inter-connected. Much better regulations would be obtained in each district than at present exists. With existing arrangements the pressure in the town has to be kept constant, irrespective of the pressure in the outlying districts, which suffer thereby. This difficulty will be remedied, at any rate as far as the Park district is concerned, by the use of boosters and separate mains. At the last meeting the Council accepted a tender for the mains for the sum of £2,264. The present recommendation was for a further expenditure of £1,578 on distribution, which would make a total of £3,842. The committee have brought this part of their scheme forward so that the work might be proceeded with during the coming summer, and the increased pressure be available for next winter. The minutes were adopted.

Waterford.—Referring to the proposed electric tram scheme previously noted by us, the Joint Finance and Law and S[illegible] Committee have submitted the appended report: "We beg to report to the Council that having considered the application of Mr. Palmer for a concession for the erection of electric tramways on the quay, The Mall, Parnell-street, William-street, Lombard-street, and portion of the Manor, we would recommend that such concession be granted on the following terms—viz., a lease for 75 years to be granted to the tramway company for carriage of passengers and parcels only, at a nominal rent. The question as to what constitutes parcels to be considered hereafter. That after payment of a dividend of 6 per cent. on the capital of the company to the shareholders, any surplus arising after such payment to be divided equally between the Corporation and the company. The Corporation reserves to themselves the right to seek parliamentary powers to purchase the tramway. The company to aid the Corporation in obtaining such powers, which are not to be sought for until after the expiration of 35 years. All plans and specifications to be subject to the approval of the Council. As the share of the surplus to which the Corporation will be entitled will be dependent upon the earnings of the line, it will be necessary to guard against undue working expenses. The estimated capital submitted to us by Mr. Palmer is as follows: £12,000 for making permanent way, £7,500 for electric installation and works, £[illegible] for four motorcars. After a good deal of discussion the [illegible] matter was referred to a committee of the whole Council, and [illegible] come up for full and final discussion at next meeting. Mr. Palmer, the chief promoter, will attend by invitation."

Stourbridge.—The Earl of Jersey and Colonel Boughey, two of the Light Railway Commissioners, held an enquiry at Stourbridge on Tuesday respecting the proposal of the British Electric Traction Company to construct an electric tramline between Coal, Hea[illegible] brook (Stourbridge), and Kinver. It was stated that the Kinver manufacturers had been ruined by want of a railway, but that it had now become a favourite pleasure resort for people from the "Black Country." Although it was not embraced in the d[illegible] of the scheme, it was brought before the Commissioners that the promoters were also ready to make a line from High-str[illegible]

Stourbridge (*viâ* Enville-street), to join the other route at Wollaston, whence the line would proceed *viâ* the Stewponey to Kinver. There was a numerous attendance of officials and others connected with the district, including the clerks to the County Councils of Worcestershire and Staffordshire. A large body of evidence was given in support of the scheme, and the desirability of improved communication with Kinver was strongly testified to. It was shown that since the works at Kinver had been closed from want of railway facilities, there had been a large traffic to Kinver for pleasure purposes. One witness said some 8,000 persons went there on Bank Holidays, but someone cried out there were double the number. A suggestion has been made that instead of taking the line by the Stewponey, it should be carried *viâ* the sewage farm at Whittington, and the witnesses were emphatically against this suggestion. They said it would not be an incentive to people going to a health resort to have to cross a sewage farm, and supported the Stewponey route. Mr. Foley had intended to oppose the scheme, but he withdrew his opposition at the enquiry. After Mr. Sellon had answered many questions as to details of the width of the road and bridges, Lord Jersey said he might say that as regarded the preamble there was a case, and the Commissioners would be happy to recommend to the Board of Trade that the order should go forward. He was bound to point out that many difficulties might have arisen had not Mr. Foley so handsomely come forward.

Ipswich.—At the quarterly meeting of the Town Council, Mr. J. Pratt moved that the Electric Lighting Committee (with the substitution of Alderman S. R. Anness and Mr. F. Bennett in place of Mr. T. W. Cotman and the late Mr. F. G. M. Stoney) be reappointed, and that the Council instruct such committee to proceed to carry out the powers conferred by the provisional order, and to take the necessary steps to borrow £36,200, or such other sum as may be required. Mr. Pratt gave figures relating to other towns, showing that out of 45 provincial towns 22 showed a surplus of £54,244, one (Whitehaven) paid its own way, and 22 showed a deficit of £17,605. About six years ago, he proceeded, the Leeds City Council decided, by a majority of one, to hold aloof from the electric lighting, and allow a company to burn its fingers if it so desired. If that single vote had been cast on the other side, Leeds would have been from £150,000 to £200,000 better off to-day. There were two sides to municipal prudence, and the policy of allowing a company to come in and burn its fingers was not devoid of all risks. They had here a company very anxious to come in and take up their provisional order. They would pay all out-of-pocket expenses, carry the concern on for 10 years, and at the end of that time turn round and sell it to the Corporation, if they so desired, on the latter paying 18 per cent. on all their out-of-pocket expenses. The firm in question had canvassed the town, and they bore witness to what he stated five years ago, when in two afternoons he received 90 promises. Councillor Bales thought Mr. Pratt had gone too far that morning, and he moved an amendment that the committee be instructed to take into consideration the offer that had been received for working the provisional order, and for the subsequent transfer of the undertaking to the Council, and to report to the Council at an early meeting the course which they consider would be best to take. Mr. Bales appealed to Mr. Pratt to withdraw his motion, and adopt his, and this course Mr. Pratt adopted. Some discussion took place as to whether members of the Council holding gas shares could vote, but no ruling was given on this point. Councillor W. A. Churchman was in favour of the adoption of electric light, but thought a company should be allowed to undertake the work. The resolution was carried.

London County Council.—Amongst the reports before the meeting of Tuesday last we note that of the Highways Committee, which recommends that the sanction of the Council be given to the works proposed under the notices of the Westminster Electric Supply Company, the London Electric Supply Company, the Vestry of St. Pancras, the House-to-House Electric Light Supply Company—*i.e.*, to lay certain mains, etc. Two notices of the County of London and Brush Provincial Electric Lighting Company are also dealt with, one under the St. Olave electric lighting order is to be granted, while about the other, under the Southwark electric lighting order, the report states: "A notice, dated Jan. 29, 1898, has been given by the County of London and Brush Provincial Electric Lighting Company, under the Southwark Order, 1892, of intention to lay high and low tension mains in and across in several places, Old Kent-road, Tabard-street, Newington-causeway, Borough High street, Borough-road, London-road, Lambeth-road, Great Suffolk-street, St. George's-circus, Westminster Bridge-road, Blackfriars-road, Waterloo-road; high-tension mains in Wellington-street, Blackfriars, and King Edward-street; and low-tension mains in New Kent-road and Southwark Bridge-road, also to construct nine transformer boxes. This is the first notice which the company has given under its Southwark order, and in connection therewith we have had before us a letter from the Vestry of St. George-the-Martyr, Southwark, asking the Council to withhold its sanction to the works referred to in the notice. The Vestry states that it has applied to the Board of Trade for the revocation of the order, having regard to the default of the company in not having complied with the requirements of the order, which was granted five years ago, that the mains within a certain fixed area should be laid within a specified time. The Vestry further states that it has under consideration the question whether it should itself undertake the supply of electric current in the parish. In the circumstances we think that the Council should withhold its sanction to the works referred in the notice: and we recommend that the Council do formally disapprove of the works referred to in the notice dated Jan. 29, 1898, under the Southwark Electric Lighting Order, 1892, of the County of London and Brush Provincial Electric Lighting Company." The Parliamentary Committee recommend the Council to pass the following recommendations: "That the Council is of opinion that applications under the Light Railways Act, 1896, for powers to construct, within the county of London, lines under the name of light railways which do not differ in their essential features from tramways, should be opposed by the Council. That the Parliamentary Committee be authorised to oppose the proposed Finchley, Hendon, and District Light Railways (Electric) Order. That the course taken by the Parliamentary Committee in issuing the advertisement of the Council's intention to oppose the Gaslight and Coke Company's Bill be approved, and that the question be considered at the meeting of the Council on Feb. 22. That a petition against the Gaslight and Coke Company's Bill be sealed and presented." The electric lighting of the Embankment (for particulars of which we refer to our previous issues) has been finally decided upon.

PROVISIONAL PATENTS, 1898.

FEBRUARY 7.

3032. Steering torpedoes electrically. Walter Jamieson and John Trotter, Orangefield, Greenock, N.B.

3034. Improvements in block signalling for the regulation of railway traffic. William Edward Langdon, Telegraph Department, Midland Railway, Derby.

3074. Improvements in electric bells. Paul Jenisch, 45, Southampton buildings, Chancery-lane, London. (Complete specification.)

FEBRUARY 8.

3123. Improvements in electric switches. Johan Marinius Andersen, 11, Southampton buildings, Chancery lane, London. (Complete specification.)

3136. Electrolytic treatment of sulphides. James Swinburne, 66, Victoria-street, Westminster, London.

3137. Improvements in the treatment of complex sulphides. James Swinburne, 66, Victoria-street, Westminster, London.

3192. Improved method for the electrolytic treatment of sugar juice. Ernest De Pass, 78, Fleet-street, London. (La Compagnie Electro-Sucrière, France.)

3193. Process for the electrolytic treatment of sugar juice. Ernest De Pass, 78 Fleet-street, London. (La Compagnie Electro Sucrière, France.)

3198. Improvements in the manufacture of carbons for electrical purposes. Cecil Lord Saunders, 322, High Holborn, London.

3204. Improvements in electric arc lamps. Charles Antoine Vigreux and Lucien Victor Brillié, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

3207. An improved guide for the carbon-holder of an electric arc lamp. Sigmund Bergmann, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

3209. Improvements in electrical signalling apparatus. Harry Gerard Leopold, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

3218. Improvements in electric motors and dynamo-electric machines. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane. London. (Eugenio Cantono, Italy.)

3219. Improvements in electrical measuring instruments. Arthur Cecil Heap, 18, New Bridge-street, Blackfriars London.

FEBRUARY 9.

3258. New process for manufacturing objects and specially cases for electric accumulators in unbreakable celluloid. E. Marckwald, 8, Rue de Princes, Brussels.

3259. Improvements in the construction of apparatus for producing and receiving Hertzian electric waves. Eugène Ducretet, 8, Rue des Princes, Brussels. (Complete specification.)

3278. Improvements in or connected with indicating electrically the changes of market prices of goods and other data. Henry Robert Meyer, 15, Water-street, Liverpool.

3285. Improvements in and connected with plates for electrical storage batteries. Rankin Kennedy, 11, Furnival-street, Holborn, London.

3313. Improvements in electromotors. P. Iserloth, 7, Quality-court, Chancery-lane, London. (Complete specification.)

3316. Improvements in a self-restoring annunciator more particularly suitable for employment in connection with telephone switchboards. John Edward Kingsbury, 24, Southampton-buildings, Chancery-lane, London. (The Western Electric Company, United States.) (Complete specification.)

FEBRUARY 10.

3368. Improvements in secondary batteries. Dominique d'Arbel, 64, Mark-lane, London. (Complete specification.)

3365. Improvements in telephone systems. Daniel Sinclair and William Aitken, Oxford-court, Cannon-street, London.

3367. Improvements in the production of acetylene light by electrolysis. Dominique d'Arbel, 64, Mark-lane, London. (Complete specification.)

3381. Improvements in electric alarums. Henry John Blakeway, 37, Chancery-lane, London.

3412. Improvements in combined fuse and switch boxes for use with high or low tension electric currents. Allan John Lawson and James Douglas Dallas, 4, South-street, Finsbury, London.

FEBRUARY 11.

3431. Improvements in anodes used in the electro-deposition of metals. Herbert Edward Beach, 5, Church-avenue, Water Orton, near Birmingham.

3449. Improvements in the electrical driving of machinery. Joseph Richardson Garner, 70, Deansgate, Manchester.

3476. Improvements in combined motors and electric generators. James Atkinson, The Woodlands, Marple, Cheshire.

3495. Improvements in electric motors. John Smith Raworth, 46, Lincoln's-inn-fields, London.

3496. Improvements in electrical cut-out apparatus. Leonard Andrews, 46, Lincoln's-inn-fields, London.

3501. Improvements connected with apparatus for producing and utilising electric currents. William Speirs Simpson, 166, Fleet-street, London.

3503. Improvements in insulating materials. John Henry William Stringfellow, Canal Side, Andrew's-road, Hackney, London.

3507. Improvements in electric meters. Evershed and Vignoles, Limited, and Sydney Evershed, 1, Queen Victoria street, London.

FEBRUARY 12.

3520. An improved holder for electric glow lamps. George Herbert Verity, Plume Works, Aston, Birmingham.

3555. A combined switch and controller for electromotors. Chaimsonovitz Prosper Elieson and William Slater Naylor, 4, South-street, Finsbury, London.

3563. Improvements in or relating to electric arc lamps. Frederick Brown, 11, Burlington-chambers, New-street, Birmingham.

3569. Improvements in electrical apparatus for indicating or recording at a distance the position of an index hand or analogous movable object. Alphons Custodis, 37, Essex-street, Strand, London. (Complete specification.)

3589 Improved collision mat with improved method, by which electricity is used, of fixing the same over a hole or fracture on the side of a ship Charles Mackintosh, 159, Euston-road, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1896.

22794. X-ray tubes. Böhm.

26425. Electric railways and their vehicles. Sayer.

1897.

1648. Electric switches and apparatus for connecting electric circuits. Andrews.

1789. Electric cables. Smith and Granville.

1964. Electric arc lamps. Fesquet and Keys.

2418. Form of electrode for galvanic or secondary batteries. Bonson.

2790. Electric furnaces for use in the manufacture of calcium carbide, applicable also for obtaining metals from their salts. Bresson and Pacotte.

2935. Switches for electric currents. Rawlings and Rawlings.

3772. Portable electric lamps for use in mines and other places. Walker.

4461. Brushes and their holders for dynamos. Mordey.

6308. Indicators for telephone exchanges. Siemens Bros. and Co., Limited. (Siemens and Halske.)

6353. Electrical switch or contact maker or contact breaker. Yeatman and Donovan.

6674. Dry primary cell or battery. Shaw.

7420. Electrical resistances. Marquand.

9907. Telegraphic transmitters. Porter.

12028. Carbon plates for galvanic batteries. Atkinson and Walker.

22807. Alternating-current electromotors. Bradley.

25744. Alternate-current induction motors. The British Thomson-Houston Company, Limited, and Hobart.

26023. Electromagnetic switch apparatus for railway signalling and other purposes. Allison. (Banks.)

29273. Plates or electrodes for electric accumulators. Lake. (Francke.)

29493. Field telephone and telegraph stations. Bernstein.

29589. Electric arc lamps. The British Thomson-Houston Company, Limited. (Thomson and Harthan.)

TRAFFIC RECEIPTS.

Dover Tramways.—The traffic receipts for the week ending February 12 were £105. 3s. 6d. The total receipts for the year 1898 are £643. 4s. 2d. The mileage open at present is 2¾ miles.

Bristol Tramways.—The traffic returns for the week ending February 11 were £2,296. 3s. 9d., compared with £2,120. 15s. 5d. for the corresponding period of last year, being an increase of £175. 8s. 4d.

Birmingham Tramways.—The traffic receipts for the week ending February 12 were £3,518. 8s. 7d., as compared with £3,230. 1s. 6d. in the corresponding week in 1897, being an increase of £288. 7s. 1d.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended February 13 amounted to £1,380, as compared with £1,219 in the corresponding week of the previous year, being an increase of £161.

City and South London Railway.—The returns for the week ended February 13 were £1,058, compared with £1,062 for the corresponding period of last year, being a decrease of £4. The total receipts for the half-year amount to £7,514, compared with £7,673 for the corresponding period last year, being a decrease of £159.

South Staffordshire Tramways.—The traffic returns for the week ending February 11 were £580. 6s. 4d., as compared with £584. 10s. 5d. in the corresponding week of the previous year. The aggregate receipts for the year are £3,537. 18s. 9d., as against £3,312. 10s. 6d. in the corresponding period of the previous year.

S.D. United Tramways.—The traffic receipts for the week ending February 11 were £375. 9s. 5d., as compared with £433. 13s. 5d. in the corresponding week in the previous year, being a decrease of £58. 4s. 0d. The number of passengers carried was 68,846 in 1898 and 68,108 in 1897. The aggregate returns up to date are £2,478. 5s. 7d., as compared with £2,463. 9s. 0d. last year, being an increase of £14. 16s. 8d. The mileage open is the same as last year—viz., 8 miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	[illegible]
Brush Company, Ordinary	2	[illegible]
—— Non. Cum., 6 per cent. Pref.	3	[illegible]
—— 4½ per cent. Debenture Stock	100	[illegible]
—— 4½ per cent. 2nd Debenture Stock	100	[illegible]
Callender's Cable Company, Debentures	100	110-113
—— Ordinary	5	9-10
Central London Railway, Ordinary	10	[illegible]-11
——	6	6¾-7
—— Pref. Half-Shares	1	[illegible]
—— " "	5	4½-5
Charing Cross and Strand	4	[illegible]
—— 4½ per cent. Cum. Pref.	5	6-6½ xd
Chelsea Electricity Company	5	11½-12½
—— 4½ per cent. Debentures	100	115-117
City of London, Ordinary	10	[illegible]
—— Prov. Cert.	10	[illegible]
—— 6 per cent. Cumulative Pref.	10	[illegible]
—— 5 per cent. Debenture Stock	100	[illegible]
City and South London Railway, Consolidated Ordinary	100	69-70 xd
—— 4 per cent. Debenture Stock	100	[illegible]
—— 5 per cent. Pref. Shares	10	[illegible] xd
—— " " " '96	10	[illegible]
County of London and Brush Provincial Co., Ordinary	10	[illegible]
—— 6 per cent. Cum. Pref.	10	[illegible]
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	[illegible]
—— 5 per cent. Debentures	—	[illegible]
Edison and Swan United Ordinary	3	[illegible]
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	[illegible]
Electric Construction, Limited	2	[illegible]
—— 7 per cent. Cumulative Pref.	2	[illegible]
Elmore's Copper Depositing	1	[illegible]
Elmore's Wire Company	1	[illegible]
W. T. Henley's Telegraph Works, Ordinary	10	[illegible]
—— 7 per cent. Preference	10	[illegible]
—— 4½ per cent. Debentures	100	112-117
House-to-House Company, Ordinary	5	[illegible]
—— 7 per cent. Preference	5	11½-12
India Rubber and Gutta Percha Works	10	[illegible]
—— 4½ per cent. Debentures	100	[illegible]
Kensington and Knightsbridge Ordinary	5	[illegible]-17
—— 6 per cent. Pref.	5	[illegible]
London Electric Supply, Ordinary	5	[illegible]
Metropolitan Electric Supply, Limited, Ord. No. 101-50,000	10	[illegible]
—— " " " 50,001-82,500	10	[illegible]
—— 4½ per cent. First Mortgage Debenture Stock	100	[illegible]
National Telephone, Ordinary	5	[illegible]
—— 6 per cent. Cum. First Pref.	10	[illegible]-17
—— 6 per cent. Cum. Second Pref.	10	[illegible]
—— 5 per cent. Non. Cum. Third Pref., No. 1-119,224	5	[illegible]
—— " " " 119,225-250,000	5	[illegible]
—— 3½ per cent. Deb. Stock, Red.	100	[illegible]
Notting Hill Company	10	[illegible]
Oriental, Limited, £1 shares	1	[illegible]
—— £5 Shares	5	[illegible]
—— £4½ shares	4½	[illegible]
Oriental Telephone and Electric Company	1	[illegible]
Royal Electrical Company of Montreal	—	[illegible]
—— 4½ per cent. First Shares Mortgage Debentures	100	[illegible]
South London Electric Supply, Ordinary	2	[illegible]
St. James's and Pall Mall, Limited, Ordinary	5	[illegible] xd
—— 7 per cent. Pref.	5	[illegible]
—— 4 per cent. Deb. Stock, Red.	100	[illegible]
Telegraph Construction and Maintenance	12	[illegible]
—— 5 per cent. Bonds	100	[illegible]
Waterloo and City Railway, Ordinary	5	[illegible]
Westminster Electric Supply, Ordinary	5	[illegible]
Yorkshire House-to-House	5	[illegible] xd

NOTES.

aph Congress.—An international congress of sts will be convened at Milan in connection with ıary festivities to be held in honour of Alessandro

Prevention Committee.—We are informed C. H. Wordingham has joined the working of this committee with the particular view of ing the electrical interests on it.

ic Light in Mexico.—The Dresdner Bank that, according to telegraphic advices received cico, the central station of the Mexican Electric imited, has been so far advanced that the lighting r of Mexico was commenced on the 14th inst., d a complete success. The installations for the ghting and the supply of electrical power are apid progress, and it is anticipated that these the works will be opened in the summer.

an Telegraph Monopoly.—We understand Government of Mexico have determined to take of the telegraphic communication into their hands. t to be done in the usual method, by buying out ng companies. It seems that the railway com- Mexico have developed a considerable amount of business over their lines, and that they have got s to the States. Now all local or international er these lines is forbidden by the Government, esult is likely to be costly litigation.

Proposed Cape Cable.—The Cape *Times* an account of an interview with Mr. Hofmeyr, resented as having pledged himself to support ple of a general naval contribution from the Cape, hat the Imperial Government carry out the cable Mr. Hofmeyr added that it would make the new popular with Afrikanders if it did not fall into hands as those owning and working the present There is no doubt but that the competition d would be beneficial to the general public.

ic Stoves.—Mr. Fernand Le Roy recently before the Société des Ingenieurs Civils de France on an electric heating apparatus he has devised. ods of silicium heated by electricity. He claims heating apparatus low first cost and efficient As far as we can see, this claim is made on the at the specific resistance of the material used is hat this has to do with the ultimate efficiency of heating apparatus we do not see. The author er, very exact in his details. Thus, silicium has a sistance 13·333 greater than arc-lamp carbon. The he last two digits is very doubtful.

ated Institution of Mining Engineers.—rated Institution of Mining Engineers, which all the mining districts of England and Scotland, wenty-sixth general meeting at Newcastle-on-Tyne k. On the first day Mr. A. M. Chambers, of president, was in the chair. Prof. Henry Louis, College of Science, Newcastle, contributed a paper hnical Education in Mining." A paper on the of Wallsend Colliery, which, after having been for many years, has recently been drained, read by Mr. Ayton, and several papers were ted on improved methods of shipping coal.

for Thought.—According to a recently-issued document, the United States sent to this country last trical apparatus of one kind or another to the value f £88,000. When we add to this amount that of s obtained from the Continent, we begin to ask, what are our own factories doing? There is one thing they seem not to be doing, and that is making good profits. The share quotations are not particularly favourable. One thing we venture to prophesy, and that is the present craze for monophase alternate-current installations is doomed. Our commercial travellers are simply ages behind the times as things go elsewhere, and deserve to be kicked out of the market. Naturally, they are so kicked.

A Decade of Electric Traction.—It is said by some that Feb. 3 this year marked the completion of the first decade of commercial electrical traction. It was on Feb. 3, 1888, that the Union Passenger Railway Company of Richmond, Va., opened their lines, which were equipped on the trolley system by Mr. Sprague. We dispute, however, that this date can be said to be that of the opening of the first practical line, as in 1885 there were several electrical tramways running in the United Kingdom. These included the Brighton Beach line, the Bessbrook-Newry line, the Portrush-Bushmills line, and also the Blackpool trams. All of these are either now working, or have been at work up till quite recently, and their success moves the above date back by several years.

Petroleum Lamp Accidents.—A committee of the London County Council has presented the following report on this subject, in which the conclusions below are given: "That the number of accidents arising from the burning of mineral oil in lamps has increased, notwithstanding the voluntary efforts made for preventing them, and that effectual means of prevention can only be found in compulsory measures; that raising the flash point fixed by the Petroleum Acts to 105deg. F. (Abel test) would be effectual in preventing lamp accidents, if the sale and use for illuminating purposes of oil below that flash point is prohibited; that it is also desirable to prohibit the importation and sale of the more dangerous types of lamps, as suggested by the Lamp and Stove Trades Association."

Radiation in a Magnetic Field.—Herr Michelson has examined the phenomenon discovered by Zeeman with his very sensitive interferometer, and finds that in general the effect of the magnetic field is to separate rather than broaden the lines, and that the phenomenon is not of the nature of a reversal. Thus with sodium, the lines are doubled in a field up to about 2,000 C.G.S. units, the separation being nearly proportional to the strength of field. Beyond this point the components become broadened as well as separated with increased strength of field. The broadening effect was noticeable only when the pencil of light was at right angles to the field. The red cadmium line gave similar but even more pronounced results. The green and blue cadmium lines, and the green line of mercury, on the other hand, were both separated and broadened. The hydrogen, lithium, and thallium lines were but slightly affected by the magnetic field.

The Third-Rail System in the Snow.—The great snowstorm of Jan. 31, 1898, which raged over New England, has proved that a railroad can be operated by the third-rail electric system under the most adverse conditions. That portion of the New York, New Haven, and Hartford Railroad, between New Britain and Hartford, operated by electricity, was kept open during the whole of that day, and the trains were run with but a few seconds' delay in the schedule, while the steam trains on the main lines were held up and delayed for three or four hours. It is stated by the *Electrical World* that a heavy snowstorm had long been desired by the electrical engineers and railroad officials in order that as severe a test as possible might be applied to the third-rail system. It has been a question whether, with the third rail, practically surrounded by snow and moisture, the current leakage would seriously

affect the operation of the motors on the cars. This question was settled by the snowstorm. There was absolutely no leakage, and, once the heaviest part of the snowfall was removed by the snow-ploughs, no interruption in the motor-car service occurred.

Ringing Church Bells Electrically.—To overcome the cost, inconvenience, and even danger connected with the ringing of great church bells by hand has now successfully been solved by the application of electrical machinery in the church of St. George, Berlin. A 10-h.p. electromotor turns, at a speed of 160 revolutions per minute, a shaft upon which three drums are placed, but which are not keyed to the shaft. At the side of each of these drums a small friction wheel is fixed upon the shaft. When the latter is pressed against the former both revolve, and so moves the rope which is fixed at one end to the drum, while the other acts upon the lever of the bell. When the bell gets into the middle of its swing it lifts an eccentric, which loosens the pressure of the wheel upon the drum. This releases the drum, and allows the bell to ring back. A weight acting on the rope and the drum gives sufficient tension to prevent slack ropes from giving trouble. One man only is required to attend to the three bells. He has to start the clutches against the drums. After giving a few impulses this way the bells get up their swing, and the period between the consecutive rings is then automatically maintained.

Concerning Weather-Proof Wire.—Mr. A. Dow contributes an article to the February number of the American journal, *Electrical Engineering*, on the so-called weather-proof insulation for overhead wires. He advances reasons for the continued use of a wire having a cheap insulated covering, which he allows is not able to withstand moisture. In other words, if two such wires get twisted together, they will break down if there is a difference of potential between them as soon as a shower of rain falls. It is extremely difficult to see what ultimate use such a covering can be, and, in our opinion, the only valid advantage it has is that, if a new wire has to be placed on a pole already supporting a large number of live wires, the work can be carried out in dry weather without much risk of short-circuit. The author speaks of trunk lines for overhead wires containing between 24 and 64 conductors so insulated, some of which are used with alternating currents at 2,200 volts, and others for series arc lamps at 5,000 and 6,000 volts. If, as he says, the linemen are expected to crawl up through the network of the conductors he describes, we should expect numerous coroners' inquests to result, even with the weather-proof covering.

Steel for Dynamo Magnets.—From the February number of the *Transactions* of the Institution of Engineers and Shipbuilders in Scotland we gather that an interesting discussion recently took place on a paper entitled "Basic Refined Steel on the Continent." Mr. W. Cuthill informed the author that such superior steel as he spoke of, and better, had been made regularly by the Steel Company of Scotland for a dozen years at least. The speaker did not say it was made by the basic process at all, but, what was of more importance, it was steel of the very finest quality, with all the impurities, such as phosphorus, sulphur, and silicon, at the very lowest ebb, while the carbon could be made of any percentage required. It was, of course, more costly to make than ship and boiler steel, and was never employed for these purposes; but no finer steel could be employed for special purposes, where a little extra price could be afforded, and certainly there was no need to go to Germany for it. The following was an analysis of the steel made by the Steel Company of Scotland for the field magnets of dynamos, etc.: carbon, ·06 per cent.; silicon, 0·5 [illegible] cent.; sulphur, ·04 per cent.; phosphorus, ·012 per ce[illegible] manganese, ·10 per cent.

Extensions to the Telegraph Service.—A re[illegible] has been received from the Duke of Norfolk to suggesti[illegible] made by the Associated Chambers of Commerce on t[illegible] above subject. The Duke says that these questions were de[illegible] with in a letter to the president in July, 1896. Since th[illegible] the Lords of the Treasury have been consulted, and they d[illegible] not consider it advisable to propose the abolition of th[illegible] separate account for telegraphs. On the subject of fr[illegible] addresses, he cannot add anything to what has be[illegible] communicated to the Chambers. With regard to th[illegible] extension of telegraphic facilities in rural districts, th[illegible] Duke has given the matter special consideration, and th[illegible] concessions given on the occasion of the Diamond Jubi[illegible] were evidence of the desire of the Government for th[illegible] increase of such facilities. At that time the porter[illegible] charges up to three miles were abolished, and the char[illegible] for delivery at longer distances reduced from 1s. to 3d. [illegible] mile. In the course of the year many new telegra[illegible] offices have been opened, and costly extensions are in ha[illegible] The total number of telegraph offices of all kinds now op[illegible] to the public is 10,432. Under the circumstances [illegible] Duke does not consider that a further discussion at [illegible] present time would be profitable.

High-Voltage Transmission.—Our namesake [illegible] New York gives details of a trial run of a transmis[illegible] plant at 50,000 volts at Telluride, Colorado. The po[illegible] was transmitted to the Gold King Mills, about three mi[illegible] away. The first plant used for this scheme consisted [illegible] single-phase 3,000-volt alternator with direct transmis[illegible] to a synchronous motor three miles away. This has si[illegible] been replaced by a three-phase transmission with step[illegible] and step-down transformers. It was about the time [illegible] change was made that the experiment was tried of tra[illegible] mitting at 50,000 volts three-phase alternating curre[illegible] The transformers used were those now employed on [illegible] three-phase transmission there. These transformers w[illegible] arranged to give a number of different voltages fr[illegible] 50,000 down, according to the way they are connec[illegible] This transmission at 50,000 volts three-phase current [illegible] kept in service for about two weeks and no accide[illegible] occurred during the time. The line consisted of galvani[illegible] iron telegraph wires supported on glass insulators. It [illegible] found that the self-induction afforded by the iron wire [illegible] a beneficial effect in counteracting the capacity of the l[illegible] The experiment was not continued for a longer t[illegible] because a rainy season came on and proper provisi[illegible] against lightning were not at hand.

Domesticated Electric Motors.—The *Elect[illegible] Review* of New York describes and illustrates an elec[illegible] floor-scrubbing machine, designed by a Mr. H. F. Ackerm[illegible] of Cleveland. The inventor states that the machine [illegible] been in actual service for the past two years in the Hic[illegible] building, Cleveland, doing the scrubbing work on ei[illegible] floors in 2½ hours, as against 10½ hours' hand lab[illegible] formerly required. The machine is operated by an elec[illegible] motor, which receives its current through a flexible co[illegible] which may be attached to any convenient incandes[illegible] lamp socket. A reel at the top of the trolley pole w[illegible] a spring tension takes up the slack cord. The [illegible] carries three scrubbing brushes, which are held agai[illegible] floor by means of spring pressure, and are geared w[illegible] motor so as to revolve at about 400 revolutions per [illegible] The wheels of the machine are rubber tyred, and [illegible] whole apparatus can be very easily pushed along the f[illegible] somewhat like a lawn mower. It is found that the ac[illegible] of the brushes in rotating tends to draw the machine alo[illegible]

at the operator has really little more to do than to › it. Water is thrown on the floor and the scrubbing line guided over it by the operator, and the work is . When in use, the front and sides of the machine protected by zinc splash boards. The whole apparatus hsabout 300lb.

he Brussels Exhibition.—We have received the rt to the Marquis of Salisbury, as Secretary of State Foreign Affairs, on the British section at the recent rnational Exhibition at Brussels. It shows that the sh exhibitors received more than their proportionate ber of awards as compared with the numbers exhibit- The greatest successes were secured in the British ection. There does not appear to be any reference in eport as to the electrical exhibits, but the awards are . In the report of Mr. Conrad W. Cooke on the ical and mathematical science sections, the author ts that Great Britain was, numerically, so very ly represented, there being but three representatives ritish manufacturers of mathematical and physical ratus, but this numerical weakness was to a certain at met by a display of intrinsic merit. The author iders it a deplorable fact, but one that must be recog- l, that British manufacturers appear to be tired of national exhibitions, and seem to be becoming more more indifferent to their importance, whether for ridual competition or advertisement, or for setting ı the excellence of the products of their country. aps the heavy import duties prevailing in some tries explain this, as advertising in a quarter where sees cannot possibly be done cannot pay.

rerhead Telephone Wires.—The overhead wires ondon are unsightly, are a nuisance to the householders, are both a nuisance and an endless expense to the phone Company. The following letter by Mr. E. A. gerald to the *Daily Chronicle* puts the case very ly. He says: "May I draw attention in your columns the unpleasant position in which householders are ed regarding telephones in the parish of St. James's, g to the fact that the Vestry declines to allow the ional Telephone Company to place their wires under- nd, while the householders object, with much reason, rerhead erections. When we apply for the installation f telephone the company produce their contracts, which nd they sign, but they are apparently entirely unable fulfil these. After the contract is signed they explain t, owing to the objection of the vestries on the one d and the householders on the other, they see no spect of immediate installation of the instrument. y are good enough to say they will do their utmost, they are unable to name any fixed date upon which service may be expected to begin. Under these mstances surely some public authority—I will not ture to say which—ought to take this pressing matter nd, that a London householder may not be in a worse tion than a resident in a small Norwegian or South rican town."

gh-Tension Lightning Arrester.—The *Revue Electricité* publishes an account of a lightning arrester for use in connection with high-tension electric lines. The ditions required of such an apparatus are that it shall able a flash of lightning to get to earth without maging the apparatus, and at the same time prevent line current from passing along the path the lightning taken. In fact, the electric circuit after the flash must such that there is no interruption to the supply. The tning arrester described in the article was manufac- ed by the Alioth Company. In this, two carbon plates h an air gap between them is used as the spark gap for the lightning. The upper of these two is attached to a long arm connected with the armature of an electromagnet, which is energised as soon as the machine current passes between the carbon discs. This causes the disc to be separated to such a distance as to break the arc. As soon as this is done, the electromagnet is demagnetised, and the disc returns to its first position ready to receive another shock. The distance between the disc in the first instance is varied according to the working pressure of the line. Thus if 2,000 volts alternating is used the gap is $\frac{1}{16}$in., but if the current is continuous it is only ·08in. With 10,000 volts these distances become ·32in. and ·2in. respectively. The apparatus is said by the author to have given great satisfaction in Spain in a locality particularly liable to thunderstorms.

Compounding.—The great convenience of compound winding direct-current dynamos is unquestioned, and with single machines the series turns can be made to compensate for the drop of pressure in the wires between the dynamo and the lamp network. When, however, two compound dynamos are mechanically worked together this effect cannot be produced, as the rise of pressure is caused by the currents of the individual dynamos and not by the sum. Mr. George T. Hanchett, in the *Electrical World* of New York, gives a solution of this difficulty, which requires two series windings on each machine: one to balance out the fall of voltage arising from the action of the machine itself and its engine, and the other to effect the over-compounding and thereby balance out the drops in the feeder and distribution system. While this complicates the field windings of the generators somewhat, a modification is possible which will overcome this—namely, the placing of the compounding coils on every alternate field core, and the over-compounding coils on the intermediate cores, as it is not at all necessary that the field windings be uniformly distributed over all the limbs of a multipolar field. It may interest Mr. Hanchett to know that this device is already used in England on some multipolar dynamos at Arundel Castle, the seat of the Duke of Norfolk. There two series windings are used on each dynamo, one of which carries the whole current output for the time being to the castle, and the other the current generated by the individual machine.

Electric Light in the East.—The following are interesting extracts from a letter appearing in *Indian Engineering* on the electric light for Calcutta. The writer says: "Most dwellers of the City of Palaces will be glad when the proposed electric lighting of the town is an accomplished fact. The electric light has been a long time coming to Calcutta, but it is a moral certainty once it comes it will stop, and the present antiquated smoky gas burners, that damage pictures, walls, and furniture, will be things of the past. There is no light to beat the incandescent electric lamp for tropical climates, especially on those sultry nights when every room is like a furnace, and made more so either by the flaring gas or the kerosine oil lamps which are in general use in all the Calcutta residences. Then, again, the sleepy night punkah coolie will also be a relic of a bygone age, as the simple turning on of a switch will set your punkahs going. Calcutta is a most difficult city to supply with current in regard to the economical laying in of the line wires, for the reason that the houses are so far apart; for where in a quarter of a mile in any other city of the West there would be 100 individual consumers, in Calcutta the electric light company can count on only five or six. This will be one of the chief drawbacks in supplying the Indian metropolis with current as cheap as it is supplied in European towns. Another improvement every humane person would like to see in Calcutta is the substitution of electric power to the

Calcutta trams, thereby doing away with the present horse haulage."

Advice to Inventors.—Mr. H. Remfry, of Calcutta, sends us a specimen chapter on "Inventions likely to take and pay in India and the East," from a large volume he is publishing on "India and the East from a Business Point of View." The author takes an optimistic view of the industrial future of India, and proceeds to give hints as to what improvements are wanted in the machinery, etc., used in the various industries. It is perhaps hard on the author to expect expert knowledge of him in all departments, but his remarks on electricity are not very critical. He says, not without precedent, that "this science is in its infancy, and its possibilities are immense. A much-looked-out-for project, which there seems little doubt that we will yet obtain through human ingenuity and skill, is some sure method of generating electricity either directly from heat of fuel or otherwise without the intervention of steam or dynamos, and of storing or transmitting this versatile agent for the production of light, chemical action, or mechanical force, or for the conveying of messages; also for punkah-pulling, medical treatment, and other purposes. Not a tithe of the possibilities of utilising this invisible fluid has as yet been fathomed. It is even rumoured that dynamic electricity and magnetism will repay careful investigation. Be this as it may, enquiries are still being made for a primary battery economically available for heavy work." In other parts of the book it seems to us that useful hints are given, but we have no love for the primary battery for heavy work.

Overhead Wires.—The gentlemen responsible for our Electric Lighting Acts, which forbid generally the use of overhead wires, should congratulate themselves when reading the adjoining account of the effects of the recent snowstorm in Boston, U.S.A. We had refrained from noticing the reports of the untechnical Press for fear of exaggeration, but the following from the *Electrical World* should be free from that fault: "The snowstorm is said to be the most severe on record, and it did a great deal of damage to overhead wires, and caused a complete suspension of electric railway traffic. For about 18 hours Boston was cut off from all communication with the outside world and paralysed, all telegraph and telephone wires being prostrated and all trains and electric cars stalled. About 18in. of snow fell, and hundreds of miles of wire were carried down by the weight of the snow. The streets in many places were literally covered with a network of tangled wires, and in the darkness which prevailed on the Monday night (Jan. 31) on account of the cutting off of electric light current, it was extremely dangerous to pass along the streets. The fire-alarm wires were also badly crippled. Owing to the dangers of the falling wires the mayor ordered the current to be cut off from all electric light wires on Monday night, except those underground, and for this reason the city was in darkness, except an area in the very centre, about a square mile. Very few of the suburban cities had any lights on account of the damage done to the lines and the necessary shutting off of current. It is stated that the storm will cost the electric traction company alone over £200,000." It will be interesting to know how far the falling electric light conductors conduced to this damage, but at any rate it should be made imperative for those conductors to be placed underground now. The lighting of a great city must, in the interests of law and order, be independent of the elements.

The Progress of Electric Lighting.—Last Tuesday night, at the Gloucester Guildhall, Mr. Hamilton Kilgour, electrical engineer to the Cheltenham Corporation, delivered a lecture, entitled "Notes on Electric Lighting and Electric
Works," to the members of the Gloucestershire Eng
Society. Mr. Kilgour reviewed the steady growth
electric lighting undertakings, starting from the di
boom in 1882. He illustrated his lecture by man
and diagrams, showing the progress in London
provinces. Thus one diagram showed the lamp con
of London and the provinces from 1890 to the
last year. From this it was seen that although
started with a good lead the provinces had n
stripped her, the respective totals of London a
provinces at present being 1,840,000 and 2,120,00
lamps. The next diagram showed the relative la
nections of alternate-current and continuous-current
and of works supplying on mixed systems. In t
vinces, alternate and continuous current works
almost equal numbers of lamps, whereas in Lond
continuous-current works had about 50 per cent
lamps connected than the alternate-current. As
the capital expended in electric lighting enterpri
the end of 1895 4½ millions were invested b
panies, while 1¾ millions belonged to munici
In 1896 the company capital rose to about £5,4
and the municipal capital to £3,400,000. In 18
revenue to companies for units sold was about half a
to municipalities £200,000. In 1896 the com
revenue rose to £600,000, and the municipali
£300,000. This made a total revenue of £900,
electricity supplied in the kingdom. For 1897 th
would be considerably over a million. Other de
to the reduction of works' costs as the demand in
were fully gone into by the author. The paper w
cluded by particulars as to the Cheltenham station, o
Mr. Kilgour is engineer. From these it is gather
a condensing pond with jet cooling has been const
and that oil fuel is to be used for the boiler at t
heavy load.

"Underground Systems of Electric Trac
This was the subject of a lecture delivered by Mr
Seaman last week under the auspices of the
Institute of Engineers. Mr. Seaman spoke first
progress which had been made in this country in tr
facilities, and then proceeded to deal with the variou
of traction. Dealing next with cable lines, he sa
system was used in America, on the Continent, and
country to some extent. With the cable power
necessary to have a frequent service, otherwise it wo
more expensive than an electric system. The object
this system were its cost, which was greater than elec
the complications required when lines diverged fro
other, the complete cessation of the service when th
broke down, and the inability to vary the speed an
the cars. In the case of electric traction, on the co
they had complete control of the cars, they could va
speed, and get up speed very quickly without inconv
to the passengers. It had been objected to the elect
that they could not go up steep gradients, but in Ge
the gradients were as steep as 1 in 10. The three
natives to the overhead system, he said, were the a
lator system, the open-conduit system, and the close-c
system. The accumulator system had not been
successful. The reason of the failures was the ex
weight and the cost in keeping the accumulators in w
order. Dealing with the open-conduit systems, he sai
of them had the conduit in the centre of the track,
under one of the lines, and others, again, outside th
The Simplex system had the conduit under the li
the conductor in this system was light and flexible.
avoided costly supports, and the insulators were 30ft.
instead of 15ft., as in other cases. It had been obje

duit system that it could easily be flooded, but it md in Washington that flooding did not interfere e traffic, and that the extra leakage was comparatively Indeed, the officials in Washington considered that matter of maintenance the conduit system was r than the overhead system. As for the cost of the track, in New York it was £10,000 a mile, in ls between £7,000 and £8,000, and in Budapest .

thern Society of Electrical Engineers.—th annual dinner was held at the Grand Hotel, ester, on Thursday, Feb. 17, and was well attended mbers and distinguished visitors. The toast of President (Mr. J. S. Raworth) and the Society" was d by Mr. John Aspinall, the locomotive engineer of ncashire and Yorkshire Railway Company. The tive engineers, he understood, were to be superseded trical engineers, who would run the trains more ically by means of motors. For himself he wished he time when the combined labours of the engineer mist would succeed in producing a storage battery per cent. efficiency. The electrical cab with the battery and motor was much heavier than the poor se, whose four legs carried a good mechanism. They d a nice, comfortable noiseless vehicle whose cells be charged at night and be ready for use next g. He did not think much of the oil-engine, which fficult to manipulate, and of it was said that it like a dog and stinks like a cat." The President, onding, made some suggestive remarks as to the of electrical engineering. He said that it was a able thing that sometimes a spell of bad trade did good than a period of prosperity. A spell of ity seemed to be now looming or beaming for al engineers, and he hoped that they would be able t the demand, so that there would be no necessity ir customers to go to Germany or America, whose statives would be very ready to sell their goods ke their customers in the middle of Manchester. ught that railway engineers would gradually convert lves into electrical engineers, but at the present here were many more developments more certain acticable. The distribution of electrical energy from it-bank deserved immediate attention, and if the s of the Mines Pumping Committee of Staffordshire arried out it would be possible to reduce the price to r unit, which would certainly not meet the views of local authorities who charge 5d. or 6d. In Lancashire ld be easy to find positions for stations which could a radius of three miles distribute 50,000 h.p to 0 h.p. They must aim to reduce the cost per unit. s a matter of extreme satisfaction that the Corpora- f the city of Manchester could supply under certain stances at only 1½d. a unit. The watchword of the ial engineer should be "Faith and Foresight." In rise we had many lessons to learn from America. ished to make the society a means of education to customers, and would institute a class of associates, spinners, engineers, and machine makers, who would their meetings when there was a subject of special st to them. Mr. H. Fawcus proposed the health e retiring president, Mr. Dorman, and Mr. H. nds, in the absence of Mr. Dorman, replied. He, dmunds, certainly thought that we were on the eve at developments, and must remove from the minds sible customers that British goods are dropping out, but we are being left behind. Ferraris, who had done ch for multiphase methods, was apparently little dated in England, our subscriptions to his memorial at Milan being small compared to those from abroad and America. In replying to the toast of "The Visitors," Mr. Joseph Nasmith, ex-president of the Society of Mechanical Engineers, contended for the thorough training of electrical engineers. It was not sufficient for them to have a knowledge of electricity, but they must have a sound knowledge of mechanical engineering. During the evening a programme of glees, songs, and sketches was contributed by Messrs. Greenwood, Robinson, Pickford, and Marr.

The Electric Furnace.—Messrs. Gin and Leleux recently presented to the Académie des Sciences a paper on the electric furnace. Starting with Mr. Blondel's theory, that the arc resembles an ordinary resistance, and that to establish the nature of this resistance one must study the action of the arc in very many different conditions, the authors present deductions from their experience. The deductions are not put forward as facts, but as reasonable hypotheses. The authors then start with the idea "that the characteristic fall of potential in an arc playing in the midst of a given medium is due simply to the resistance of the gaseous mass interposed between the electrodes and resulting from the vaporisation of the electrodes, or of the materials submitted to the action of the arc." Considering this resistance as a cylinder and taking l and s as the length and cross-section of this cylinder respectively, ρ, its specific resistance, and, c, its specific heat, the authors proceed to develop the following formulæ. The energy transformed into heat in unit time is $R I^2$; this corresponds to a quantity of heat expressed by $\frac{1}{A}\left(\frac{I}{s}\right)^2 \rho l s$. If the effect was limited by the furnace walls being perfect non-conductors of heat, we should get $\frac{1}{A}\left(\frac{I}{s}\right)^2 \rho l s = c l s t$; or $t = \frac{1}{A}\left(\frac{I}{s}\right)^2 \frac{\rho}{c}$. In words, the temperature of the arc increases as the square of the current density and as the ratio of the specific resistance to the specific heat of the atmosphere of the arc. These last two quantities are variable with the temperature. The above formulæ are only rigidly true for adiabatic heating, which is not attainable. The conditions are approached, however, by making the arc act in a space surrounded by material of low heat conductivity; as, for instance, the charge used in the manufacture of calcium carbide. In such a case the arc creates a space for itself, and the volume of this space increases to a given point. This is reached when equilibrium has been established, and the vaporisation and chemical actions having ceased, the quantity of heat given off by the arc is balanced by the heat transmitted outwards through the raw material in the furnace. After cooling, the sides of this space or pocket consist of the following stratified layers, commencing from the inside: (1) a layer of bright graphite of open texture, looking as though it had been boiling; (2) a layer of crystallised calcium carbide; and (3) the raw charge of the furnace. It is concluded from this that internal temperatures had been sufficiently higher than the dissociation pressure of the vapours of calcium and carbon to oppose the combination of these two elements, which can only occur on the solidified sides of the cavity, which are at a lower temperature. If one does not like to admit the dissociation of calcium carbide, it is necessary to explain the existence of the layer of graphite when the arc is stopped and the furnace cooled. The authors then show how the resistance varies with the material used. Thus, in the ordinary calcium carbide furnace, 18 to 20 volts are required ($s = 100$ square centimetres; $I = 1{,}000$; and $\frac{I}{s} = 10$). If oxide of manganese is added, this voltage can be reduced to 10. Other interesting facts are given.

NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

[*Copyright.*]

LXXXII.

Dr. Paul Schoop adopted gelatinous silica, a substance not liable to chemical alteration, in the construction of an afluidic accumulator. One recipe for obtaining the gelatinous electrolyte is to mix three volumes of dilute sulphuric acid, specific gravity 1,250, with one volume of a solution of sodic silicate (water-glass) of specific gravity 1,180. This mixture, at first quite fluid, gelatinises in the form of a stiff jelly within a few hours. In the experimental trials at Frankfort, with E.P.S. cells, the electrolyte was formed of a mixture of dilute sulphuric acid of specific gravity 1,220, sodic silicate of specific gravity 1,200, and asbestos fibre which had been treated with hot dilute sulphuric acid. Various proportions, approximating to those given above, were tried, the object being to obtain a permanently gelatinous mass. To ensure this object, it is necessary that the mass should be covered with a slight layer of dilute sulphuric acid.

When, in the operation of charging, gas is evolved from the surface of the elements, this does not break up the gelatinous mass, but escapes between it and the plates. The resistance of the solid electrolyte is considerably higher than that of the ordinary acid—in some cases, indeed, it was found to be twice as great; but it does not greatly differ from that of the sulphate of zinc electrolyte in Reynier's lead-zinc accumulator. At the Frankfort Electrical Exhibition of 1891, the Oerlikon Company ran, for the accommodation of visitors, a tramcar furnished with accumulators mounted on the Schoop system. It was found that, *cæteris paribus*, about the same weight of these cells was required as in the case of the Julien accumulators used in 1883 by the Tramways Bruxellois—*i.e.*, 1,600 kilos for a car weighing, when empty, 7,500 kilos, the distance traversed being about 1,200 km.

In some experiments by Prof. Kohlrausch at the Hanover University, it was found that, in spite of the reversal of the charging current, a discharge at nearly twice the normal rate, and other severe treatment extending over several months, the gelatinous electrolyte remained be in excellent condition, the plates had not buckled or warped, and the plugs of active material remained firmly in their original position. A comparison of the discharges of two cells, respectively mounted with sulphuric acid of specific gravity 1,185, and with the gelatinous electrolyte, was, however, unfavourable to the latter. Commencing with a P.D. (potential difference, or E.M.F. acting over the external portion of the circuit) of 1·98 volts, and ending with a P.D. of 1·83 volts, the fluid electrolyte gave 249 watt-hours in 13 hours; whereas the solid electrolyte, with an initial P.D. of 1·89 volts, and a final P.D. of 1·76 volts, gave 184 watt-hours in 10 hours. The difference in the results is mainly attributable to the difficulty opposed to the diffusion of the acid through the gelatinous mass; this diffusion being molecular, and the circulation of the acid being entirely prevented.

LXXXIII.

In August, 1895, Mr. R. J. Jocelyn Swan, A.I.E.E., carried out under my direction some experiments with two E.P.S. (E·7) cells, one of which (A) was mounted in the usual way with dilute sulphuric acid of specific gravity 1,190; whilst the other (B) was filled with a mixture of granulated pumice and a small proportion of the double ferrocyanide of zinc and potassium [$K_2Zn_3(FeCy_6)_2$], which mixture was saturated with sulphuric acid of specific gravity 1,300. The absorbent then had the appearance of a nearly dry, hard cake. When so mounted, cell A weighed 24lb. 13oz., and cell B 26lb. 2oz.; the containing boxes being of wood, with lid. According to the instructions issued by the Electrical Power Storage Company, the maximum rate of charge of these cells is 12 amperes; the maximum rate of discharge being 13 amperes, and the time of discharge at this rate being about three hours. Thus the capacity should be about 39 ampere-hours.

One hour was taken as the period of discharge; this
being considered as economically the maximum dur
a tram or road trip without renewal of power.

The cells, A and B, were connected in series and
until gas was freely evolved from all the plates. Th
then discharged at the rate of 13 amperes. At the
one hour the P.D. at the battery terminals respectivel
(A) 1·90 volts, (B) 1·82 volts, showing an advantage
side of the more freely-circulating electrolyte.
following day, however, the respective E.M.F.'s wer
1·98 volts, (B) 2·0 volts; and a second discharge,
recharging, was taken for one hour, commencin
18 amperes and ending with 20 amperes. Just
stopping, the P.D.'s were: (A) 1·79 volts, (B) 1·40
and five minutes after breaking the circuit the E
were: (A) 1·87 volts, (B) 1·72 volts.

The cells having been recharged at 12 amperes fo
hours, the initial E.M.F.'s, after breaking the circu
found to be: (A) 2·1 falling to 2·02 volts, (B) 2·2
to 2·11 volts. A discharge of 20 amperes for one h
then taken. The respective P.D.'s indicated were:

	After 30 min.		After 45 min.		Just prior to t
(A)...	1·90 volts	......	1·89 volts	......	1·85
(B)...	1·85 „	......	1·80 „	......	1·72

But five minutes after breaking circuit the E.M.F.'
(A) 1·94 volts, (B) 1·91 volts.

After a third charge of the cells in series, the
discharged with a "spurt" of 30 amperes for three m
followed by 20 amperes for 17 minutes. This was r
three times, thus making up the hour. Just bef
expiration of the 20 minutes the P.D.'s were: (A
volts, (B) 1·87 volts. The P.D.'s observed dur
second "spurt" of 30 amperes were: (A) 1·85 vo
1·79 volts. After a second 17 minutes at 20 ampe
third "spurt" at 30 amperes showed: for (A) 1·8
for (B) 1·70 volts. Lastly, after a third 17 min
20 amperes, the final P.D.'s were: (A) 1·80 volts, (
volts. But five minutes after breaking the circ
respective E.M.F.'s on open circuit were: (A) 1·9
(B) 1·87 volts. Up to this point cell (A) showed l
no indications of damage due to the comparativel
discharges. After a fourth charge this experim
repeated with similar results.

After a fifth charge, the cells were dischar
22 amperes for 17 minutes, and 30 amperes fo
minutes, these alternations being repeated three t
make up the hour. The initial E.M.F.'s were: (A
volts, (B) 2·10 volts. The P.D.'s during the first "
of 30 amperes were: (A) 1·89 volts, (B) 1·79 volts.
the second spurt (or *coup de fouet*) they were: (A) 1·
(B) 1·67 volts; and lastly, during the third spu
1·83 volts, (B) 1·35 volts. Five minutes after breal
circuit the E.M.F.'s were: (A) 1·91 volts, (B) 1·85

In these experiments the advantage of a free cir
of the electrolyte is clearly exhibited. But it mig
mistake to overestimate this advantage as compar
that of an afluidic system in which the circulatio
no means altogether impeded. For, on examin
elements of cell (A), it was now found that some of th
of active material (peroxide) had become detached f
grids, and that near the edges of the latter there
few patches of active material above the level
surrounding surface, and showing signs of disinte
Whereas in cell (B), although the elements w
examined, they were so tightly packed in the
material that it appeared obviously impossible t
active material could have become detached from th

The last experiment was now repeated wi
difference: that the *coups de fouet* of 30 amperes f
minutes preceded currents of 25 amperes contin
17 minutes, these alternations being repeated thre
to make up the discharge for one hour. The res
not differ materially from those last given, the fina
being, however: (A) 1·80 volts, and (B) 1·60 vol
the E.M.F.'s five minutes after breaking the circu
1·95 volts, and (B) 1·88 volts

It now become evident that cell (A) would
destroyed if worked at such high rates of dischar
the experiments were continued with cell (B) only.
charging at the usual maximum rate of 12 ampe

this cell was 2·15 volts. The discharge was with a current of 30 amperes for three minutes, '.D. being then 1·93 volts. The current was ished to 25·5 amperes for 17 minutes, after .D. of 1·88 was indicated. Then 32 amperes for three minutes, at the end of which the ·80 volts. Next, the current was reduced to for 17 minutes, when the P.D. was 1·71 volts. *fouet* of 32 amperes was then given for three ter which the P.D. fell to 1·60 volts. A current peres was then taken; but this could not be for the full remaining period of 17 minutes, falling to 21 amperes at the conclusion of the e minutes after breaking circuit, the E.M.F. olts. The absorbent in cell (B) was found to be too dry.

experiments were from time to time made with e elements of which have not to this day been This cell is now in charge of Mr. C. H. nd is probably yet in a condition to allow of Cell (A) was ultimately mounted with afluidic similar manner to cell (B); it is now in charge Andreoli.

ly, these afluidic cells are mounted with the nixture:

l sulphate of zinc ($ZnSO_4,7H_2O$)	30
ssiate of potash ($K_4FeCy_6,3H_2O$)...........	20
coarse powder	100

may be added about 150 parts, by weight, of huric acid, specific gravity 1,300, or lower. Tripoli stone may be substituted for the d 22 parts of copperas—*i.e.*, ferrous sulphate O)—for the 30 parts of zinc sulphate. With the prussian blue [$C_{18}N_{18}Fe_7,18H_2O$, or—expressing etical ferrocyanogen (FeC_6N_6) as Fcy—Fe_4Fcy_3, formed.

ific gravity of a sample of ground pumice (con- was found to be ·624 (water being unity). The ated with water was 1·294, and saturated with cific gravity 1·3, 1·541. The specific gravity of Tripoli stone was ·774, coarse silver sand was the same saturated with water was 2·080.

ted or coarsely powdered pumice without admix- tutes a good absorbent, the insoluble zinc salt d mainly to obviate or to remedy sulphating, and augment the E.M.F. by the deposition of zinc ode, and by the liberation of hydroferricyanic Cy_6), becoming hydroferricyanic acid ($H_3C_6N_6Fe$, the hypothetical ferricyanogen Fdcy—H_3Fdcy) de. When granulated pumice, alone or in admix- ed as absorbent, the completion of the process of *i.e.*, the liberation of gas from the surface of the is indicated by the rising of the fluid electrolyte surface of the filter-like absorbent, the bubbles sing through the expelled fluid. It is necessary, to allow room for the latter in the containing ve the level of the absorbent.

tructing afluidic cells with the pumice absorbent, en usual to allow per ampere-hour of capacity the moist material—*i.e.*, the pumice saturated of specific gravity 1·3; or from 1·36 to 1·46 cubic e saturated material is allowed per ampere-hour e capacity.*

son why acid of such high specific gravity as 1·3 le in afluidic cells is that the layer of acid in ith the spongy-lead plate soon becomes weakened ction, and that this layer is not readily displaced r acid whilst the cell is at rest, as would be the re were a free circulation of the electrolyte.

here be useful to state that, in order to reduce r prussiate of potash (potassic ferrocyanide) to he salt must be rendered anhydrous—*i.e.*, the ecules of water must be expelled by heat.

LXXXIV.

st the most curious and interesting of the s of chemistry is that of the expulsion and liberation of a powerful acid by another which we are accustomed to regard as a comparatively weak one. Many men having a tolerably extended knowledge of chemistry might nevertheless receive with an incredulous smile the proposal to liberate sulphuric acid from plaster of Paris ($CaSO_4$) or from zinc sulphate ($ZnSO_4$), or to decompose common salt (NaCl) with liberation of hydrochloric acid (HCl), by means of a solution of oxalic acid ($H_2C_2O_4$). Nevertheless there is no difficulty in obtaining the reactions involved in this suggestion. Now hydrocyanic acid (HCN or HCy) is with good reason considered to be a very weak acid indeed, although argentic cyanide (AgCy) may be precipitated by it from a solution of the nitrate of the metal ($AgNO_3$). Partly on this account, perhaps, hydroferrocyanic acid (H_4FeCy_6 or H_4Fcy), which is innocent of corrosive properties, is also regarded as a very weak acid. Nevertheless it will precipitate zinc, or iron, from solutions of the sulphates of these metals, or, so far as I know, from any of their salts. This fact may be utilised in the working of voltaic batteries, for, when sulphuric acid has become neutralised by the production of sulphate of zinc, it can be regenerated, and the crystallisation, "creeping," and efflorescence of the salt can be obviated, by the addition to the electrolyte of a solution of hydroferrocyanic acid. The white gelatinous precipitate thus produced is the ferrocyanide of zinc (Zn_2FeCy_6 or Zn_2Fcy), a salt which, of course, cannot be decomposed by dilute sulphuric acid, and which I have found to be a very useful addition to afluidic absorbents, since it is an electrolyte, and therefore a conductor of the current, and since it adds somewhat to the E.M.F. and to the capacity of an accumulator, as above intimated.

To obtain hydroferrocyanic acid, dissolve 58 parts by weight of crystallised tartaric acid in alcohol, and add the solution to one of 50 parts of ferrocyanide of potassium dissolved in 180 parts of warm water. Bitartrate of potash ($KHC_4H_4O_6$) is precipitated and H_4Fcy is liberated in solution. This solution must be kept in the dark, as otherwise it soon becomes decomposed, with production of prussian blue.

But to obtain a useful absorbent which is an electrolytic conductor not decomposable by sulphuric acid, it is not necessary to isolate hydroferrocyanic acid. When a solution of potassic ferrocyanide is added to one of zinc sulphate, a double ferrocyanide of potassium and zinc is precipitated, according to the equation:

$$ZnSO_4 + K_4Fcy = K_2SO_4 + K_2ZnFcy.$$

It is this double ferrocyanide which is utilised in the afluidic absorbent referred to in the preceding section.

* residual acid is required to have the specific gravity h is that of maximum conductivity, this value should ic inch.

LORD KELVIN'S PATENTS.*

There are altogether 47 patents from Feb. 20, 1858, to Sept. 28, 1896, a period of 38 years. All of them can be conveniently classified under four heads:

A. Patents relating to improvements in electric telegraphic apparatus.

B. Patents relating to improvements in navigational apparatus.

C. Patents relating to improvements in generating, regulating, measuring, recording, and integrating electric currents.

D. Improvements in valves for fluids.

Under the first head (A) there are 11 patents containing (1) 211 pages of descriptive reading, and (2) 24 large sheets having 127 separate figures or diagrams, as shown in the following tabular statement A.

Fleeming Jenkin was associated with Lord Kelvin in patents 2047 and 2086, and Cromwell Fleetwood Varley was associated with him in patent 1784.

Under the second head (B) there are 10 patents containing (1) 89 pages of descriptive reading, and (2) 27 sheets having 151 separate figures or diagrams, as shown in the following tabular statement B.

* Paper read by Dr. Magnus Maclean before the Philosophical Society of Glasgow on Feb. 23.

STATEMENT A.

Number of patent.	Date of provisional specification and of complete specification.	Title of patent.	Number of pages.	Number of sheets.	Number of figures or diagrams.
329	Feb 20, 1858 Aug. 19, 1858	Improvements in testing and working electric telegraphs.	36	1	9
329	May 19, 1871	Disclaimer.	19	—	—
2047	Aug. 25 1860 Feb. 25, 1861	Improvements in the means of telegraphic communication.	37	4	27
1784	July 6, 1865 Jan. 6, 1866	Improvements in electric telegraphs.	14	1	9
2147	July 23, 1867 Jan. 23, 1868	Improvements in receiving or recording instruments for electric telegraphs.	10	1	7
3069	Nov. 23, 1870 Not allowed	Improvements in electric telegraph transmitting, receiving, and recording instruments, and in clocks.	33	—	—
252	Jan. 31, 1871 July 31, 1871	Improvements in transmitting, receiving, and recording instruments for electric telegraphs.	24	7	37
810	Mar. 25, 1871 Void.	Improvements in clocks and apparatus for giving uniform motion.	4	—	—
2086	June 12, 1873 Dec. 12, 1873	Improvements in telegraphic apparatus.	14	4	11
1095	Mar. 13, 1876 Sept. 13, 1876	Improvements in telegraphic apparatus.	16	4	21
24868	Dec. 28, 1895 Sept. 28, 1896	Improvements in recording instruments for telegraphic and other purposes.	4	2	6

STATEMENT B.

Number of patent.	Date of provisional specification and of complete specification.	Title of patent.	Number of pages.	Number of sheets.	Number of figures or diagrams.
1339	Mar. 29, 1876 Sept. 27, 1876	Improvements in the mariner's compass and in the means of ascertaining and correcting its errors.	12	2	20
1339	Nov. 30, 1877	Disclaimer and memorandum of alteration.	8	—	—
3452	Sept. 1, 1876 Mar. 1, 1877	Improvements in apparatus for navigational deep-sea soundings.	8	1	9
4876	Dec. 18, 1876 June 15, 1877	Improvements in the mariner's compass and in appliances for ascertaining and correcting its errors.	17	3	22
679	Feb. 20, 1879 Aug. 20, 1879	Improvements in the mariner's compass and in appliances for correcting its errors.	8	2	15
781	Feb. 23, 1880 Aug. 23, 1880	Improvements in navigational sounding apparatus.	15	7	31
5675	Dec. 8, 1883 June 7, 1884	Improved navigational sounding apparatus.	7	3	12
5676	Dec. 8, 1883 June 7, 1884	Improvements in the mariner's compass and in the means for ascertaining and correcting its errors.	5	5	12
12240	Oct. 14, 1885 July 12 1886	An improved navigational sounding machine.	6	2	24
8959	June 10, 1890 Mar. 10, 1891	Improvements in the mariner's compass.	3	2	6

Under the third head (C) there are 24 patents containing (1) 177 pages of descriptive reading, and (2) 123 sheets having 287 figures or diagrams, as shown in the following tabular statement C.

Under the fourth head (D) there are two patents containing (1) 10 pages of descriptive reading, and (2) eight sheets having 25 separate figures or diagrams as shown in the following tabular statement D.

There are up to Sept. 28, 1896, 47 patents containing (1) 487 pages of descriptive reading, and (2) 182 sheets having 590* separate figures or diagrams.

* The number of separate diagrams is underestimated here, for in some cases the diagrams are numbered 1, 1A, 1B, 1C, etc., and these in the above counting are reckoned as one.

STATEMENT C.

Number of patent.	Date of provisional specification and of complete specification.	Title of patent.	
3032	July 9, 1881 Jan. 9, 1882	Improvements in regulating electric currents, and in the apparatus or means employed therein.	1
5668	Dec. 26, 1881 June 28, 1882	Improvements in dynamo-electric machinery, and apparatus connected therewith.	1
2028	April 21, 1883 Oct. 20, 1883	Improvements in apparatus and processes for generating, regulating, and measuring electric currents.	2
4617	Sept. 28, 1883 Mar. 27, 1884	Apparatus for generating, regulating, measuring, recording, and integrating electric currents	4
4655	Mar. 10, 1884 Oct 8, 1884	New or improved suspensions for electrical incandescent lamps.	
5355	Mar. 22, 1884 Nov. 10, 1884	Improvements in dynamo-electric machinery.	
6410	Mar. 10, 1884 Oct. 28, 1884	Improvements in breaking electric contact to prevent overheating by imperfect contact.	
10530	July 24, 1884 April 25, 1885	Safety fuses for electric circuits.	
11106	Aug. 9, 1884 May 7, 1885	Improvements in apparatus for measuring electric currents.	1
9016	July 10. 1886 April 9, 1887	Improved apparatus for measuring the efficiency of an electric circuit. (Amended Oct. 4, 1887.)	1
18035	Dec. 11, 1888 Sept. 7, 1889	Electrostatic apparatus for measuring potentials.	
18035a	Dec. 11, 1888 Sept. 7, 1889	An improved ampere-gauge and connections.	
18035b	Dec. 11, 1888 Sept. 7, 1889	Improved apparatus for continuously measuring potentials or currents.	
15769	Oct. 8, 1889 July 7, 1890	Apparatus for measuring and recording electric currents. (Allowed to lapse.)	
1004	Jan. 20, 1891 Oct. 20, 1891	An improved indicator for electric potentials.	
18436	Oct. 27, 1891 July 22, 1892	Improved apparatus for measuring and recording electric currents.	
10230	May 30, 1892 July 2, 1892	An improved electric condenser.	
2198	Feb. 1, 1893 Nov. 1, 1893	Improvements in balances.	
2199	Feb. 1, 1893 Feb. 1, 1893	An instrument for measuring electric currents.	
5733	Mar. 17, 1893 Dec. 16, 1893	Improved arrangement for reading the deflections of electric instruments.	
24471	Dec. 20, 1893 Oct. 20, 1894	Improvements in electric supply meters.	
24979	Dec. 29, 1893 Dec. 29, 1894	Improvements in instruments for measuring and recording electric pressures and currents.	
15034	Aug. 7, 1894 —	Improvements in instruments for measuring electric currents.	
2261	Nov. 27, 1895 Sept. 28, 1896	Improvements in apparatus for indicating and recording electric supply.	

STATEMENT D.

Number of patent.	Date of provisional specification and of complete specification.	Title of patent.	Number of pages
5471	March 31, 1889 June 8, 1889	Improvements in valves for water, steam, or other liquids or gases.	4
3864	March 4, 1891 Dec. 3, 1891	Improvements in valves for water, steam, or other liquids or gases.	6

James T. Bottomley was associated with Lord patent 10530.

Under the first head reference was mad "retardation" occasioned in electric impulse

marine cables by "electrostatic capacity," and sity of having a receiving instrument so sensitive able to indicate or record continuously every in the strength of the received current. The ılvanometer and the siphon recorder, which were scribed, fulfilled these conditions.

the second head, the sounding machine, the corder, and the compass were exhibited and . The three principal errors to be corrected in ass—viz., the semicircular, the quadrantal, and ng errors—were referred to, and the methods by ese are corrected in the Kelvin compass were l. Short reference was also made to the tide ial harmonic analyser, and tide predicter.

the third head reference was made (I.) to electro- (II.) to electromagnetic instruments for measuring and differences of potentials; (III.) to electro- instruments for measuring currents and differences ials; and (IV.) to instruments arranged for record- ntegrating electric currents.

ectrometers were divided into two classes: (a) cal electrometers, and (b) attracted disc electro-

Quadrant electrometer. By the heterostatic and arrangements, differences of potentials from to 100 volts can be accurately determined by this nt.

ticellular electrometers (40 to 1,600 volts).

tical electrostatic voltmeters (200 to 20,000 volts).

Absolute electrometer.

Long-range electrometer.

Portable electrometer.

Electrostatic balance (5,000 to 100,000 volts).

Graded current galvanometers reading from re to 200 amperes.

Magnetostatic current - meters reading from pere to 300 amperes.

Ampere-gauges reading from ¼ ampere to 6,000

Graded potential galvanometer reading from a tion of a volt to 200 volts.

Standard direct reading electric balances.

ti-ampere	balance from	1 to 100 centi-amperes.
i-ampere	,, ,,	1 to 100 deci-amperes.
a-ampere	,, ,,	1 to 100 amperes.
to-ampere	,, ,,	6 to 600 ,,
ampere	,, ,,	25 to 2,500 ,,
posite	,, ,,	0·02 to 500 amperes, and to 50,000 watts at 100 volts.

i-watt balance to suit currents from 0·1 to 20

a-watt balance to suit currents from 0·5 to 100

to-watt balance to suit currents from 5 to 500

lo-watt balance to suit currents from 25 to peres.

lo-watt balance to suit currents from 100 to mperes.

pere-balances are designed to carry 75 per cent. maximum current *continuously*, and carry their a current long enough for all standard purposes.

l. Recording voltmeters and ampere-meters.

Electricity supply meter.

d account of some of these instruments will be our next and subsequent issues.

(To be continued.)

TECHNICAL EDUCATION.

OF. W. E. AYRTON, F.R.S., PAST-PRESIDENT, I.E.E.

llowing is a verbatim report of an address delivered Ayrton to the Coventry Technical Institute. The was that of the distribution of prizes to the

AYRTON said: The object of technical instruction able a person to apply himself with advantage to some industrial pursuit. Such instruction may now be obtained at very many technical schools throughout the country, and in a much less formal way a large amount of technical information can, of course, be picked up in a factory by an intelligent person.

The ideal technical school would be one attached to the works, in which the employés would be systematically taught their trade, the application of the principles of science to their particular industry, and so forth, in somewhat the same sort of way that in former times the few apprentices were taught the "mysteries of their craft" by their master. But modern development has not tended in that direction, and at the present time, instead of a manufacturer deputing his teaching duties to persons paid directly by himself to perform them on his behalf, he delegates them to the nation generally. And the nation, recognising the fact that the apprenticeship system is dead, accepts the responsibility, passes Technical Instruction Acts, and builds technical schools in which people can learn at a small fee how to use their brains and their hands for the benefit of themselves, for the benefit of the masters, and for the benefit of the nation at large.

Technical schools, then, have this resemblance to Board schools—that in both the main part of the cost of teaching is not borne by those on whom the burden of defraying the expenses of education formerly fell. To-day the Board school rate is levied on all, and the British parent, who formerly recognised that his children had a claim on him, not only for board, clothes, and lodging, but also for education, is now, if he is poor, entirely relieved of this responsibility. So also is the technical instruction rate levied on the whole community, but in this case it is the rich manufacturer who is freed from the responsibility of technically educating his apprentices.

There is an old adage, "If you want a thing done well, do it yourself," but with technical instruction there is an advantage in the duty of teaching being deputed by the masters of works to the masters of schools. For the main duty of a factory is to turn out manufactured articles of the best quality for their price, and so engrossing has this problem become that the manufacturer has but little time or opportunity to concern himself directly with the turning out of men. Hence to manufacture goods and men in different establishments is only an example of the modern division of labour.

But not only have technical schools come into existence in consequence of the universality of the division of labour in our day, but they are maintained to counteract the evils that arise from this very division of labour; and the remedy they apply is to give the apprentice a far wider knowledge of his trade than he can obtain from the highly specialised work at which he is kept in the factory. And so it is hoped that should the workman have his particular division of the trade taken away from him by the general introduction of some machine, he may be able to avoid loss of work by turning to some other branch more or less allied to his own.

Great hitherto has been the diversity of opinion as to what should be taught at a technical school. Some advocate that the teaching in chemistry, for example, should be limited to a sound training in chemical principles and methods, while others urge that a technical school should be expected to teach the actual application of science to industrial processes. A third party, on the other hand, consider it proved that a technical school may with advantage aim at imparting a knowledge of what a few years ago would have been slightingly called mere handicraft.

Personally, I see no objection to instruction in *any* use of the hand being given at a technical school provided that it be accompanied with teaching that leads the worker to use his brain also; or, perhaps, I should say that since the teaching of *any* use of the hand cannot be adequately given without its being accompanied with a certain amount of mental training, such teaching has a perfect right to be regarded as a part of technical education. I am aware that a sharp distinction between education and training has been drawn by some authorities, and that they have pronounced it a misnomer to apply the name education to what is often called the training of the hand and eye. This appears to me, however, to be a mistake, for there is no radical

difference in the method of trial and error which has to be followed in learning to perform *any* useful operation really well, whether it be making a first-rate fit between two pieces of material, skilfully fingering the violin, or adroitly solving problems in Euclid. Determination, application, the appreciation of the importance of accuracy and continued practice are necessary in each case, and the bodily as well as the mental improvement which is effected in the individual *during* the acquisition of any such form of dexterity is of the nature of education, but does not by itself, of course, constitute an entire education. When the dexterity has been once acquired, however, the mere repeated use of it is neither education nor training, any more than the daily solution of problems in trigonometry would be an education after a lad had mastered the methods. Further, it is not because the successful management of a football team is not educational that it would be unwise for a person to make this the main business of his life if he desired to become an engineer, any more than it would be because I thought making experiments in a well-fitted and well-organised electrical laboratory necessarily not an educational process that I should dissuade a person from thus wasting his time when he was preparing to appear on the concert platform.

So far from there being a risk of the instruction in a technical school becoming too practical, there is a much greater risk of its becoming too purely theoretical. For when a technical teacher has to spend the greater part of his time giving out information, he has but little left to take any in, and he thereby runs the risk of losing touch with his trade, or profession, especially if it be one in a state of rapid development, like electrical engineering. His so-called practical teaching may then easily become unpractical and untechnical, academic, stereotyped, and only distantly related to industry.

Hence we technical teachers ought to welcome any suggestions from manufacturers as to what should be taught in technical schools, and, indeed, even how it should be taught. Certainly nothing is more acceptable to myself than the hints about the teaching at the City and Guilds Central Technical College which I occasionally receive from some of my old students who hold important posts in the industrial world. For the more valuable we can render our students to their employers, the more valuable we can render them to themselves, and the greater is our success as technical teachers.

Further, I would urge on my teaching brethren that not only should we keep in close touch with the trades we represent, not only should our aim be to avoid imparting antiquated, or unpractical, knowledge, but we should make an effort to keep our teaching to some extent even in advance of the industry it deals with.

There is, however, one subject of overwhelming importance which it is incumbent on every technical school to teach, especially as it is one that has been much neglected in the past, and that is the knowledge that the wide employment of machinery in a country is a real gain to every one of its inhabitants. Whether one reads in Charlotte Brontë's "Shirley" what was the feeling concerning the use of machinery at the beginning of the century, or in to-day's newspapers what is the attitude of certain workmen towards machinery now at the end of the century, one is struck at finding the same stubborn resistance fostered by the same misguided notion that the amount of work to be done in the world is a fixed quantity, and, therefore, that it ought to be dealt with sparingly and parcelled out like food among a shipwrecked crew, so as to be made to go as far as possible.

I am not here entering on politics, or taking a side in the recent misunderstanding between capital and labour; I am merely deploring the want of exact knowledge that has existed, and which I fear still exists, regarding the effect on a people of the wide use of machinery—a want for which all the teachers of this country, by whatever titles they may be designated, are directly or indirectly responsible. And however much we may personally sympathise with the desire of the Englishman to resist an innovation which he fears will take the bread out of the mouth of his wife and children, it is the duty of teachers at the present time, especially of those of us who have had the opportunity of travelling and studying the ways of distan countries, to urge on our people that what is to a nation benefit must ultimately benefit each of its inhabitants, an that anything which resists the expansion of trade in Grea Britain cannot be for the good of its people.

Which, for example, is the country where the earning of the workmen are the largest? Why, the United States— the one in which the use of machinery is the most exten sive, where the highest wage goes with the smallest bill fo labour in employments like the manufacture of steel which, although developed in this country, is, partly fo this reason, being rapidly wrested from us by America The American preference for doing purely mechanical work with inanimate machinery, and reserving the animate instrument—man—for brain work, combined with the wide diffusion of technical knowledge on the other side of th Atlantic, has already inaugurated a keen rivalry with Grea Britain. And this rivalry—which extends not only t foreign markets, where perhaps we could only hope to b on an equal footing, but even in the supply of goods to ou own colonies and dependencies, where we might hav expected to have an advantage—will grow into a supremacy unless we keep on our guard, and give unmistakabl evidence of our readiness to adapt ourselves to new method of manufacture.

A striking instance of the futility of supposing that th amount of work to be done in the world is fixed may b found in that prominent industry of this city, the manu facture of bicycles. How has it come about that thi industry is to be found here? Did you inherit it from your forefathers, or did Coventry snatch it away from Birmingham and despoil the Birmingham workmen o their birthright? No! It happened that, when in 188 the old French boneshaker was brought to the works o the Coventry Machinist Company, James Starley was thei foreman; and he was shrewd enough to foresee that th bicycle had a future. For had not Starley, when gardener to the engineer Penn, spent his leisure studying mechanics and repairing watches, and when he came acros the then novel sewing machine had he not effected importan improvements in them?

The Coventry Machinist Company took up the manu facture of the bicycle, and became the pioneer of tha industry. Later on, Starley left them and started th firm of Smith and Starley to make cycles and sewing machines. Next the cycle branch was transferred t Haynes and Jefferies, the first firm established exclusively to manufacture cycles; and in 1876 Starley, their engineer succeeded in producing a perfectly rigid wire-spoke whee by inventing the tangent-spoke device.

Much ingenuity, perseverance, and hard work were put by Coventry into the cycle industry, and a market wa made for that town before others were ready. "Factorie sprang up as if by magic," your president tells me, "and the great majority stuck to the best ideals of material and work in preference to cheapness, and so consolidated th trade."

Nobody is the loser, no one is the poorer; a change ha been effected throughout the civilised world, probably th greatest change in the last quarter of this century; friend have been brought closer together; and the world ha grown smaller. Women who dreaded a weary walk o five miles now ride 30 for pleasure; the workmen can liv away from the works. Outside the factory in America where some of the parts of the Coventry electric tramwa were made, I saw between 600 and 700 bicycles las autumn waiting in a shed to take some of the staff hom to dinner. The life of a girl has been made freer, for th staid elderly chaperon of our youth has had to give way t one of the other girls on her bicycle. Not merely hav riches come to you, the dwellers in this city, but every person in the world is the gainer because there was James Starley, and because Coventry believed in him.

Take, again, electric lighting, which has progressed with such gigantic strides during the past five years. Has impoverished those who earned their living through supply of illuminating gas? Assuredly, no. For noth has done so much to increase the demand for gas as higher standard of illumination to which people have becom accustomed through the spread of the electric lamp.

hear some of you saying, this is political economy, y rate, the economics of industry and not technical ı, and that it would be unsuitable to offer such tions to students who come here to learn watch-weaving, and woodworking.

a good deal of sound political economy may be n connection with watchmaking. It might, for be impressed on the student that while the idea machinery in watchmaking was started in England, America that it was first carried into practice, as Americans who first made large fortunes with made watches. Meanwhile, the English watch steadily declined, until your townsman, Rother-rived it by introducing American watchmaking y in the face of the opposition of his work-the loss of money, and apparently great loss of low Mr. Rotherham employs automatic machines, ted in his own engineering shop, with which he can 500 high-class watches per week, and so his name in many other places besides Coventry.

st important part of all technical education consists ily in encouraging people to learn how things are day, but in leading them to ascertain what exactly rticular result each special manufacturing process to accomplish, and then to consider whether the ne result cannot be arrived at more simply and aply in some totally different way. For analysis thesis—the splitting up into elementary com-and the building up again—is the basis of much n, as it should be of all technical education.

pork, according to Lamb, was originally produced lly on the burning of a farm, and perhaps le sauce owed its origin to that farm having an on it. Therefore the Chinaman supposed that it ssary to sacrifice a farm each time that somewhat ble luxury was desired. Gradually, however, it on the Oriental mind that one farm, one pig, ted an undue proportion of fuel, and finally it be realised that the pork and the sauce could be onomically produced by separate operations, one ut in front and the other on top of a kitchen fire.

s present cost of production can in many cases be decreased by the employment of new methods of ture; also the work to be done in the world can be increased by the starting of new industries. Hence seen that one of the most important duties of a turer is to create wants on the part of the public, merely to supply existing demands. For there is of money in England waiting investment, and there rich community ready to purchase any good thing ycles and electric energy when these commodities red.

there seems to be a considerable difference in the nce attached to the performance of this duty by rican and the English manufacturer. The American in the proverb, "L'Appétit vient en mangeant"—comes with eating—and so he manufactures plies "notions" before the public is aware it is in them, whereas the Englishman, with some brilliant ions, does not take up a novelty until it ceases to be d until he is no longer able to resist the clamour of le hungering after some innovation of recognised.

trast, for example, the overhead railways in New nd Chicago with the underground railway in London. ht were always airy (I have travelled on both), the lways sulphurous, as I know to my cost. Yet, the steam locomotive on the overhead American has given way to the electric motor, the use of electric n on the London underground system—which is a far more pressing necessity—is even now only consideration.

substitution of electric for horse traction in streets, has excited so much interest in the world generally the past few years, and which is just beginning to general attention even in our own country, differs he bicycle trade and the electric light industry in hile giving work to many it must at first interfere the employment of some, such, for example, as ers, dealers in horse fodder, harness-makers, etc. Ultimately, however, the total number of people who will be employed in connection with tramways will certainly be largely increased by the application of technical knowledge in the development of electric traction, for at the present time there are over 17,000 miles of electric tramlines in the streets of the United States on which run some 50,000 tramcars propelled with electric motors. Indeed, in Boston alone (Boston in America, I mean), which has a population only about one-tenth of that of London, the steam-engines in the various stations which drive the dynamo machines for supplying electric current to the tramways can develop nearly 50,000 h.p. continuously if required, and this, bear in mind, is altogether apart from, and in addition to, the engines driving dynamos for the electric lighting of that city.

Well, now, coming to the object of our meeting here to-night—prize-giving. We all like to come out well in examinations, to be awarded prizes, and win the approbation of our relations and friends. And this desire to stand high in the examination list undoubtedly furnishes a keen incentive to many young people to work hard. It should be, however, a consolation to those who do not shine in the examination room, but who yet feel that they have got something in them, to remember that success in life is not attained by supplying written answers to a series of questions.

Some there may be who can point to their having made a small steady income for a short period by regularly sending in the missing word, or by supplying answers to a series of questions set pictorially in one of the weekly collection of snips regarding the names of 50 famous authors, or a like number of cricketers. But it can be scarcely maintained that this class of competitive written examination constitutes a lucrative profession, or can be relied on to produce an income not distinctly precarious.

The examinations held at this Institute are, of course, of a totally different character, and to a certain extent they accurately test your value. But if I express a doubt as to whether any of the ordinary examinations can really test a person's powers as distinct from his capability of doing a particular piece of work, it is because I frequently set myself a question and give myself but a low mark for the inadequate character of my answer. And that question is: Does my own system of marking my own students really place them in the order of value that they will be to the world?

For it is comparatively easy to test the memory of an examinee for reproducing book-learning, or his dexterity in working out set problems on paper, or to test his skill to do a certain amount of manual work neatly and in a workmanlike fashion in a fixed time. But it is far less easy for an examiner to assign marks for a student's force of character, for his power to overcome previously unforeseen difficulties, for his coolness under trying conditions, for his quickness in observing a small effect on which large issues may depend, for his good presence and power of impressing his fellow-man, etc. And yet all these qualities are of enormous value in real life.

Am I, you will ask, estimating at a low value the training at a technical school, or is it that I expect but little from the effects of the liberality of men like Mr. David Spencer, or of your president, your six times mayor, a double Dick Whittington? I will answer that by asking whether you think it probable that I estimate of little value the work to which I am voluntarily giving my life?

It is no argument against technical education that it can only assist in developing *some* of the good qualities which endow an individual with charm and power; still less is its extension in our country of doubtful value, because there have been many in the past who produced great results without having ever entered a technical school. For it must be remembered that, although Nelson achieved all his success in entire ignorance of the construction and use of ironclads, Maxim guns, and torpedoes, he would certainly have made it his business to master these subjects were he fighting his battles to-day instead of nearly a century ago, and he would say now, as he said then, that he owed his success to always being on the spot half an hour before anyone else.

The moral then seems to be for the methods taught at a technical school to be kept well up-to-date, and for you, its

students, to do your best to excel in them, ever striving the while to increase your stock of those all-important characteristics—alertness, thoroughness, and truthfulness—not merely truthfulness in word, but also in work at the bench, the forge, and the vice, the truthfulness which is the slayer of shoddyism.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *two shillings and sixpence* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared, and should be written on one side of the paper only. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time.

Questions.

40. Describe with sketches a good direct-current motor-starting switch for use on a supply company's mains. What is specially required of such switches?—A. D. J.

41. What are the objections in actual working to separate switch pillars to each generating unit in a central station?—E. K. Scott.

Answers.

Question 34.—Would it be false economy to use galvanised iron-wire rope instead of copper tape for a lightning conductor?

Answer to No. 34 (*awarded* 5s.).—In order to answer this question, the practical as well as the solely financial advantages and disadvantages of the two systems must be weighed. Opinions differ as to the precise nature of a flash of lightning. Some hold that it is a spark simply passing from cloud to earth, or *vice versâ*—that is, a momentary *direct* current. The other theory is that it is oscillatory, like the spark of a Leyden jar frequently is; and this seems most probable, owing to the tremendous difference of potential between the earth and the cloud before the flash. The best way to grasp this idea is to think of a strong spiral spring hanging vertically. When the lower end is pulled and then let go, its elasticity causes it not only to regain its former position, but to go beyond it, and so on, the force decreasing with each oscillation until it comes to rest in its original position. In a lightning flash the difference of potential—*i.e.*, force—is so great that these oscillations occur very rapidly and cannot be detected. Here is an alternating current of very high frequency (probably some millions per second), and consequently "skin effect" comes into action—that is, the current flows entirely on the surface of the conductor and not *through* the metal, as in the case of a direct or a low-frequency current. In order to make sure whether lightning belongs to the first or second theory, two rods might be erected side by side, both of the same height, and same quality and cross-section of metal; one, however, being a solid rod, the other a tube, and therefore having a greater surface. They would have to be in an open space, with an arrangement (in a break in the conductor) for a fuse to automatically replace itself when burnt out. I don't think this has ever been done, but I am not sure. Now supposing lightning is, as in the first theory, a momentary direct current, then the conductivity of the conductor is of primary importance. The conductivity of copper is six times as great as that of iron—that is, if the conductor is of iron, its cross-section must be six times as great as if it is of copper. A section area of half a square inch is required if iron is used, and one-twelfth of a square inch if copper is used. Perhaps the copper should be rather larger, as its conductivity gets less with the passage of currents, whilst that of iron improves. As far as initial cost is concerned, the iron-wire rope would be cheaper than copper tape, as iron in the form of galvanised iron-wire rope would

probably cost about one-seventh as much
copper.
In the other and now generally recognise
cross-section of conductor is not so important as
That is, the conductor, of whatever material, m
round. This necessitates a large cross-section of
in the case of copper this would be expensive
reason copper tape is used in preference to co
the same surface with smaller cross-section i
The skin effect is also less marked when condu
round. Now, if stranded iron-wire rope is u
surface is obtained with comparatively small c
and the cost is considerably less than that of a
ductor with the necessary surface and, if in t
tape, the requisite strength. A large surface
cross-section of metal may be obtained by using
of large diameter, as mentioned above, but such
would be liable to rupture. The rod and points
of the conductor and the earth-plate at the bot
be of the same material as the main conductor,
thereto to prevent electrolytic action at the joint
wire rope is used, an earth-plate is not absolutel
as the ends of the wire may be untwisted and
to make earth contact. A joint is also thus s
thus obvious that, provided the iron-wire rope is
well galvanised throughout (and especially the p
top of the rod) to prevent rust, it is in every w
to copper tape for the purposes of a lightning co
C. I

Answer to No. 34 (*awarded* 5s.).—In no way
considered false economy at the present time
galvanised iron-wire rope instead of copper ta
protection of buildings from lightning. Wer
that the mechanical properties of the fo
inferior to those of the latter, or that
greater resistance to the high-frequency di
lightning, then undoubtedly its adoption on t
lower first cost would be one of false economy.
paratively speaking, the lightning conductor or
conductors in a building is a small item in the e
and it would be necessary for true economy to e
relative properties other than cost before adopt
preference to copper. From the first adopti
lightning conductor the latter material has b
exclusively employed in its construction, the
course, being that copper was the best comm
ductor known for steady or low-frequency
currents, and it was naturally assumed that it
be the best material to employ for the conduct
lightning discharge. Later experiments have
proved that not only is the resistance of a materi
frequency oscillating currents dependent on it
perimeter and *not* on its section area, but
Heaviside has also shown that the higher ohmic
of iron as compared with copper is a positive ad
a conductor to such currents of which the ligh
is composed. It is well known that the introd
resistance into the circuit of an electrostatic di
the effect of *damping* the oscillations, and thu
the *time* during which that discharge lasts, and i
to this fact that iron is a more effective prot
structure when employed as a lightning cond
copper.
The fact, however, that in the question under
tion copper *strip* and galvanised iron *rope* are the
mentioned (from which it must be inferred that
is of round section) subtract somewhat from the
of the iron, as weight for weight its sectional
would be less, but even under this condition i
undoubtedly be the best and cheapest material t
Copper has perhaps the advantage of deterior
rapidly than iron under the same conditions,
latter is well galvanised it will in all probabili
the building which it is destined to protect, and
no fear need be entertained in this respect.
effective and, at the same time, the cheapest
protecting a structure from lightning is to run
galvanised telegraph wire up every prominent po
connect the whole network with one, two, or more

pes carried to earth down the sides of the building. ite time that the common mistake was recognised in of erecting an elaborate copper pedestal 5ft. or 6ft. whatever happens to be the highest point, like a le Ajax, actually *enticing* by its defiance the wrath of ments. A lightning conductor to be of any value e of such low resistance as to insure a path of very nced preference to the discharge than the building it protects, but at the same time it should have ntly high resistance to damp down as soon as s the destructive oscillation of such discharge.—

er to No. 34 *(awarded* 5s.*).*—To get the answer to estion there are three things to be considered: (1) ative theoretical advantages of iron and copper for ng conductors; (2) their relative durability in this ; and (3) their relative cost. Dr. Lodge's theory action of a lightning conductor is now almost ally accepted by physicists, and as it considerably s some of the conclusions arrived at by the Lightning nference, it will be interesting to mention his main ions. A flash of lightning is admitted to be the s a spark from a Leyden jar, but only on an usly greater scale, hence the phenomena which any the discharge of a Leyden jar through a wire e similar to those which ensue when a lightning ge passes through a lightning rod. Now it is known Leyden jar is discharged much more easily through of small inductance, even although it has high ohmic ce, than through a wire of greater inductance and mic resistance. A copper tape has much less nce than a round copper rod of equal cross-l area. It has less inductance even than a wire rope, and hence it is theoretically prefer- either. Again, the material of which the ng rod is made has no effect on its inductance, herefore, so far as inductance is concerned, a tape is preferable to an iron-wire rope of cross-section. On the other hand, as Dr. Lodge out, iron has a higher fusing point and a greater heat than copper; it can therefore get rid of a amount of the energy stored in the flash more So far, then, as theory goes, the relative merits two are not very different. If the copper tape have ts from the elevation rod to the earth-plate, there o reason why it should ever need replacing. Ordinary ire which has been carelessly galvanised by the usual g-into-zinc method, sometimes rusts after exposure weather for several years; but still, in an iron-wire f many strands, the chances against all the wires g at the same place are almost infinite, and need not sidered. Hence their relative durability also leaves estion an open one. The question of prime cost is re all we have to consider to settle the question, ease with which the two can be fixed in position is ally the same. In the best practice, with iron-wire ropes, lightning conductors arranged over the Hotel de Ville sels by M. Melsens, the earth-plates and the elevation re of iron and the points are of iron nickel plated. opper conductors of course the earth-plates and the on tubes must be of copper. Hence the relative f the two are nearly in the ratio of the price of tape to the price of galvanised iron rope, or, roughly, ratio of 5 to 1. Personally, for a valuable public g I should be inclined to recommend copper tape, a country house galvanised iron-wire rope would be st.—J. C. R.

[—The above three answers are so alike in value have decided to share the prizes equally amongst se.—Ed. *E. E.*]

35.—A lead-covered high-tension cable is to be used a drawing-in system. Discuss the advantages and disadvantages of the use of earthenware conduits, wrought or t iron pipes, respectively. Should the lead be braided compounded, or not?

Answer to No. 35 *(awarded* 10s.*).*—Regarding the rt of the question, relating to earthenware conduits, ntages are not many: (1) they are cheaper than nduits for a given number of cables; (2) they are easily and quickly laid; (3) they take up much less room than pipes for a given number of cables; (4) for drawing in cables there is less danger of the abrasion of the insulation from sharp edges than with pipe conduits, providing they are well vitrified and glazed. Against this, however, there are some serious drawbacks. Earthenware conduits are extremely liable to get damaged, perhaps by a workman who will cover it up and say nothing, and you will most likely get your immediate draw boxes filled with water or the cable badly damaged. Another objection is the difficulty in making good joints without making them so rigid that they will not adapt themselves to any alteration in the ground due to subsidence or other causes. They also do not adapt themselves to overcoming any difficulty that might be in the way in the shape of gas services and mains or old foundations, etc.

With reference to the advantages of wrought-iron pipes there is very little danger of sharp edges of metal being inside to damage the cable insulation, but all pipes should be examined, and a ball slightly smaller than the inside diameter of the pipe passed through each length before laying. They are easily laid, have good reliable joints when made with screw collars, and adapt themselves to overcoming any obstacle or bend more so than any other conduit. The disadvantages overbalance all that can be said in their favour. The relative cost of screwed-joint wrought-iron pipe is more expensive than cast iron. Extra care has to be taken when a pipe is cut, owing to the burr on the inside; for if this is overlooked, the cable is sure to be damaged when drawing in. It does not last long, comparatively speaking, in the ground, even when galvanised or served with compounded jute, and consequently the mechanical strength is not to be compared with cast iron. Wrought-iron pipes are used extensively in America, and with success, but the system of installing is such as to prohibit their use where economy has to be considered. The system consists of grouping a series of pipes together, and embedding them in concrete or hydraulic cement, which, although it makes a splendid job and is gasproof, it takes up a lot of room, and is not at all flexible for overcoming any obstacle.

The part of the question relating to cast-iron pipes has undoubtedly the best of the argument. Their cost is very moderate compared with other systems. They have great mechanical strength, affording a perfect protection; the joints are easily made, either caulked with yarn and lead, or simply with a rubber ring. This latter method does not commend itself to engineers, owing to the difficulty in keeping the pipes anything like watertightness, and it is desirable to have as little water in as possible—in theory, none; in practice, it is unavoidable All cast-iron pipes should be well compounded inside and out, and they will withstand any action of the soil indefinitely. The writer has seen cast-iron pipes taken up after being in the ground 10 years, and there were very little signs of deterioration. The greatest testimonial in their favour is the fact that the General Post Office, after having used them for over 40 years, and having tried all other kinds of conduits, have now solely adopted them. Their disadvantages are few and easily overcome. With bad castings there are sometimes long knife-like edges along the inside where the metal has run into the core, which, if not tested before being laid, will do considerable injury to the cable in drawing in. They do not adapt themselves readily for going round obstacles or bends, necessitating special bends in most cases, although a reasonable amount of "set" can be got on the joints.

From the foregoing it will be seen that cast-iron pipes are far the best for a drawing-in system, excepting, of course, low-tension bare conductors, which have generally a specially-made conduit, and hardly come within the scope of this question.

Referring to the final query. On no account should lead-covered cables be drawn in conduits without being covered with compounded jute or some such substitute, as the sole object of such covering is to protect the lead from damage in drawing in or out. The lead covering in fibrous cables is essentially an integral part of the insulation, having to exclude all moisture, and consequently requires more care in installing to ensure it not being damaged.

With light rubber cables the lead covering is put on chiefly for mechanical protection, and there is not the urgent necessity for a jute covering, but the extra cost is so little that it is always advisable to have it. There are always in all conduits slight projections at some parts which are sufficient to damage secretly, if not pierce, the lead when it is being drawn in without the jute protection. —J. E. DONOGHUE.

Answer to No. 35 (*awarded* 2*s.* 6*d.*).—Notwithstanding the advantages possessed by wrought-iron pipes, among which may be mentioned the readiness with which they can be bent to any curve on the site of the work, the facility of jointing, and the small space they occupy (owing to the absence of sockets), these are overwhelmed in the objection presented by the shortness of the life of wrought iron when in contact with the soil. An additional disadvantage is that they are more costly than cast-iron pipes. The comparison therefore resolves itself into one between earthenware conduits and cast-iron pipes. Wherever a drawing-in system has been adopted in this country during the past few years, both for new schemes and for extensions to existing ones, with very few exceptions either one or the other of these two systems has been used. While the number of engineers to favour earthenware has been increasing, the use of iron pipes has correspondingly diminished. The points to be urged in favour of cast-iron pipes are that they afford good mechanical protection to the cables within, they withstand heavy crushing and breaking strains, and they are manufactured in longer lengths than earthenware. Further, they were recognised as practically the standard drawing-in system before earthenware conduits were introduced in this country, and this is a fact which, until earthenware had been extensively used, naturally carried some weight with engineers who were considering the relative merit of the two materials.

The earthenware, or (to be technically correct) stoneware conduit, claims attention in the first place because its cost is considerably below that of iron. This is very apparent when only a few ducts have to be provided. As the number increases, the cost per duct of earthenware diminishes, while that of iron, of course, remains constant; consequently the difference in favour of the former becomes still more noticeable. The question to be considered is whether, in adopting earthenware, the economy effected thereby is being obtained at the loss of advantages which could be secured, at a higher cost, by the use of iron. The preponderance of opinion seems to be to the contrary. Earthenware is imperishable, and consequently its depreciation may be regarded as nil. Of all available material it possesses in the highest degree the power to withstand chemical or electrolytic action. What it lacks in strength as compared with iron, section for section, is compensated by the adoption of a proportionately greater thickness. At the same time, owing to the grouping of the ducts, it occupies less space than an equal number of single pipes, and the section becomes one which secures the maximum transverse strength. It is perhaps somewhat natural that the idea of fragility should associate itself with earthenware, but experience with conduits of this material shows that the thickness adopted by the manufacturers is sufficient to prevent liability to fracture, and that the stoneware as regards strength is as satisfactory as cast iron. The Board of Trade approve the use of high-tension lead-covered cables in stoneware conduits, and this may be regarded as sufficient indication that such a combination involves no undue risk to human kind. As a precaution, the lead cover is earthed at various places. That iron pipes are to be obtained in greater lengths than earthenware conduits is an advantage rather apparent than real, as the shorter sections of the latter enable changes of direction to be made gradually in the line, a feature which all will appreciate who have had practical experience of laying electric conduits in streets where the numerous other services have been previously installed. The smooth, glazed interior, and the fact that in each section the ends of the ducts are bevilled off, ensures a facility for drawing in the cable without injury, which, if iron pipes were used, could only be approximated by incurring extra expense in finishing the interior and ends of the pipes.

The answer to the question as to whether the lead sh[…] be braided must depend upon the views of the engine[…] to how much cost should be incurred with the obje[…] minimising risk of damage to the cable. There is […] reason for protecting the lead when the conduit is of ear[…] ware than when iron pipes are used, but looking to […] vital importance of maintaining the lead casing free f[…] abrasion, and to the fact that it is so readily damaged, […] writer holds that the cost of providing a protective b[…] is fully warranted.—C. E. M.

Answer to No. 35 (*awarded* 2*s.* 6*d.*).—The answer to […] first part of this question is, of course, very much a m[…] of opinion, but the chief points which would gui[…] selecting any of these systems are relative cost, leng[…] time required for laying, depreciation, mechanical str[…] and facility for drawing in the cables. Earthenware […] and casing seem lately to have had a very extende[…] owing to a number of reasons, one of the principal of w[…] is price. Some idea of the relative cost of 100 yards o[…] three types may be gathered from the following table:

3in. earthenware pipe with patent joint, laid	[illegible]
2½in. × 2½in. Doulton casing, three-way	12
2½in. × 2½in. Doulton casing, four-way	15
3in. cast-iron pipe, socket and spigot joints	[illegible]
3in. wrought-iron pipe, socket and spigot joints	[illegible]

From this it will be seen that earthenware pipes […] roughly, about half as much as cast iron. A cheap[…] better method still, where a number of cables run s[…] side, is obtained by the use of Doulton casing of […] four, or any number of ways, one advantage of this […] that spare ways can be left for extensions at a very […] extra initial cost, which does not apply to single l[…] pipe. There are two forms of joint for this casing[…] is by means of a cast-iron chair placed underne[…] joint and bituminous cement run all round in a me[…] indiarubber mandril being inserted during the pro[…] keep the ways clear and the two lengths of casing in […] the other is an ordinary cement joint on an earth[…] cradle. The prices quoted above are for this typ[…] bitumen joint being a little more expensive, but pr[…] for its insulating properties, and the fact that it i[…] quick-setting. Among the other advantages clai[…] earthenware, owing to its being in shorter lengths t[…] usual with either cast or wrought iron pipes, it is very […] more flexible, which is a matter of considerable mo[…] some situations. Its insulating properties are good, […] of course, does not apply to metal pipes. It is pr[…] to either of the other two, for the ease with which […] can be drawn in owing to its smooth-glazed interior. […] better to manipulate, being in shorter lengths and […] easily cut. It does not require the ground to be k[…] so long for laying, this latter being a very importa[…] in its favour; and, finally, depreciation with it is al[…]

The principal advantages of cast-iron piping […] mechanical strength, which permits it being laid ve[…] the surface and in exposed situations. Jointing is […] and tedious job, and generally skilled labour is r[…] for laying it. In price, as shown above, it does n[…] pare with earthenware. Its depreciation varies in d[…] situations, but is always heavier than earthenware.

Wrought iron is to be condemned on account of it[…] life in most soils, and prohibitive price in the large[…] It can be jointed in a number of ways; one of th[…] for big diameters is by means of the ordinary spig[…] socket joint, which, as far as laying is concerned, […] on a par with cast iron. The proper place for w[…] iron is for very small sizes, varying from ¾in. to 1[…] when it will compare very favourably in price with […] the other methods.

With reference to the last part of the question, the[…] should undoubtedly be braided and compounded o[…] some other form of covering over the lead to p[…] mechanical injury in drawing in. Braiding must […] sarily prevent a lot of chafing of the lead at the e[…] the pipes and boxes. Possibly it may take a little […] drawing in when braided, but with plenty of French […] and efficient rollers at the top and bottom of the […] there will not be much difficulty experienced in […] direction.—H. BELL.

'HE TRIALS OF MAINS ENGINEERS.

BY J. H. C. B.

article is intended to ventilate some of the s of that responsible body of men whose duties upervision of electrical mains.

hours are all times of the day, and they are ly out all night at work, as their landladies may Their *confrères*, the engineers-in-charge at the y works, have their eight-hours' or so shift, and o one will gainsay it that their work is sufficiently and unintermittent, yet even it does not compare exertion, the skill, and the tact needed by the gineer. All day long does he walk his streets, or gangs, or interview his consumers and prospective s. He must be ready to receive the tale of woe man whose lights all went out when his motor orking: and he must not swear when he finds that r is a new addition without a rheostat in circuit, this and about a dozen lights had been added to lainer's premises (all without notification) since the e was put in. He must be prepared for the s intimation from the works that there is a dead-earth on the mains, and that the voltmeters and , the engineers and electricians, the engines, and boilers were in a state of excitement and n. Yes, he must put down his glass at once, and w whereabouts to find the cause of the trouble, te it in the shortest space of time, disconnect all e fault, and repair within an hour, or there will é from those whose sleep of innocence has been sturbed to attend to the sudden call upon the its and machinery in their charge.

nount of tact required by a mains engineer is n inverse proportion to the regularity of the but it sometimes happens that the *fortiter in re* is ferred to the *suaviter in modo*. For instance, not an old lady deliberately stepped over a drawing-in was being hauled upon. Naturally, she tripped, and slightly hurt herself. The engineer helped othed her, took her to a doctor's, and did all he pacify the dame. Notwithstanding this, and the she was herself to blame, she brought an action £200 damages. Soon afterwards, in the same a street box was left open and unguarded by a nd a man coming along reading a newspaper ght into the box. The engineer's attention being to the unfortunate, who was helplessly prostrate, igled with the cables inside, he rushed up, gripped dered diver by the scruff of the neck and the coat-dragged him out, to a running accompaniment of nvective. Then he bestowed a parting kick, with g of the terrible fate that would overtake the should he ever come and fall down among those cables again. The man limped sadly away, rubbing nd nothing more was ever heard of the accident. words won't do," observed the aggrieved engineer, t try foul, and the fouler the better."

aining and watching of one's men is, under the nces, not the easiest of tasks if mains engineers eep their staff's name as unsullied as their own—itself is a glorious ambition. The meter inspectors ost exposed to temptation, as meters are usually the servants' quarters, and in close proximity to cellar or beer barrel, when these exist. It has posed to have a certain class of men for meter-on the same principle as Eastern potentates choose em attendants, but even this does not do away wine-cellar risk.

s of wine-cellars, a disgraceful thing happened a ne ago while connecting up a private asylum in The service mains, coming in from the street, rough the wine-cellar to the main switchboard, so e engineer warned the asylum factotum that he r count his bottles and keep his eye on the service-n gang. The factotum did so, and no one went e cellar with the ghost of a bottle upon him, nor ttle opened or broken. Notwithstanding this, at seen bottles were missing from the bins during a inspection at the dinner hour. The affair would have remained an insoluble mystery but for the jointer in the tent outside having to be wheeled home on his truck, paralysed and odorous. Also a piece of iron wire, with a loop at one end, was found in the short length of service pipe, from the joint-box to the cellar, in the place of the service cable; and that gang's good name was blighted past redemption.

There is no need to expatiate upon the calls for infallibility in mains engineers. That is taken for granted. Their ability to withstand temptations of the flesh, however, is sorely tried. Some day, it is sad to reflect, it may be tried too much, and upon one or another of the happy band the white flower of a blameless life will fade and die, for the temptations are many and the tempters subtle. There is the contractor's representative, who stands drinks; and the representative of the would-be contractor, who stands more drinks. There are the thousand-and-one persons who wish to keep on the right side of the suffering mains engineer, and who to this end strew his path with drinks and cigars—all enervating and of evanescent pleasure.

Then there are the theatres and music halls that have to be visited to arrange for special effects, etc., and with this the constant strain upon the higher moral nature to repress feelings which flood the soul when ballets are under rehearsal, and especially aerial ballets.

As an instance of the criminal thoughtlessness of wiring contractors, it may be mentioned that the meter in one theatre was put in the chorus-girls' dressing-room, necessitating the meter inspector passing through a particularly trying ordeal at times. This might also be quoted as an instance of true self-sacrificing heroism on the part of the local mains engineer, as he saved his meter inspector the sad experience by voluntarily taking the reading himself when necessity required.

The inspection of houses for the various purposes connected with the supply of electricity is another class of operations that calls for the exercise of those beautiful puritan qualities that distinguish this branch of our profession. Sometimes in a certain class of house the "electric light man" will be invited up to the bedroom of the late-rising lady of the house to discuss the knotty question of connecting to the mains her 12 8-c.p. lamps with a poor little demi-megohm between the leads and earth. And sometimes refreshments and other things will be offered to cajole the official visitor into passing the installation as O.K.

These, then, are a few of the drawbacks to happiness in the life of a mains engineer to an electricity supply company or corporate body; and it is to be hoped that young men who purpose filling such a position will ponder it carefully, so that they may not find out when it is, alas! too late, that their moral natures are not equal to the strain.

INSTITUTION OF ELECTRICAL ENGINEERS, Feb. 24.

At last night's meeting of the Institution the following were the candidates balloted for:

Member.—H. S. Maxim, 28, Victoria-street, S.W.

Associates.—J. C. Bannister, 13, High-street, Wandsworth, S.W.; J. D. Cormack, B.Sc, the University, Glasgow, N.B.; F. G. Mahon, 181, Victoria-buildings, Victoria-street, S.W.; R. A. McClymont, Duncrag, Dumbarton, N.B.; L. S. Meintjes, P.O. Box 148, Cape Town, S.A.; H. F. Phillips, Guildford Electrical Works, Guildford; F. M. Rogers, 4, Gordon-road, Clifton, Bristol; R. C. Simpson, 8, Park-hill, Richmond, Surrey; W. A. Tritton, 51, Carleton-road, Tufnell Park, N.; J. Walton, the Manchester Corporation Electrical Works, Manchester; W. B. Winfield, 102, Terminus-road, Eastbourne; C. J. Wood, 98, Horseferry-road, Westminster.

Students.—T. F. Allden, 18, Archbold-terrace, Newcastle-on-Tyne; A. J. Bohringer, 30, Alfred-place West, London, S.W.; W. H. Derriman, 6, Beaumont-crescent, West Kensington, W.; W. N. Y. King, 34, Park-hill-road, N.W.; W. T. Marsden, 18, Lawson-road, Broomhill, Sheffield; C. F. Maypee, 19, Bedford-place, W.C; F. S. Miller, Manor House, Old Malden, Worcester Park, Surrey; P. G. Pettifor, 6, Lincoln-terrace, Alfred-street North, Nottingham; F. Saunders, 25, Cloudesley-street, Clerkenwell, E.C.; R. Scruby, 169A, London-road, Leicester.

Bournemouth.—The *Poole Herald* yesterday issued an illustrated supplement describing the proposition of the British Electric Traction Company to provide electric tramways under the Light Railway Act at Bournemouth. We know Bournemouth well, and hold very strong views upon some of the schemes that have been propounded there, but in this case, if it can be shown that tramways are required, we are wholly in favour of electric traction.

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TO CORRESPONDENTS.

 Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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THE WEBB TESTIMONIAL.

If the records of history be ransacked it
found that the memory of the multitude i
and that most great men have outlived the
larity. If it be a criterion of wisdom to kn
to work and to take the right moment to gi
to younger men, then the late secretary
Institution is singularly well endowed with
The members of the Institution, for wh
among whom he has worked during the past
eventful years, have gratefully and gracefully
their appreciation of the honest, hearty
rendered. It has been our duty to speak i
of the Institution and at times to utter
of warning—such are the penalties which
themselves to those responsible for technical p
but it has ever been felt that, whether th
were of praise or blame, no word of aug
savoured of blame could be uttered agai
gentleman who was the responsible per
head of the Institution. Presidents and
did come and go, yet ever with unfailing t
courtesy the secretary won the confidence of
men, and, what is more to the point, has
that confidence and obtained their friendship
therefore with great pleasure we put on rec
proceedings of last Monday, when the nu
friends of Mr. F. H. Webb met him and Mrs
at dinner at the Métropole, and subsequ
brilliant gathering met to show practica
general friendship that existed toward t
secretary. Sir Henry Mance presided at the
and afterwards at the reception. Mr.
Edmunds looked and ought to have felt p
the success of his labours. He really has bo
brunt of the work in corresponding with the m
and the thanks of the members are due to
having so well gauged their views, and so e
cally and admirably carried out the programm
was called upon by Sir Henry Mance to e
the galaxy of ladies—for the members mu
known something of the secret—that the r
was held in order to testify the esteem i
Mr. Webb was held, and to present to
souvenir in the shape of a cheque fo
six hundred odd pounds to give point
esteem, and to Mrs. Webb a diamond b
to be worn by her as a constant reminder
large number of life-long friends who gathered
herself and her husband upon that mem
evening. General Webber spoke of the im
work carried out by Mr. Webb, Sir H.
echoed the words of praise, and all went
as a marriage bell, even when the older
of Mr. Webb might be forgiven uttering
at the severance of pleasurable ties. Th
since the movement was originated to re
Mr. Webb's services has not been long en
enable replies to come from all members; he
hoped that other subscriptions will be added t
already received, and, at any rate, that the
classes of members will make the autograp
complete by sending their autographs to
Edmunds, the hon. secretary to the Test
Committee. Many of Mr. Webb's friend

o be present either at the dinner or recep- nd many congratulatory telegrams were during the evening; among others was one r. G. Ward, general manager of the Com- Cable Company, New York, who, by cable, 'I wish I could be present at banquet . Hearty congratulations and best wishes happiness." These words are appropriate occasion, and express the feelings of the riends.

UNFAIR CRITICISM.

say that "All is fair in love and war," but has been brought to our notice lately where nds of fairness have, in our opinion, been . The facts are these: Weston-super-Mare electric lighting schemes before it, due to gy of a syndicate wishing to establish works wn and to take over the provisional order the District Council. The Council, there- pointed Mr. W. C. C. Hawtayne as their , and obtained a report which pointed the value of the order would increase pply was taken up, and gave details of the ne advised and figures as to the returns in years of the undertaking. A ratepayers' was then organised on behalf of the syndi- d a Mr. Wigham, an electrical engineer, k on their behalf to criticise Mr. Hawtayne's This is all quite fair and above board, but is gentleman says "it was very natural . Hawtayne, in his position of engineer, ave persuaded the Council to carry out the lighting themselves because he was fighting own bread-and-butter," he goes beyond ism. On the bread-and-butter theory, Mr. could not show a clean sheet, and we now how to reconcile his professional that only eighty 8-c.p. lamps would be in the first two years with the fact syndicate was prepared to spend fifty pounds on lighting these eighty lamps. that many ratepayers are deceived by p-trap arguments should not influence ton-super-Mare Council in adopting their s report.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

T ENGINEERS AT £50 PER ANNUM.

"Shilling a day, bloomin' good pay,
Lucky to get it, a shilling a day."

omebody really should speak to the borough engineer of Tunbridge Wells. How am I to ngineers to run my station at the standard rate 1½d. per hour) if Mr. Boot offers such absurdly ies? There will soon be no electrical engineers ndon if this sort of thing is allowed to go on ovinces. Somebody must speak to Mr. Boot.— c, INDIGNANT.

I notice in your issue of Feb. 18 that Mr. Boot idge Wells is advertising for a "shift engineer" at the princely salary of £50 per annum. It certainly appears to me that the unfortunate shift engineer of the future will not only be held responsible for the working of some £10,000 worth of machinery for eight hours every day, but will also be expected to tip the chief engineer for being allowed to do it. No doubt Mr. Boot is very proud of that passage in his report which runs: "Tunbridge Wells is the only station working on the high-tension system which has not made a call upon the ratepayers in the first completed year's working." It seems probable to me the staff were called upon rather than the ratepayers. Possibly the air of Tunbridge Wells is so invigorating that shift engineers require no dinner, or, perhaps, being springtime, the happy (?) successful candidate will lightly turn his thoughts to "love," and live on that. Is it not time, in these days of successful stations, junior electrical engineers should receive a fair day's pay for a fair day's work? Mr. Boot is evidently more successful in drawing up high-sounding reports than in learning what is meant by a living wage. My heartiest sympathies are with the successful candidate.—Yours, etc.,

DISGUSTED.

SWITCHBOARDS.

SIR,—Will you please let me know through your paper the maker of name-plates for switchboards.—Yours, etc.

R. N. R.

[We will forward replies.—ED. *E. E.*]

INSTITUTION OF CIVIL ENGINEERS.

At the ordinary meeting on Tuesday, Feb. 22, Sir John Wolfe Barry, K.C.B., F.R.S., president, in the chair, two papers were read: "The Theory, Design, and Working of Alternate-Current Motors," by Mr. Llewelyn B. Atkinson, A.M.I.C.E., and "Dublin Electric Tramway," by Mr. H. F. Parshall, M.I.C.E.

The first paper was principally devoted to consideration of asynchronous motors, which, although the subject had on two previous occasions been referred to in the *Proceedings* of the institution (in 1883 and 1889), had not hitherto been discussed. The principles of alternating currents, so far as necessary for their use in alternate-current motor design, were first dealt with, and the method of graphically making the necessary calculations was illustrated. After showing the principles on which the continuous-current motor was based, and that it consisted of two parts, a field magnet and an armature, the author pointed out that a similar construction (a magnetic field being made of laminated iron) enabled motive power to be derived from alternating currents, provided that means were taken to ensure the phase of the magnetic field and of the current in the armature being the same. This gave rise to the first class in the classification adopted by the author—that was to say, motors in which the energy was conveyed to armature through brushes, and which were therefore called "conductive motors," which might be series wound, shunt wound, or separated excited; in the latter case the phase of the E.M.F. producing the exciting current differed by a quarter period from that producing the armature current, thus forming an example of the application of multiphase currents to alternate-current motors. The transformation of energy from one circuit to another by electromagnetic induction instead of by conduction was next considered, and by diagrams and curves the working of transformers, both with magnetic leakage and without magnetic leakage between the primary and secondary windings, was illustrated. This gave rise to a class of motors in which the energy was supplied to the armature not through the brushes, but through the air-gap; these motors in the simplest form having, however, a commutator for short-circuiting the coils so as produce a proper distribution of current in the armature. The author classed these motors as "inductive motors with brushes, having one inductive electric axis and one magnetic axis." A modification of this class furnished a third class, "inductive motors with brushes," in which there were "two reciprocal induc-

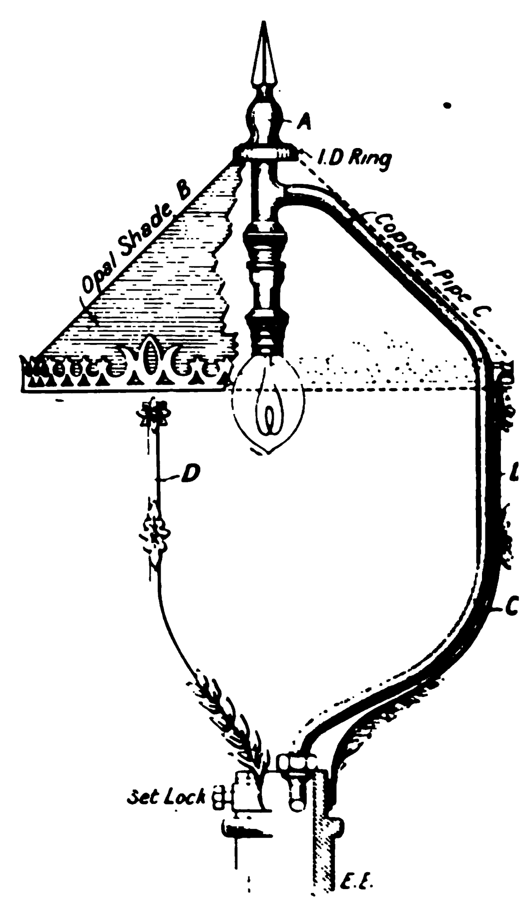
tive electric and magnetic axes." The brushes might then be dispensed with, giving rise to a class of "inductive motors without brushes, having short-circuited coils and two reciprocal inductive electric and magnetic axes"—the modern induction motor. The author proceeded to examine in detail the theory of such motors, and showed how by means of a diagram its properties might be determined. It was then pointed out how in such a motor when running the supply on one phase might be eliminated and the motor would remain self-exciting, furnishing itself a magnetising current in phase with the supply current, thus forming the modern monophase induction motor. The supply might be on any number of phases, to the same number of magnetic systems, provided that a proper relation existed between the two. The use of asynchronous motors as generators was next touched upon, and the author showed that the various motors explained might be used as motor-generators, in which case, not only the pressure, but the phase of the current might be changed. All these machines might be used as generators, and the various combinations of motors and generators of this class were illustrated. In a second part of the paper the author dealt with the design of alternate-current motors, and showed the necessary conditions to produce the proper distribution of currents in the armature and of the magnetic field, and further gave a formula for determining the proper loading of the armatures, and from this showed how all the other dimensions of a machine for any given power might be derived. The wave-form and frequency as affecting alternate-current motors were discussed, and examples were given showing to what extent the necessary conditions were realised in practice. In the third part the author dealt with the practical construction and working of asynchronous motors, and, taking each class described, illustrated them by examples so far as they existed, and tests where these were available. This part was illustrated by curves and data relating to a large number of different classes of motors. Curves were also given showing the relative weight of continuous-current motors, single-phase motors, two-phase motors, and three-phase motors.

The second paper embodied an account of the Dublin Southern Tramways, which was to some extent peculiar, in that the installation as originally designed would not conform with the Board of Trade regulations in the matter of the fall of potential in the earth return. The machinery had been ordered and the work proceeded with before the author had been called in to advise in the matter. The problem became, therefore, to utilise as much of the machinery ordered as possible, and to instal such other machinery as would be necessary to distribute the electricity under the Board of Trade regulations. The high-tension alternate-current method of transmission was considered most suitable. It was necessary to make use of the sites owned by the tramway company, and to execute the work as cheaply as was consistent with safe operation. The three-phase machines and switchboards were specially designed for the installation, which was the first one of its kind established in the British Isles. The installation had been in operation for nearly two years, and had been found entirely satisfactory. The operation of the sub-stations had been found to be very simple, so simple, in fact, that only a boy was employed in each station to work the machinery. Owing to the low frequency the motors were very easily synchronised, and even though they were thrown in considerably out of phase they quickly fell into step. Since the opening of the road the load had been greatly increased by a considerable number of additional cars and trailer cars, yet the machines had never given trouble, nor had the synchronous motors fallen out of step, even in the case of the most severe loads. The requirements of the Board of Trade had been satisfactorily met, and owing to the number of points of distribution it was possible to work some 60 cars on the line instead of 20, as originally designed to comply with the Board of Trade regulations. As originally designed, the fall of potential in the earth return would have been some 18 volts to 20 volts, whereas in the present installation it was found to be 3½ volts. The installation was, perhaps, most interesting from a commercial rather than from an engineering standpoint, in that it illustrated how traffic might be developed by an improved
Formerly the traffic was worked by three disjointe
lines, none of which were profitable. They were
sold for about £14,000, whereas the value of the
property was estimated at £300,000, and the re
were consistent with this figure. At the time the i
tion was designed the total number of cars conte
was 20. Since that time it had been found profit
work as many as 50 cars on the line, even thou
line had been subjected to the disadvantage
having a through connection to the centre of I
Owing, therefore, to the largely increased loa
capacity of the power-house at Ballsbridge had been
added to by a large direct-connected unit, whic
more suited for heavy traction loads. Likewis
sub-station at Blackrock had been redesigned, and
place of the 60-kw. motor-generator sets originally in
there were two 200-kw. rotary converters, with the ne
static transformers and an improved switchboa
manipulating it. The principal point of importan
the ease and reliability with which such a syste
shown to be operated. The efficiency of the
was shown by the working cost to be satisf
although, as might be gathered from the pape
efficiency of the machines in the sub-stations was
high as would be the case with larger machines an
rotary converters. For a small tramway installatio
ever, the sureness of operation and the minimum of
were of vastly greater importance than any small
efficiency.

The discussion on this paper was adjourned till T
March 1.

INCANDESCENT STREET-LIGHTING.

The desirability of street-lighting with incandescent
lamps has been a matter of great consideration with the



Electric Lighting Committee. To meet this, the borou
trical engineer, Mr. J. E. Stewart, has designed a lan
per illustration, which so adapts itself to the requireme
it has been decided to replace in some of the main ro
existing gas lamps with Mr. Stewart's lantern. As will
by the illustration, the lantern can be fitted on already
gas lamp-posts by means of an iron band and set bolts

tern is fitted with a large opal shade, B, which is held in sition by means of an ornamental cap, A, which is also ovided with an indiarubber ring for weathering purposes. e copper pipe, C, carries the wires, and also forms the main pport for the lamp connections, which are so constructed as enable one or more lamps being fitted. The uprights, D, e of steel, and are riveted to a circumferential T-ring, to hich is attached the ornamental copper spinning. The Cor- ration have approved the design, and will shortly erect some f the lanterns in the main thoroughfares of Derby.

FORTHCOMING EVENTS.

FRIDAY, FEB. 25.

yal Institution.—At 9 p.m., "The Theory of Colour Vision Applied to Modern Colour Photography," by Captain Abney, C.B., D.C.L., F.R.S., M.R.I.

Institution of Civil Engineers.—Students' meeting, at 8 p.m., "The Problem of Train Resistance," by C. E. Wolff, B.Sc., Stud.Inst.C.E.

Institution of Electrical Engineers.—At 6.30 p.m., Students' visit to the Shoreditch Electricity Supply Station.

stro-Harmonic Society.—At St. James's Hall, at 8 p.m., ladies' night.

SATURDAY, FEB. 26.

ysical Society.—Meeting at Windsor, 4 p.m., to visit Eton College. Train leaves Paddington at 2.25 p.m. The Rev. T. C. Porter will describe: (1) A new theory of geysers; (2) a new method of viewing Newton's rings; (3) experiments bearing on the sensation of light; (4) a method of viewing lantern projections in stereoscopic relief; (5) winter observations on the shadow of El Teide, with a new method for measuring approximately the diameter of the earth; (6) temperature of the water of Niagara.

MONDAY, FEB. 28.

Institution of Junior Engineers.—Visit at 3 p.m. to the Westinghouse Brake Company's Works, York-road, King's Cross.

TUESDAY, MARCH. 1.

Institution of Civil Engineers. — At 8 p.m, Discussion on "The Theory, Design, and Practical Working of Alternate-Current Motors," by Llewellyn B. Atkinson, Assoc.M.Inst. C.E.; and "Dublin Electric Tramway," by H. F. Parshall, M.Inst.C.E.

yal Institution, Albemarle-street.—At 3 p.m., Prof. E. Ray Lankester, M.A., LL.D., F.R.S., on "The Simplest Living Things."

ntgen Society, at 11 Chandos-street. — At 8 p.m., "The Photographic Activity and Penetration of Röntgen Rays at Different Vacua," by Mr. J. H. Gardiner. Other papers by Mr. Wilson Noble and Mr. Hall Edwards. Mr. Isenthal will show some new apparatus.

WEDNESDAY, MARCH 2.

ciety of Arts.—At 8 p.m., "Kites: Their Theory and Practice," by Captain B. F. S. Baden-Powell.

THURSDAY, MARCH 3.

yal Institution, Albemarle-street.—At 3 p.m., "Recent Researches in Magnetism and Diamagnetism" (Lecture I.), by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., M.R.I.

Institution of Civil Engineers.—Students' visit, at 2.30 p.m., to the works of Messrs. John I. Thornycroft and Co., Chiswick.

nsbury Technical College.—At 8 p.m., L. J. Steele, Esq., on "Electricity Meters"; first lecture of course of five.

FRIDAY, MARCH 4.

yal Institution.—At 9 p.m., "Some Recent Results of Physico-Chemical Inquiry," by Prof. T. E. Thorpe, LL.D., D.Sc., F.R.S., M.R.I.

Institution of Junior Engineers, Westminster Palace Hotel.—At 8 p.m., "An Outline of Patent Law and Practice," by Mr. Arthur H. Stanley, F.C.I.P.A., member.

CAMBERWELL.

At a meeting of the Vestry on the 23rd inst. a report from vestry clerk (Mr. C. W. Tagg), and the returns of municipal lighting undertakings, was considered, from which we the following: "I can only, in passing, say in regard to turn that in answer to the question, 'Has the Act in istrict been a success?' the reply is in the affirmative, amount charged to the vestry or borough rates appears ve been very small, if any. The offer of the London ic Supply Corporation to supply electric current wholesale at the following rates per Board of Trade unit; for a minimum of 100,000 per annum, 3d.; for the next complete 150,000, making 250,000 per annum, 2¾d. for the second 150,000; for the next complete 150,000, making 400,000 per annum, 2½d. for the third 150,000; for the next complete 150,000, making 550,000 per annum, 2¼d. for the fourth 150,000; for the next complete 150,000, and all units thereafter per annum, 2d. The London Company's offer to supply wholesale current is, of course, upon certain terms and conditions that I have already reported to you, but which perhaps might be made after negotiation more favourable to the Vestry. If the Vestry were to supply current retail for use, the very low estimate of 7,500 lamps at 8 c.p. at 6d. per unit, or an average revenue of 10s. per lamp per annum, or 156,000 Board of Trade units at 6d. per unit, would be £3,750 annual revenue. I venture to anticipate that the parishioners on the line of the compulsory route, as shown in Appendix I., will largely avail themselves of the advantage of having electric light fitted to their premises, and that the amount to be consumed by the Vestry might safely be taken in excess of this. The amount now paid for gas and electric light by the Vestry at the baths, vestry hall, art gallery, technical school (estimate), and central library is £750 per annum. Of course, if this was replaced by electric light under the Vestry, the expense of wiring would have to be taken into account, but the set-off against that is the improved lighting and the pureness of the atmosphere and the necessary saving in painting, cleansing, and decorating. It is estimated that the replacing of the existing gas illumination for the public buildings belonging to the Vestry mentioned would take about 50,000 units per annum, whilst those for street-lighting, to take the place of street lamps, would require 120,000 units per annum. As to the expenditure that would be immediately necessary, the following report and figures supplied by the London Electric Supply Corporation, which have been worked out for me by the acting surveyor, and will be found in Appendix I., together with our present street-lighting (cost for year), and an approximate estimate for replacing the same by electricity, will give an idea of the actual expenditure it is at once necessary to make. The usual percentage for repairs to and maintenance of plant and mains taken by electrical engineers is, I find, as follows: buildings, 2½ per cent.; generating stations, 5 per cent.; accumulators, 15 per cent.; insulated conductors, 6 per cent.; conduits, 3 per cent. Of course, I think it would be safer to add slightly to these, but probably the system to be adopted by the Vestry would not require accumulators.

ESTIMATE.

Estimated capital expenditure	£20,500
Interest at 3 per cent. on above amount	£615
Repairs and maintenance	600
150,000 Board of Trade units at 3d.	1,875
Wages and salaries	1,000
Total	£4,090
Deduct gas-lighting (street and private purposes) as at present	1,450
Total	£2,640

APPENDIX.

Approximate cost of laying mains, plant, transformers, etc., for about 10 000 8-c.p. lights, the current being supplied as wholesale, our station being situate near the line of route; also of erecting lamps along the line of public streets—viz., Camberwell-road, Camberwell Green, Church-street, Peckham-road, High-street, Rye-lane, and Queen's-road:

Station for 10,000 lights of 8-c.p., alterations to buildings, transformers, switches, fuses, pilot transformers, instruments, sundries, etc., say	£2,000
1,700 yards 10,000-volt trunk main	5,100
5,000 yards high-tension distributing main in pipes, also armoured low-tension cable, in same trench	7,000
Nine transformers	630
Nine transformer chambers, laid in streets, including fuse boxes, etc., and high and low tension connecting leads	315
Sixty arc lamps, standards and fittings, with alternate incandescent burners	1,500
Sixty ordinary lamps fitted with incandescent burners	300
Laying on services to, say, 250 consumers, including all connections and first cost of meters (meter rent repaid)	2,500
Fitting up vestry hall, fine-art gallery, central library, and underground urinals	1,000
Extras and sundries, say	155
Total	£20,500
The present estimated annual expenditure in gas in public lamps in streets mentioned is	700
Ditto in public buildings already mentioned	750
Total	£1,450

The following recommendations were also made by the General Purposes Committee: "(a) That the special vestry for the purchase of the undertaking of the County of London and Brush Provincial Electric Lighting Com-

pany be now taken; (b) that in the event of the resolution for the purchase of this undertaking being carried the General Purposes Committee be empowered to take all steps necessary for the completion of such purchase, and also for the carrying out of such undertaking; (c) that the Board of Trade be asked to fix Monday, Feb. 28, 1898, as the date from which such purchase is to take effect."—At a special meeting of the Vestry held on the same day the following report of the General Purposes Committee on electric lighting was received: "Your committee has had under consideration the desirability of acquiring the provisional order of the County of London and Brush Provincial Electric Lighting Company, Limited. Section 60 (2) of the Electric Lighting Orders Confirmation (No. 5) Act, 1896, under which it is proposed to proceed, states: 'The local authority may at any time before the expiration of the said period of 42 years give notice in writing to the undertakers requiring them to sell the undertaking authorised by this order to the local authority, and thereupon the undertakers shall sell the same to the local authority upon the terms of the local authority paying to the undertakers such an amount of money as shall be equal to a sum of £133 for every sum of £100 properly expended by the undertakers upon the said undertaking and chargeable to capital account, and the amount properly expended by the undertakers upon the said undertaking and chargeable to capital account shall from time to time for the purposes of this sub-section be deemed to be the amount so expended and chargeable as certified from time to time by the auditor in accordance with the section of this order whereof the marginal note is "Audit of undertakers' accounts." Provided that if the local authority shall exercise the power conferred by this sub-section before the expiration of 21 years from the commencement of this order, the local authority shall, in addition to the amount of money to be paid to the undertakers as aforesaid, pay to the undertakers a sum equal to the aggregate amount of a dividend of 5 per cent. per annum on the said capital expenditure less the aggregate amount of the dividends declared by the undertakers from the date or dates of such expenditure to the date of the purchase of the said undertaking by the local authority.'" The committee recommended that notice be given in writing by the vestry clerk to the County of London and Brush Provincial Electric Lighting Company, Limited, authorised by the provisional order granted by the Board of Trade, cited as the Camberwell Electric Lighting Order, 1896, and confirmed by the Electric Lighting Orders Confirmation (No. 5) Act, 1896, requiring them to sell the undertaking authorised by this order to the Vestry of Camberwell, being the local authority under the provisions contained in the above Act.

PHYSICAL SOCIETY.

The annual general meeting of this society was held on Feb. 11, Mr. Shelford Bidwell, president, in the chair.

The report of the council was read by Mr. Elder.

Dr. Atkinson then presented the treasurer's report, and informed the society of the improved conditions of its finances. The difficulties of the previous year had arisen from the expenses incurred by the publication of abstracts of current scientific literature; those difficulties had been surmounted without drawing upon the reserve fund. Very few Fellows had objected to the increase of subscription. In acknowledgment and appreciation of the abstracts, now presented to all Fellows, many of the original life-members had lately made additional voluntary donations to the funds of the society, thus sharing with new Fellows the extra outlay involved by the abstracts. It was to be hoped that all life-members would adopt this course, more especially as the scope of scientific literature covered by the abstracts was now being extended to British as well as to foreign sources.

Votes of thanks were passed to the council, the officers, and to the council of the Chemical Society for the use of their rooms at Burlington House. Two honorary Fellows were unanimously elected by ballot—*i.e.*, Riccardo Felicci, professor in the University of Pisa; and Emilio Villari, professor in the University of Naples.

The council and officers for the forthcoming year were elected as follows: *President*: Mr. Shelford Bidwell. *Vice-presidents* (who have filled the office of president): Dr. J. H. Gladstone, Prof. G. C. Foster, Prof. W. G. Adams, Lord Kelvin, Prof. R. B. Clifton, Prof. A. W. Reinold, Prof. W. E. Ayrton, Prof. G. F. Fitzgerald, Prof. A. W. Rücker, Captain W. de W. Abney. *Vice-presidents*: Prof. C. Vernon Boys, Major-General E. R. Festing, Mr. G. Griffith, Prof. J. Perry. *Secretary*: Mr. H. M. Elder, 50, City-road, E.C. *Foreign Secretary*: Prof. S. P. Thompson. *Treasurer*: Dr. E. Atkinson. *Librarian*: Mr. W. Watson. *Other members of council*: Prof. H. E. Armstrong, Mr. Walter Baily, Mr. L. Clark, Dr. A. H. Fison, Mr. R. T. Glazebrook, Prof. A. Gray, Prof. J. Viriamu Jones, Mr. S. Lupton, Prof. G. M. Minchin, Mr. J. Walker.

The **President** then read an address, in which the aims and history of the Physical Society were outlined. This address will be published in full in due course.

Prof. Rucker said that among the new and useful departures lately made by the Physical Society, the institution of a presidential address was particularly worthy of notice; it was very desirable, from time to time, to hear a summary of wha[t] achieved during the year. It was also desirable that of the society should be from time to time definit[e] This departure had been fully justified by the addre[ss] Shelford Bidwell.

A paper by **Mr. G. H. Bryan** on "**Electromagnetic in Plane, Cylindrical, and Spherical Current Sheet Representation by Moving Trails of Images**," was re[ad] Elder. The phenomena of induction in a cylindrical c[urrent] sheet in a two-dimensional field, and of induction in a sheet in any field due to the generation or motio[n] magnets, or currents in the presence of the sheet, ca[n] sented by moving trails of images which are but slig[htly] complicated than the well-known trails of images in a p[lane] The images representing the potentials of the induced c[urrents] the two sides start from the source of disturbance and point, and move normally away from the surface of [the] and cylinder, with velocity varying directly as the di[stance] At the surface of the sheet this velocity becomes eq[ual] corresponding velocity for a plane sheet. The images a[re] cases similar in nature to the inducing source of distur[bance] their intensities are found in every case to vary as a pow[er] distance from the centre. The images due to the sudd[en] tion of a magnetic pole in the presence of a spherical however, analogous to the hydro-dynamical image of a [source in a] sphere.

Dr. S. P. Thompson said the method and the result[s] would find useful application in the solution of m[any] problems.

The **President** proposed a vote of thanks to the autho[r] meeting was then adjourned until Saturday, Feb. 26, occasion the Physical Society will visit Eton College. I[t is] informed that a train leaves Paddington for Windsor at This arrives in time for the meeting, which is at 4 p.m.

LEGAL INTELLIGENCE.

KAYE v. CROYDON TRAMWAYS COMPA[NY]

This was an appeal heard before the Master of the Lords Justices Rigby and Vaughan Williams. In the plaintiff sought and obtained from Mr. Justice Ke[kewich] interim injunction restraining the directors from carry[ing] sale of their undertaking to the British Electric Trac[tion Com]pany, and from that the company now appealed.

Mr. Cripps, Q.C., appeared, with Mr. Warrington, Mr. Rowden, in support of the appeal, and stated that th[e] in question was constructed under powers given in 187[ ] so that the power of the local authority to take it over w[as] in force in 1899 and 1901. In 1883 the undertaking wa[s] the Croydon and Norwood Tramways Company, but a[s it did not] prosper a receiver was appointed. In 1889 the Croydon Company was formed, with powers under Act of Par[liament to] take over the tramway, and this company not pro[ving] successful, they desired to sell. The proposed arrange[ment with] the Traction Company provided for paying off the prefer[ence] holders in full, and returning 60 per cent. of the mone[y] subscribed to the ordinary shareholders. It was though[t] sale to the Traction Company would be more advantage[ous than] sale to the local authority, and it being understood purchasing company would probably have to spend £1[ ] the undertaking, the local authority would grant a furt[her] of 21 years. The General Act of 1870 gave the compan[y] sell, with the approval of the Local Board, but owing to tion the approval had not yet been applied for. The pl[aintiff] shareholder, objected to the sale on the ground that the insufficient, and that there were terms of the contract of were *ultra vires* as against a dissentient shareholder.

Their **Lordships** held that the agreement, though a [ ] had not been sanctioned at a meeting of shareholder[s] convened. They therefore discharged the injunction [granted by] Mr. Justice Kekewich, but granted an injunction restr[aining the] directors from carrying into effect the agreement until i[t was] properly sanctioned by the shareholders.

COMPANIES' MEETINGS AND REPO[RTS]

NATIONAL TELEPHONE COMPANY.

The annual general meeting of this Company wa[s held on] the 17th inst. As we get criticisms of the telephone thi[s] Company almost daily throughout the year, it is o[nly fair to] give in full the directors' criticism on their critics. Th[e] figures for the year have already appeared in our colu[mns. We] are indebted to the columns of the *Financial Time[s for the]* following report.

After reviewing the general balance-sheet, **Mr. Sta[nley]** said that £267,373 had been expended on capital accou[nt during] the half year, and although this was a large amount, i[t was not] unduly serious, having regard to the progress of the bu[siness. It] had been incurred partly in the erection of 5,633 exchange and private lines, and partly in the constr[uction of] underground lines in substitution for overhead wires [in] important places. The underground system, although m

at the beginning, secured greater efficiency in the conduct of the service, and at the same time safeguarded the Company against serious risks, such as snowstorms and damage to property arising from them and dislocation of service. The directors had come to the conclusion that the sooner they could substitute the one system for the other, the better it would be both for the public and for the Company. It was almost impossible to realise that their most intricate, delicate, and wonderful machinery in the air existed on sufferance. The Company had no powers of any sort or kind, but had to fight their way as best they could. They had sought from time to time to convince the various public bodies that reasonable concessions on their part to enable the Company to put cables under the streets were as much to the interests of the general public as of the Company. Happily, the difficulties experienced in that direction originally were being gradually overcome. Some of the more important centres had been enlightened enough to listen to arguments and to enable them upon something like reasonable terms to carry out the transformation, which was accompanied by a very perceptible improvement in the service. The Corporation of Manchester were the first to realise what their duty was in that respect, not to the Company, but to the public, and other places had followed. There were a good many places where they were suffering greatly from the want of those facilities. London was one of them, but they had reason to believe that London would follow the lead of Manchester. By the tabulated statement in the report it would be seen that as between Dec. 31, 1896, and Dec. 31, 1897, there had been an increase in the income of £113,800, that they had paid the Post Office £89,238 in royalties, being an increase of about £10 000, that the net income had increased by £103 800, that the working expenses had increased by £74,900 and the net result of the year had increased by £28 929. What had they done for all this? One was constantly being told how bad the service was, how costly it was, how extravagant the whole foundation was, and how much better it would be done by other people, and these statements were justified by certain figures. He supposed an ounce of fact was worth a great deal of the other thing, and the Company's figures were eloquent. Either they must be living in perfect illusion and must be absolutely ignorant of what they had got to do, or else the other gentlemen outside must be somewhat ill-informed. He was afraid the people outside were ill-informed. The popular theory was that in London they could get a magnificent telephone service for about £20 capital outlay per subscriber, and in the country for £5 or £6. He was afraid a fairy tale would have to be imported into that, and the power of the fairy before it was done, judging from their experience. In the past year they had increased their subscribers' wires in London by [illegible]1, and in all the other centres in the United Kingdom by [illegible]110, making a total increase of 11,781. That brought the total on Dec. 31, 1897, to 17,371 in London and 88,817 in all the other places, making together 106,188. That seemed satisfactory progress, being 18 per cent. in London, 11·43 per cent. in other places, and 12·48 per cent. upon the mean. The 1,219 wires in London cost in actual cash £53. 12s. 8d. apiece to erect, and 4,414 wires in the country cost £45. 15s. each to erect. That money had all to be found and expended before they got 6d return upon it. Those figures could not be controverted, though he admitted they were inconvenient to certain people. People said what a shame it was that subscribers in London should be charged £20 per annum, and £10 everywhere else; they considered they ought to have the service for £5. As a matter of fact, the average subscription in London for the whole year had been £14. 10s. 6d., and in the country £8. 10s. 10d. That did not seem to be an extravagant charge, nor was the disproportion in London so great as some people made out, if they considered that the cost of the erection of the wires in London was £53, and in the country £45. 15s. Anyone could use the telephone and speak 100 words for something under ½d., and one could enjoy that blessing every hour of the day and throughout the night for 6d. Then it had to be remembered that these two sums of £14. 10s. 6d. and £8 10s. 10d. were subject to a very large tax. The Post Office royalty came to no less than £89,000 in the present accounts. That was a big sum, and if the Chancellor of the Exchequer could be persuaded to forego that royalty it would take £1. 12s. 10d. off the London subscription, reducing it to a shade over £12, and 18s. 2d. off the subscription in other places. These facts, however, were conveniently ignored by their critics. They were told they ought to go to Stockholm or Norway, or some remote parts of the world, for parallels. He had really dwelt upon these matters so often that it seemed rather like beating a dead horse to talk about them, but he was obliged to do so from time to time in the hope that sooner or later those who criticised them would be put out of conceit of their illusions. In comparing the results, it must be remembered that in the year [illegible] the Company had a portion of the trunk revenue which in [illegible] had entirely disappeared, so that they had made up that [illegible] which was a considerable figure. He did not know whether the substitution of a dual trunk system for the old one had [illegible]ously improved the general convenience. In some [illegible] it certainly had, but in a good many others they [illegible] complaints that it was not quite as good as it used to be [illegible] the Company were the sole workers. Of course, it was [illegible] that if they had the thing in their own hands, with one [illegible] from the caller to the called, it was a much easier [illegible] and much more prompt and generally more satisfactory [illegible] when there was a multiplication of delicate operations, any [illegible] which might fail and cause inconvenience and delay. He [illegible] say, however, that this would be put right in time. The [illegible] concluded by moving the adoption of the report and [illegible] and the declaration of the dividends recommended.

Lord Harris, in seconding the motion, expressed a hope that their critics would appreciate the difficulties of the system more, the delicacy of the instrument which they were working, and be more disposed to be lenient in regard to any faults they might commit. They were working in the face of very considerable difficulties, but, on the whole, with very great success.

Mr. A. H. Hastie thought that in London they had a most excellent service, and that the rates were not unreasonable. He considered, however, that the present working of the trunk-line system was abominable, and, compared with that of a fifth-rate state, like Sweden or Switzerland, was disgraceful. He wished to know whether the directors would undertake to bring proper pressure to bear upon the Post Office to ensure the immediate carrying out of the necessary works for connecting the more important towns in England. If they would not give that undertaking, he would at once take steps to compel the execution of his demands.

The **Chairman** said he quite agreed with the speaker that it might be possible to improve the trunk wire system. If the Company had been left alone, trunking now would have been a totally different thing from what it was. That was the policy of the Government, and he would be very happy if Mr. Hastie would bring pressure to bear upon the authorities in the matter.

The report and accounts were unanimously adopted.

A vote of thanks was passed to the chairman, directors, officials, and staff on the motion of **Mr. Campbell**, seconded by **Colonel Mitchell**, and the **Chairman** having briefly acknowledged the compliment, the proceedings terminated.

METROPOLITAN ELECTRIC SUPPLY COMPANY, LIMITED.

An extraordinary general meeting of this Company was held on Tuesday at Winchester House, E C., Sir Eyre Massey Shaw presiding. The meeting was held for the purpose of sanctioning a Bill now before Parliament to enable the Company to acquire a site at Willesden on which to erect additional generating machinery.

The **Chairman**, in moving the resolution, said that, owing to the increased business of the Company, it had been found necessary to acquire a site at Willesden on which to erect additional generating machinery. Everything pointed to the fact that the time would shortly arrive when more stations would be required, as the increase in the demand for lamps was steady. It was impossible to find room for additional plant at the present works, and hence the Bill. He was glad to say they had succeeded in acquiring a most suitable site at Willesden, 8½ acres in extent, bounded by the Acton-lane, the Midland and London and North-Western Railways, and the Grand Junction Canal; and distant only three miles from the Company's nearest station, at Amberley-road, Paddington. It afforded admirable facilities for the delivery of goods, especially coal. No experiments, he would assure them, were to be made at the expense of the shareholders, as the systems of generation and distribution to be adopted were already in general use.

Lord John Hay seconded the resolution, which was adopted.

Mr. Wickham asked whether there would be any competition with this extension, as at a former meeting the late Sir John Pender had told them that they suffered severely from competition.

The **Chairman** said the Board of Trade gave authority to certain companies to supply within a certain district, and they allowed also a second company to come in and compete. That was where the competition came in.

CAPE ELECTRIC TRAMWAYS.

The first ordinary (statutory) general meeting of shareholders in the Cape Electric Tramways, Limited, was held on the 23rd inst. at Winchester House, Old Broad-street, E.C., Colonel Sir Charles Euan Smith in the chair.

The **Chairman** said: The Cape Electric Tramways, Limited, was formed on July 1, 1897, with a share capital of £400,000 fully paid and a debenture issue of £430,000, leaving £25,000 worth of debentures still unissued, for the purpose of taking over as going concerns the tramway companies then existing at Cape Town and at Port Elizabeth. First, there is the City Tramways Company of Cape Town, with an issued share capital of 158,500 shares of £1 each; secondly, the Metropolitan Tramways Company of Cape Town, with an issued capital of 130 000 shares of £1 each; thirdly, the Southern Suburbs of Cape Town Tramways Company, with an issued capital of 45,000 shares of £1 each—all these are fully paid; and, fourthly, the Port Elizabeth Tramways Company, with an issued capital of £120 000 fully paid. The Company took over these tramways from the companies named in good working order, and has since made many extensions and improvements, and the whole system is now worked by electric power. Since July 1, 1897, until the completion of the six months ended December, 1897, the Cape Tramways Company has carried 3,300,000 passengers. For July last the traffic receipts showed the gross total of £5,587, but since then the earnings have steadily increased. January's total receipts amounted to £9,400. The directors have under their consideration proposals for extensions, which will have for their object the completion of the entire system of tramways in Cape Town and in Port Elizabeth, and which, it is believed, will meet all the existing requirements of the public. On the Cape Town system we have about 22 miles of track, running through some 18 miles' length of streets, and our rolling-stock consists of 42 cars of the latest and most approved pattern. With regard to the Port Elizabeth tramways systems, this entire system is now also worked by electric power; but the completion of the installation

was rather later than that at Cape Town, and I may say we are only now beginning to reap the benefits of our improved service. For the six months ended December, 1897, 869,559 passengers have been carried on the Port Elizabeth system, and they have paid £11,984 in fares. Our receipts for last July—the first month of our operations—were £1,397, and our total receipts for December amounted to £2,734. In Port Elizabeth we possess about 11 miles of track, covering six miles of streets. We have also 19 cars running. Having regard to the earnings of the tramways, I am glad to say that the directors are able to declare an interim dividend of 2½ per cent. on the last six months' working, notice of payment of which will be given in the usual course. I trust that at the end of the financial year we may have the pleasure of announcing to you that the extensions which we have in contemplation will be completed. Arrangements have been made for securing a special settlement for the shares of the Company on the Stock Exchange.

No questions were asked, and there being no business before the meeting, the proceedings terminated.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY, LIMITED.

The thirty-fourth ordinary general meeting of this Company was held last Wednesday at Cannon-street Hotel, E.C., the chairman being the Hon. Henry Marsham.

The **Chairman**, in opening, said that their turnover last year had been greater than in any previous year. The price of raw rubber, however, had for some time past been steadily increasing. A sign of the times was that a company had been formed to grow and supply indiarubber. The factories at Silvertown and Persan were in a high state of efficiency. The ships "Silvertown" and "Asia" had been engaged on some unimportant cable work. The Company had suffered somewhat from the engineers' strike, but were not greatly affected by it. Their representative in Melbourne, Australia, had written to tell them that the works there had been destroyed in the great fire of Nov. 21. The loss was fully covered by insurance, and they had been able to take other premises, and new stock had been sent out. The directors recommended a dividend of 10 per cent. for the year, leaving £13,173 to be carried forward.

The report was adopted.

General Trevor said that the auditors' certificate was not satisfactory when they made the statement "subject to the correctness of the value placed on the 'debentures and shares in other companies,' and certain debts included in the item of 'debts owing to the Company,' as to which we are unable to certify." He thought they ought to go into this matter more thoroughly.

The **Chairman** said they would be asked to do so.

The auditors were re-elected and also the retiring director, Major Darwin.

CITY OF LONDON ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: Sir David L. Salomons, Bart., chairman; the Earl of Suffolk and Berkshire; Edward Lucas; Colonel B. H. Martindale, C.B.; Frederick W. Reynolds. Frank Bailey, engineer to the Company. J. Cecil Bull, manager and secretary.

Abstract of report of the directors to be presented to the shareholders at the ordinary general meeting of the Company to be held in the Great Hall, Winchester House, Old Broad-street, E.C., on Wednesday, March 2 1898, at 2 30 p.m.:

The expenditure on capital account during the year ended Dec. 31, 1897, amounted to £82,085. 17s.

	£ s. d.	£ s. d.
The total revenue for the year was		£190,573 12 11
From which must be deducted the following items:		
Expenses of generation and distribution	£42,923 10 8	
Rents, rates, taxes, general charges..	23 980 19 6	
Allowances to consumers	14,780 19 9	
Transfer to depreciation fund No. 1..	17,000 0 0	
Transfer to reserve fund	3,528 0 0	
Amount written off suspense account	1,338 0 8	
		103,551 10 7
Leaving		87,022 2 4
To which must be added the balance brought forward from 1896		1,415 3 1
Making a total available revenue of		88,437 5 5
Of this sum the following amounts have been distributed:		
(a) Interest on debenture stock for year ended Dec. 31, 1897	20,000 0 0	
(b) Interim dividend on £400,000 6 per cent. preference shares, half-year to June 30 last	12,000 0 0	
		32,000 0 0
Leaving for further distribution		£56,437 5 5

The directors now recommend the payment of the following dividends, subject to the deduction of income tax to members registered in the books of the Company on Feb. 16, 1898: preference shares—6s. per share for the six months ended Dec. 31, 1897, making, with the interim dividend already paid, a total distribution of 12s. per share, or at the full rate of 6 per cent. per annum; ordinary shares, Nos. 40,001 to 80,000—£1 per share for the 12 months ended Dec. 31, 1897, being at the rate of 10 per ce[nt. per] annum; ordinary shares, Nos. 80,001 to 90,000 (February issue)—10s. 7d. per share, being at the rate of 10 per ce[nt. per] annum, calculated from the due dates of the respective insta[lments] to Dec. 31, 1897. This will absorb £55,381. 18s. 10d., and [leave a] balance of £1,055. 6s. 7d. to be carried forward. It is pr[oposed] that the respective dividends shall be paid on March 3, 189[8]. statutory provision for depreciation and reserve funds in [accord]ance with the City of London Electric Lighting Act, 18[..., has] been made, of which £20,528 have been set aside out of re[venue]. The generation and distribution expenses for the year, inc[luding] repairs and renewals, were 31·3 per cent. of the earnings a[s com]pared with 34 per cent. in 1896, 36·87 for 1895, 46 for 18[94, and] 54·2 for 1893. The Company continues to make satisf[actory] progress, the number of customers and equivalent of 8 c.p. [lamps] connected being at Dec. 31, 1897, 6,322 and 296,012 respec[tively]. On Feb. 9, 1898, there were 316,705 8-c.p. lamps (equi[valent]) applied for, out of which 302,871 were connected. The inco[me as] shown in the audited statements of accounts issued by the [Com]pany, for the year ended Dec. 31, 1897, was as follows: [Gross] revenue (after deducting allowances to consumers), £1[...] 13s. 2d.; net revenue available for depreciation, reserve, interest on debenture stock, and dividends, £107,550. 2s. [...] accordance with the articles of association, two of the dir[ectors,] Edward Lucas and Frederick W. Reynolds, now retire, and, [being] eligible, offer themselves for re-election. Messrs. W. H. P[...] and Co. retire, and, being eligible, offer themselves for re-el[ection].

Revenue Account for Year ended Dec. 31, 1897.

Dr.	Public lighting. £ s. d.	Pr[ivate] lig[hting.] £
Generation of electricity—		
Coal and other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on works	3,003 6 0	18,847
Oil, waste, and engine-room stores..	401 5 11	2,052
Water	286 16 8	988
Salaries of station engineers and assistants	702 6 6	2,106
Wages and gratuities at generating stations	1,740 16 10	5,420
Sundry expenditure	97 4 11	99
Total generation expenses	£6,231 16 10	£29,516
Distribution of electricity—		
Proportion of salaries of engineer's assistants	316 1 5	1,264
Attending mains and street boxes	184 17 0	1,293
Wages and gratuities to linesmen, fitters, and trimmers of lamps	1,303 17 11	266
Wages and gratuities to transformer men and sundry stores	—	1,714
Carbons and other materials for street and other lamps	689 3 8	119
Sundry expenditure	2 15 5	19
Total generation and distribution expenses	8,728 12 3	34,194
Rents, rates, and taxes—		
Rents payable	898 12 4	4,493
Rates, taxes, and lighting	1,337 10 3	6,687
Proportion of management expenses—		
Directors' remuneration, salaries of manager and secretary, accountant, clerks, collectors, etc.	1,082 2 2	5,410
Printing and stationery	115 4 10	576
General establishment charges, including meter reading	136 6 3	681
Auditors' fees	23 4 2	116
Trustees' fees	17 10 0	87
Legal charges	50 17 6	254
Special charges—		
Allowances, deductions to consumers, and fines	354 18 1	14,42[.]
Bad debts	—	31[.]
Official testing of meters	—	1[.]
Insurances	142 14 0	1,28[.]
Claims	—	5[.]
Professional charges re buildings	—	20[.]
Total expenditure	12,887 11 10	68,79[.]
Balance, being revenue for period carried to net revenue account	270 18 10	104,88[.]
	£13,158 10 8	£173,67[.]

Cr.	Public lighting. £ s. d.	Pr[ivate] lig[hting.] £
Sale of current	—	166,72[.]
Revenue under contracts	12,958 4 10	
Meter rentals	—	4,34[.]
Rents receivable	170 12 0	2,21[.]
Transfer fees	10 10 4	13[.]
Testing fees and sundry receipts	19 3 6	24[.]
Total income	£13,158 10 8	£173,67[.]

The cost of repairs and renewals to buildings, mac[hinery,] mains, etc., amounting to £14 708. 17s. 4d., together w[ith] statutory depreciation, has been provided for out of the de[precia]tion reserve funds in accordance with the City of London Ac[t].

GENERAL BALANCE SHEET, DEC. 31, 1897.

Liabilities, etc.	£ s. d.	£ s. d.
ount—amount received		1,318,574 4 0
desmen and others, due on construction machinery, fuel, stores, etc.		11,357 2 1
ditors on open accounts		2,477 5 2
oosits from consumers		334 6 6
on reserve funds—No. 1..	£44,781 5 1	
do. No. 2..	32,367 7 7	
od	10,924 6 11	
		88,072 19 7
premiums on issue of debenture stock and s thereon	50,251 12 3	
received on issue of 10,000 shares £26,445. 4s. 3d.; ifer to depreciation funds,	1,537 4 3	
		51,788 16 6
ue account—balance at ereof	68,437 5 5	
rim dividend on £400,000 nce shares to June 30,	12,000 0 0	
vailable for distribution as proposed in		56,437 5 5
		£1,529,041 19 3

Capital Expenditure and Assets.	£ s. d.
penditure	1,283,720 16 5
tations and elsewhere	21,557 7 9
on account of contracts not completed...	7,750 0 0
otors for current supplied to September, 20. 17s. 5d.; December, 1897, £69,246.	70,167 8 3
ors and payments in advance	2,774 13 6
account, £7,183. 7s. 7d.; less written of revenue, £1,338. 0s. 8d.; and legal £123. 6s.—£1,461. 6s. 8d.	5,722 0 11
ankers and in hand—deposit account, ; current account and in hand, £19,667.	51,667 8 2
posits and interest accrued thereon	7,111 11 3
ts at cost and dividends accrued theron depreciation and reserve funds—(a) ent. Consols and 2½ per cent. Metro-Stock £16,725. 2s. 3d.; (b) British stocks, £34,248. 15s.; (c) freehold and l property, £27,596. 15s. 9d.	78,570 13 0
	£1,529,041 19 3

OL AND FLEETWOOD TRAMROAD COMPANY.

-yearly meeting of shareholders of the Blackpool and Tramroad Company was held at Manchester this week, Richardson, the deputy chairman, presiding.

port the directors state that a Bill has been deposited ent session to enable the Company to construct further also to obtain specified running powers over the Cor-amways, to raise additional capital, and to supply o private and public consumers outside Blackpool and The periodical reports of the engineers as to the the work are satisfactory, and active progress has with the construction of the tramroad during the half-efforts will be spared to complete the lines by the f May.

t was adopted.

eorge Richards and Richard Henry Prestwich were lirectors, and the nomination of Messrs. John Green-Albert-road, Southport, and Robert Slater Boddington, ery, Strangeways, Manchester, as additional directors, he number to seven, was confirmed.

CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION, LIMITED.

: G. H. Brougham Glasier, Esq, 7, St. James's-street, man; Stefano Gatti, Esq. (A. and S. Gatti), Strand, chairman and managing director; John M. Gatti, Esq. Gatti), Strand, W.C.; Richard Chadwick, Esq., 34, St. e, W.C.; W. F. Fladgate, Esq., Craig's-court, S.W. E. Wilmot Seale, Esq. Chief engineer: W. H. .M I.C.E., M.I.E.E., M I.Mech E.

the directors (with abstract of accounts) for the year 31, 1897:

ting the accounts for the year ended Dec. 31, 1897, rs are pleased to report that the business has been ceedingly satisfactory. The directors have very great nnouncing the death of Mr. Isaac Percy Mendoza, a the Corporation. Mr. William Francis Fladgate has d a director in his place. There has been connected up s of the Corporation during the past year the equiva-78 lamps, an increase of 53·7 per cent. on the lamps n 1896. During the year 1897, 6½ miles have been added s laid in the combined areas. The combined output in the stations of the Corporation has increased by about 33½ per cent. for the year 1897 over 1896. The station buildings which have been in course of erection on the wharf of Commercial-road will shortly be completed. The directors have obtained consent from the St. Giles and Holborn District Board of Works to applications being made to the Board of Trade for provisional orders for those districts respectively. These applications are now before the Board of Trade, and if granted application to Parliament will be made in due course to confirm the order. The net earnings, as shown in the revenue account, have amounted to £18,907. 2s. 11d.; £491. 10s. 8d. has been paid for income tax; £3,648. 10s. 4d. has been paid in respect of interest on debentures and temporary loans up to Dec. 31, 1897; and £4 500 was distributed in payment of an interim dividend at the rate of 6 per cent. for the half-year ended June 30, 1897. A sum of £10 267 1s. 11d. remains, which, added to the undivided profit of £2 997. 1s. 8d. from last year's account, makes £13,264. 3s. 7d., which the directors propose to deal with as follows: to provide for dividend on 4½ preference shares apportioned to Dec. 31, 1897, £4,249 5s. 3d.; to pay a dividend at the rate of £8 per cent. for the half-year ended Dec. 31, 1897, on the ordinary shares, making with the interim dividend paid in August, 1897, £7 per cent. for the whole year, £6 000; and to carry forward £3,014. 18s. 4d. Mr. G. H. Brougham Glasier and Mr. William Francis Fladgate are the directors who retire by rotation, and, being eligible, offer themselves for re-election. The auditors, Messrs. O. R. Johnson and Son, also retire and offer themselves for re-election.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1897.

Dr. Generation of Electricity.		£ s. d.
Coal or other fuel, including carriage, etc.	£10,106 1 2	
Oil, waste, water, and engine-room stores	997 0 8	
Proportion of salaries of engineers, superintendents, and officers	325 11 10	
Wages and gratuities at generating stations	3,683 10 9	
		15,112 4 5
Repairs and maintenance as follows:		
Buildings	123 5 10	
Engines, boilers, dynamos, motors, and other machinery, instruments, and tools	1,514 19 6	
Accumulators and accessories	74 17 5	
		1,713 2 9
Clearing away ashes		243 18 5
		17,069 5 7
Distribution of Electricity.		
Proportion of salaries of engineers, superintendents, and officers	888 11 7	
Wages and gratuities to linesmen, fitters, labourers	211 17 4	
Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same	315 12 11	
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises	279 8 5	
Wayleaves and licenses	572 9 0	
		2,267 19 3
Rents, rates, taxes, and insurances		1,904 6 3
Management Expenses.		
Directors' remuneration	700 0 0	
Salaries of secretary, accountants, clerks, and managers	1,939 9 11	
Stationery and printing	218 3 3	
General establishment charges	389 8 5	
Auditors of Company	52 10 0	
Auditor appointed under the provisions of the order, year 1896	65 0 0	
Surveyor's charges	22 0 0	
		3,386 11 7
Law and parliamentary charges		107 4 0
Depreciation in respect of leasehold premises, buildings, plant, machinery, etc.		5,247 0 3
		29,982 6 11
Rents, repairs, rates and taxes in respect of the Company's house property not in its own occupation		25 7 11
Total expenditure		30,007 14 10
Balance carried to net revenue		18,907 2 11
		£48,914 17 9

Cr.	£ s. d.
Sales of current, less rebates and allowances for bad debts	48,026 16 6
Rentals of meters and other apparatus on consumers' premises	582 8 1
Profits on sale of sundries	214 0 8
Transfer fees	57 12 6
	48 880 17 9
Rents receivable in respect of the Company's house property not in its own occupation	34 0 0
	£48,914 17 9

GENERAL BALANCE-SHEET, DEC. 31, 1897.

Dr. Liabilities.	£ s. d.	£ s. d.
Capital account—amount received		[illegible] 4 9
Sundry creditors for—		
Debenture interest due Dec. 31, 1897	£1,[illegible] 13 4	
Preference dividend due Dec. 31, 1897	1,[illegible] 14 [illegible]	
Various credits	1,[illegible] 4 [illegible]	
Sundry tradesmen and others due on construction of plant and machinery, fuel, stores, etc., to Dec. 31, 1897	18,[illegible] 17 [illegible]	
		22,53[illegible] 11 6
Net revenue account—balance at credit thereof	17,[illegible] 3 7	
Less preference dividend to Dec. 31, 1897	4,[illegible] 5 3	
	13,514 19 4	
Less interim dividend paid in August, 1897, on ordinary shares	4,[illegible] [illegible] [illegible]	
		9,914 15 4
Depreciation fund account	12,[illegible] 4 4	
Share premium account	9,[illegible] 3 2	
		22,[illegible] 3 2
		£279,153 13 0

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	25[illegible]	0	1
Premises not used by the Company	[illegible]	0	0
Stores on hand at Dec. 31, 1897: coal, £440. 4s.; oils, waste, etc., £112 12s. 11d.; general stores, cables, etc., £1,042. 6s. 1d.; stationery, £50. 7s. 7d.	1,655	11	7
Sundry debtors for payments on account of contracts in course of completion	2,100	0	0
Sundry debtors for current supplied to Dec. 31, 1897, £13,647. 8s. 6d., and other debtors, £756. 17s. 2d....................	14,404	5	8
Bills receivable ....-	74	7	8
Cash at bankers and in hand	2,749	8	0
	£279,153	13	0

The annual ordinary general meeting of the Company was held last Monday at their offices, 15, Maiden-lane, W.C., Mr. G. H. Brougham Glasier, Esq., in the chair.

The **Chairman** said the first duty which fell to him was to express the sincere regret of the directors at the death of their late colleague Mr. I. P. Mendoza. He would introduce them to the new director, Mr. W. F. Fladgate. He would congratulate them on a satisfactory increase in the business of the Corporation. Since 1896 they had increased their *clientèle* over 56 per cent., and the number of units sold were about 33½ per cent. above those of last year. There was an increase of 53·7 in the number of lamps connected to their mains. Rather more than one-half of this increase was derived from their last year's acquisition, the Strand district, but a substantial part was also contributed by their old area, the St. Martin's parish. They had laid down 6½ miles of mains during the past year, their total mileage being about 83. They were greatly satisfied with the result of their extension of supply area in the Strand district, and believed that similar good results would come of the Holborn and St. Giles's extension. The Holborn and St. Giles's Boards of Works had assented to their application for a provisional order, but it was only right to say that they had also consented to the application of another company. In December last they had given notice to the City Commissioners of Sewers of their intention to apply for a provisional order to supply electricity in the City of London, and had asked their consent to the application, and it was now being considered. Coming to the accounts, their net revenue for 1897 was £18,907, against £15,289 in 1896, or an increase of £3,616. They would notice that £3,649. 10s. had been paid in respect of debentures and temporary loans, and they had carried forward £3,015 to the account, a larger provision than was usual in electric lighting companies. They were not quite satisfied with regard to the coal. They had to work under very uneconomical conditions at Lambeth, and owing to building operations on the wharf front they had to have their coal land-borne instead of sea-borne, making a difference of 3s. per ton. The buildings on the wharf front would, however, soon be completed. They had been disappointed with some of the boilers at Lambeth, but deemed it inadvisable to discuss the matter. They would further notice that they had expended £1,713 in repairs and maintenance of their buildings, plant, etc. It had always been their object to keep their works in a high state of efficiency and well maintained. They had added £5,427 to the depreciation account, making altogether a total of £13,000 for depreciation, etc. In 1897 the total written off for repairs, maintenance, etc., was £7,555. They proposed a dividend of 8 per cent. for the half-year on the ordinary shares, making, with the interim dividend paid in August, 1897, 7 per cent. on the whole.

The report was adopted.

Mr. R. A. Bush asked if the item £244 was not a large price for clearing away ashes?

Mr. W. N. Adler said he would like to know if the artesian well worked well.

Mr. Fladgate, replying, said that when the wharf at Lambeth was opened there would be a decrease in the cost of carting the ashes. The well was acting splendidly.

YORK TRAMWAY COMPANY.

The half-yearly meeting of this Company was held at the Hotel, York, this week, when Mr. Joseph Kincaid, chai[rman of] the board of directors, presided.

The **Chairman**, in moving the adoption of the report, [illegible] cost of horse keep had increased, and was likely to increa[se] more. They were hoping that in the near future they migh[t] [illegible] electricity to the working of their tramways, and in this [illegible] hoped they might be met fairly by the York Corporation.

The report was adopted.

SCARBOROUGH ELECTRIC LIGHT COMPANY

The sixth annual meeting of the Scarborough Electr[ic] [illegible] Company was held last week.

Mr. George Alderson Smith presided, and moved the [illegible] of the report, which recommended a dividend of 5 per ce[nt.] [illegible] said that at Scarborough they were greatly handicappe[d] [illegible] high price of coal. In Leeds, £[illegible] of current was prod[uced] [illegible] a coal bill of £[illegible], while at Scarborough the current amo[unted to] £[illegible], and their fuel cost £1,[illegible]. The directors were givi[ng] attention to the matter to see if they could not economise [illegible] had already got a patent forced draught, and they hoped to [illegible] to burn coke during some portion of the day. There was [illegible] question of a house refuse destructor, which was causing [illegible] talk in the town. Perhaps a small one might be fixed [illegible] premises of the company, which would supply them wit[h] power. At all events the Corporation, which would ev[illegible] purchase the undertaking, would be doing something [illegible] future if they put a destructor on the premises.

Councillor Sheffield remarked that the working expenses [illegible] amounted to £3,000, were very large, considering that thei[r] [illegible] was only £5,000. He advocated a uniform charge of 6d. [illegible]

Mr. Campbell Swinton, the managing director, sa[id] [illegible] present price—6½d. for any amount under 800 units, an[d] [illegible] unit over that figure—was very low, and considerably lo[wer] [illegible] in any town of the same size.

The report was adopted, and the retiring directors, [illegible] J. W. Woodall, John Dale, and J. B. Simpson, were re-el[ected].

BRISTOL TRAMWAYS AND CARRIAGE COMP[ANY].

The half-yearly meeting of the Bristol Tramways and [illegible] Company, Limited, was held this week at Bristol, Mr. [illegible] Butler presiding.

The **Chairman** stated that the receipts from the t[illegible] department showed an increase of £9,494, which was larg[ely made] up of receipts from additional lines opened during the h[alf-year]. General expenses had increased owing to additional busi[ness, and] there had been a heavier expenditure on renewals. The b[illegible] net revenue was £16,859, as against £12,378 in the corre[sponding] half-year, being an increase, roundly, of £4,500. The C[hairman] referred at length to the points at issue between the Co[rporation] and the company on the question of electric traction. [illegible] they were anxious to avoid a fight with the Corporation, [illegible] prepared to submit to a reasonable sacrifice rather than d[illegible] he was free to confess that when one read the views exp[ressed on] the other side, he, for one, would enter upon those neg[otiations] with considerable fear that, unless more practical vie[ws were] allowed to prevail, their efforts in the direction of an arra[ngement] must necessarily prove abortive, and that they would b[e thrown] back upon their right of appeal to an impartial tribu[nal in the] form of a committee of the House of Commons, who w[illegible] that it was for the public advantage that the Compan[y should] extend the use of electric traction over the remainder [of their] system, and that their doing so should not be taken adv[antage of] for forcing upon the Company absolutely impracticable t[illegible]

Mr. C. H. Low seconded the motion, which was adopte[d].

After the ordinary meeting a special meeting was held, [illegible] confirmation was given to a resolution approving the C[illegible] Bills in Parliament seeking powers to extend their syste[m and] employ electric traction on the whole of the Company's li[nes].

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LI[GHTING] COMPANY, LIMITED.

Directors: Alfred Sobier Bolton, Esq., Sir Fred[erick] Bramwell, Bart., F.R.S., G. H. Hopkinson, Esq., Gr[illegible] Ryder, Esq., R. W. Wallace, Esq., Q.C.

Report by the directors (with abstract of accoun[ts]) presented at the eleventh ordinary general meeting to b[e held at] 1, Great George-street, Westminster, on Thursday, Marc[h] [illegible] at 5 p.m.:

During the year the number of houses and shops conne[cted to] the system has increased from 1,325 on Dec. 31, 1896, t[o] [illegible] Dec. 31, 1897, while the number of lamps calculated on [the] basis of 8 c.p. has increased from 119,955 to 137,953. A[illegible] capital required by the Company during the year has be[en raised] by the issue of £1,160 4 per cent. debenture stock, [illegible] £1,240 and 2,000 second preference shares, offered to t[he share]holders at a minimum price of £6 per £5 share, were a[pplied] for, producing £12,219. 12s. 6d. The directors have stre[ngthened] the renewal account by transferring to it £8,061. 7s. 1d[illegible] the total amount placed to that account £20,497. 13s. 10[illegible] providing for the above amount, and paying the divide[nd on the] 6 per cent. first preference shares to June 30, 1897, on

ond preference shares to Sept. 30, 1897, and an interim l at the rate of 8 per cent. per annum on the ordinary r the first half of the year, the balance standing to the the net revenue account for the year 1897 is £7,263. 11s. bove sum £1,450 has been appropriated to the payment of preference dividend to the end of the year, and £300 has aside to meet the portion of the dividend on the second ce shares accrued to the same date, leaving £5,513. 11s., which it is proposed to pay a further dividend on the shares at the rate of 12 per cent. per annum for the past r, making, with the interim dividend paid to June 30, ent. for the year. This will leave a balance of £1,163. 11s. dance with the articles of association, Mr. A. S. Bolton G. H. Hopkinson retire from the directorship, and, being offer themselves for re-election. The auditors, Messrs. k, H. W. S. Whiffin, and Dickinson, offer themselves for on.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1897.

	£	s.	d.	£	s.	d.
Generation of Electricity.						
other fuel, including dues, ge, unloading, storing, and all ses of placing the same on the	£5,467	19	8			
ste, water, and engine-room	909	12	6			
ion of salaries of engineers, intendents, and officers, as ed by the engineer-in-chief...	900	0	0			
and gratuities at generating n......	1,844	1	7			
, renewals, and maintenance, lows: buildings, £92. 11s. 11d.; es, boilers, £1,508; dynamos, 18s. 10d.; other machinery, ments, and tools, £113. 5d.: accumulators and acces-, £1,050. 14s. 11d.	2,848	5	2			
				11,969	18	11
Distribution of Electricity.						
tion of salaries of superinten- and officers, as certified by ngineer-in-chief	400	0	0			
and gratuities to linesmen, s, labourers	461	4	8			
, maintenance, and renewals ains of all classes, including rials and laying the same	139	3	8			
, maintenance, and renewals eters	255	10	3			
, maintenance, and renewals apparatus at distributing ons	53	11	3			
				1,309	9	10
Rents, Rates, and Taxes.						
payable	249	10	1			
and taxes	3,237	0	6			
				3,486	10	7
Management Expenses.						
ors' remuneration	1,000	0	0			
s of managing engineer, etary, accountants, clerks, sengers	1,686	1	8			
nery and printing	263	3	7			
al establishment charges	322	19	0			
ors of Company	52	10	0			
r appointed under the pro- ions of the order	53	0	0			
				3,377	14	3
and parliamentary charges				146	7	10
Depreciation.						
ciation in respect of leasehold ds	290	0	0			
wals and maintenance of build- , plant, mains, etc., £11,256. 8s.; amount expended during the r as above, £3,195. 0s. 11d.	8,061	7	1			
Special Charges.						
nces	403	17	4			
of conversion to 200 volts	225	2	11			
ts to freehold property	0	6	7			
				8,980	13	11
Total expenditure				29,270	15	4
ce carried to net revenue				14,639	18	6
				£43,910	13	10

	£	s.	d.
of current per meter (1,898,362 units) 5d., 6d. per B.T.U., less rebates and bad debts	40,972	18	0
under contracts	708	11	9
	41,681	9	9
of meters and other apparatus on con- ers' premises	1,323	10	0
and repairs of lamps, etc.	9	16	7
receivable	889	5	0
fer fees	6	12	6
	£43,910	13	10

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	229,455	0	0
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc., on open accounts, to Dec. 31, 1897	11,368	4	1
Net revenue account—balance at credit thereof ...	7,263	11	0
Renewal fund account	20,497	13	10
Depreciation fund account works on leasehold property	1,435	17	3
	£269,980	6	2

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	252,162	9	1
Stores on hand: coal, £256. 17s. 11d.; oils, waste, etc., £85. 16s. 11d.; general, £500. 17s. 5d.	843	12	3
Sundry debtors for current supplies to Dec. 31, 1897	14,399	4	6
Other debtors	147	8	9
Cash at bankers, £2,383. 1s. 3d.; cash in hand, £44. 10s. 4d.	2,427	11	7
	£269,980	6	2

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, LIMITED.

The annual report of the directors of this Company states that of the £50,000 additional capital authorised by the extraordinary general meetings held in the spring, the directors limited the present issue to £25,000, reserving the remainder for future needs. The whole of the £25,000 was taken up by the shareholders or their nominees at 60 per cent. premium, enabling the reserve to be increased by £15,000. After negotiations with the local authorities (protracted for several years), Victoria-road, which intersected the works at North Woolwich from east to west, has been legally closed, and its site added to the Company's property—which now lies within a ring fence. This great advantage was not obtained without the payment of a sum of £2,000 to the Woolwich Local Board of Health to be applied to some purpose of public utility. During the past year a net profit has been made of £29,584. 19s. 7d. After payment of debenture interest and income tax, and making ample allowance for depreciation of buildings, plant, machinery, etc., there remains £23,936. 5s. 7d., making, with £14,294. 6s. 7d. brought forward from last year, a total of £38,230. 12s. 2d. From this sum has to be deducted the £500 voted to the directors at the last general meeting, leaving £37,730. 12s. 2d. available for distribution. The directors have transferred £7,500 to the reserve fund (in addition to the £15,000 premiums above mentioned), and they recommend the payment of the following dividends—viz.: on the preference shares, 7 per cent., including the interim dividend of 3½ per cent. paid on Sept. 1 last; on the ordinary shares at the rate of 12 per cent. per annum, including the interim dividend of 3 per cent., also paid on Sept. 1 last. These payments will together amount to £22,941. 0s. 7d., leaving £14,789. 11s. 7d. to be carried forward. Mr. Sydney Gedge, M.P., and Mr. Frederick Newton retire from the Board in accordance with the provisions of the articles of association, and, being eligible, offer themselves for re-election. The auditors, Messrs. Ball, Baker, Deed, Cornish and Co., retire, and, being eligible, offer themselves for re-election.

BARCELONA TRAMWAYS COMPANY.

The report of the directors of the Barcelona Tramways Company, Limited, for 1897, to be presented to the general meeting to be held in London on March 2, states that further purchases of land, to complete the requirements of the electric traction, have been made during 1897 to the extent of £20,362. After the completion of the change, the Board hope to dispose of considerable plots of land comprising outlying stations. The revenue of the Ensanche Company is in excess of that for the previous year, but does not suffice, after paying interest and sinking fund on its obligations, to admit of the distribution of a dividend. Application has been made for power to adopt electric traction on the Company's system. Authority having been obtained for the first of the extensions mentioned in previous reports, the laying of the road has been effected, and the applications for the others are following the usual course. The definite sanction of the authorities to the adoption of this mode of traction was obtained last summer, the work of transformation is well advanced, and the directors hope to have it ready for the approaching summer season.

NOTTING HILL ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: Sir William Crookes, F.R.S., chairman; Arthur Ellis Franklin, Esq.; Alexander Howden, Esq.; James Thomas Jervis, Esq.; Francis Radford, Esq. Engineer and manager: Geo. Schultz. Secretary: R. G. Rawkins.

Report of the directors (with abstract of accounts) to be submitted to the shareholders at the eleventh ordinary general meeting to be held at the offices of the Company, Bulmer-place, Notting Hill, on Wednesday, March 2, at 12 noon:

The expenditure on capital account at the date of the last balance-sheet stood at £99,104. 17s. 6d., and during the past year a further sum of £14,079. 7s. 10d. has been expended, chiefly accounted for by £11,769. 13s. 11d. for mains. The total capital expenditure is therefore £113,184. 5s. 4d., which is £3,184. 5s. 4d. in excess of the capital issued. The balance due at the beginning of 1897 on the preference shares, £3,160, was called up and duly

paid during the year, thus making the whole share capital of £100,000 fully paid up. As announced in the report of 1896, the sum of £10,000 was raised by the issue of 4 per cent. first mortgage debentures maturing in 1931, and redeemable in 1907 at the option of the Company by paying the debenture holders a bonus of 5 per cent. These debentures were issued at the price of 106 per cent., and the applications were considerably in excess of the amount required. In accordance with the debenture trust deed the amount of these first mortgage debentures is limited to 50 per cent. of the share capital actually issued and paid up. At present, therefore, there are £40,000 of debentures available for additional expenditure. The capital expenditure during the current year is estimated at £7,000, for which further debentures will be issued. The following table shows the progress of the Company during the last five years:

1893	Lamps	12,153	Profit	£1,481	7	1
1894	„	15,669	„	2,101	17	8
1895	„	20,307	„	3,227	14	10
1896	„	25,716	„	4,736	9	8
1897	„	33,000	„	6,854	1	2

The directors have set aside £1,000 for the depreciation and reserve fund, and have paid a dividend of 6 per cent. on the ordinary preference shares for the year ending Dec. 31, 1897, amounting to £1,767. 14s. 4d. After payment of interest and leasehold redemption a balance is left of £3,884. 18s. 1d., out of which the directors recommend that a dividend be declared on the ordinary shares at the rate of 6 per cent., less income tax, which will absorb £3,871. 4s. The sum of £401. 16s. 2d., being the premiums received on the issue of £10,000 first mortgage debentures, after deduction of the legal and other expenses, has been written off the preliminary expenses account. The Company has hitherto supplied current at the standard pressure of 100 volts, the price charged being 8d. per unit. In March last the directors decided to supply current at a pressure of 200 volts, at a charge of 6d. per unit, less the usual rebates for long hours. It is not proposed to disturb existing contracts on the old basis, but every facility is given to those desiring to change. A contract has been entered into with the National Electric Free Wiring Company, Limited, which will enable intending consumers to obtain current without initial outlay for wiring or fittings. This only came into force at the latter end of the year, and already 17 houses have been connected on these terms. Very considerable inconvenience has been caused to the engineering staff by the non-delivery of the new and additional machinery ordered in the early part of last year, owing to the labour troubles in the engineering trade. Fortunately, the Company were able to meet all demands on them without any accident or breakdown. Great credit is due to the manager and the staff generally for their care and energy during this very anxious time, which happily is now past. The directors who retire are Messrs. Arthur Ellis Franklin and Francis Radford, who being eligible, offer themselves for re-election. The shareholders' auditors, Messrs. Fox, Sissons, and Co., retire, and being eligible, offer themselves for re-election. The accounts for 1896 have been audited on behalf of the Board of Trade, and those for 1897 will be similarly audited in due course.

REVENUE ACCOUNT, YEAR ENDED DEC. 31, 1897.

Dr. Generation of Electricity.	£ s. d.	£ s. d.
Coals and other fuel, including dues, carriages, etc.	£981 14 7	
Oil, waste, water, and engine-room stores	138 0 5	
Wages and gratuities at generating station	484 15 11	
Repairs and maintenance as follows:		
Buildings	14 1 1	
Engines, boilers	270 9 11	
Dynamos	42 6 1	
Other machinery, instruments, and tools	86 9 11	
Accumulators	204 4 9	
		2,222 2 8
Distribution of Electricity.—Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same		30 0 3
Rents, rates, and taxes		393 15 11
Management Expenses.		
Directors' remuneration	650 0 0	
Trustees for debenture holders' remuneration	52 10 0	
Salaries of engineer and manager, secretary, clerks, and messengers	937 0 2	
Stationery and printing	56 17 6	
General establishment charges	114 12 1	
Auditors of Company	31 10 0	
Auditor appointed by the Board of Trade under the provisions of the order	27 0 0	
		1,869 9 9
Special Charges.		
Insurances	86 16 1	
Rent of wayleave	2 10 0	
Law costs	19 19 8	
		109 5 9
Connecting installations and sundry stores		146 15 1
		4,771 9 5
Balance carried to net revenue account		6,854 1 2
		£11,625 10 7

Cr.	£ s. d.
Sale of current (354,969 units) £10,245. 9s. 3d.; less bad debts, £14. 17s. 4d.	10,230 11 11
Rental of meters and other apparatus on consumers' premises	518 18 9
Connecting installations, sale of stores, etc.	572 13 2
Rents receivable	266 12 3
Transfer fees, etc.	36 14 6
	£11,625 10 7

Dr. GENERAL BALANCE-SHEET, DEC. 31, 1897.	£ s. d.
Capital account—amount received	110,000 0 0
Sundry tradesmen and others, due on contracts for fuel, stores, etc.	3,050 13 2
Sundry creditors	1,385 4 1
Depreciation, renewal, and reserve fund account	3,340 0 0
Net revenue account—balance at credit thereof, £5,652. 12s. 5d.; less interim dividend paid on ordinary preference shares, £868. 6s. 4d.	4,784 6 1
	£122,560 3 4

Cr.	£ s. d.
Capital account—amount expended for works, including cost of provisional order	113,184 5 4
Sundry debtors for current supplied, etc.	4,193 17 8
Other debtors	80 16 5
Stores on hand: coal, £64. 2s. 6d.; general, £421. 9s. 11d.	485 12 5
Stock (movable plant and tools)	222 6 0
Cash at bankers, £910. 11s. 2d.; cash on deposit, £1,500; cash in hand, £8. 17s. 9d.	2,419 8 11
Preliminary expenses, compensation, etc., £2,375. 12s. 9d.; less premiums received on issue of 100 ordinary first mortgage debentures, less cost of issue, £401. 16s. 2d.	1,973 16 7
	£122,560 3 4

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY.

The report of the directors for 1897, to be submitted to the ordinary meeting on March 1, states that after charging the interest on the debentures the accounts for the year show a net profit of £61,131. Thirty-nine thousand nine hundred and forty pounds was brought forward from last year, making a total of £101,071. Deducting the interim dividend of 5 per cent., paid in July, amounting to £22,410, leaves £78,661 to be dealt with. The directors propose to distribute a dividend of £1. 4s. per share, absorbing £44,820, which is 10 per cent., or, with the amount already paid, a total dividend for the year of £1. 16s. per share, or 15 per cent., free of income tax, leaving £33,841 to be carried forward. During the year the Company's works have been actively employed in the manufacture of various lengths of submarine telegraph cable and insulated wire for land lines; and the steamships have been engaged in sundry repairing operations. The factories at Greenwich and Wharf-road are in a thoroughly efficient condition, important improvements in the buildings as well as in the plant having been carried out. The Company's steamships have been efficiently maintained, and are in good repair.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Harrogate.—Mr. T. Fawcett invites tenders for the electric lighting of The Coach and Horses, Harrogate. Apply on the premises.

Tadcaster.—Tenders are invited for dynamo and wiring to light Old Brewery, Tadcaster, maltings, offices, etc. For information apply there.

Blackpool.—The Corporation are prepared to receive tenders for the supply and erection of various plant at the Corporation electricity works, for particulars of which refer to our advertisement columns.

Glasgow.—The Corporation invite tenders for the hire or purchase from makers of dynamos and engines, direct-coupled or belt-driven. Tenders by Feb. 28. Full particulars will be found in our advertisement columns.

Cardiff.—Tenders are invited for heating and electric lighting at the new Congregational Church, Richmond-road, Cardiff. For particulars apply to the architects, Messrs. Habershon and Fawckner, Pearl-street, Cardiff.

St. Chamond (France).—Tenders are invited for lighting the town by electricity or otherwise. Particulars are to be obtained from, and tenders addressed to, Municipal Authorities at above place (Department Loire) by March 31.

Braila (Roumania).—Tenders are invited for the electric lighting of the town. The deposit required is £600. Specifications are to be obtained from, and tenders addressed to, the Municipal Authorities at Braila by Feb. 20 (March 4), at 4 p.m.

Alexandria (Egypt).—Tenders are invited for indiarubber tubes, etc., for the Post and Telegraph Department. Specifications may be obtained from, and samples inspected at, the Gabbary Stores, and tenders are to be addressed to the President of the Council of Administration, Cairo, by March 28.

ıa.—The Secretary of State for India in Council announces time allowed for the receipt of tenders by the Chief r for Irrigation, Madras, for the utilisation of water the Periyar Lake has been extended from Oct. 31, 1897 1, 1898.

urne (Victoria).—The Telegraph Department of the n Government Railways are inviting tenders for the f alternating-current transformers and one main switch- Tenders to the Telegraph Superintendent's Office, Spencer- Ielbourne, by March 21.

ıg (Belgium).—Tenders are invited for electric installa- public and private lighting and for power transmission ears, to commence from Feb. 1, 1899. Particulars are to ned from, and tenders addressed to, Municipal Authorities ng, Belgium, by April 1.

ıg (Denmark).—For complete establishment of electric works, etc. Specifications are to be obtained from ts Udvalg for Electricitätsvaerket, Sugförer Edv. Lau. pner (£3. 3s) to be returned on receipt of bona fide tender, lers addressed the same at Kolding by March 24.

ow.—The Corporation invite tenders for the supply of covered cables and accessories for a period of 12 months e of acceptance of offer, and (2) accumulators, equalisers, ncing motor-transformers, motor-driven boosters, and switching apparatus. Tenders by Feb. 28. Full par- will be found in our advertisement columns.

aw.—The Secretary of State for Foreign Affairs has a dispatch from her Majesty's Consul-General at Warsaw g that the municipality of that town are prepared to tenders for supplying the town with electrical power for s of lighting, tramways, etc. Applications should be ed to the President of the town of Warsaw, from whom ars can be obtained.

hagen.—Tenders are invited for the supply of dynamos, lators, etc., for the central station at Frederiksberg. ations are to be obtained from, and tenders addressed to, ksberg Sporveis-og Electricitets-Aktieselskab, Gammel ei No. 140, in Kopenhagen V. Tenders to be endorsed d paa del electriske Anlaeg til Frederiksberg Central- ," and sent in by March 12.

rd.—The Town Halls Committee invite tenders for the wiring of the Broughton Town Hall and the subways of ford Town Hall. Specification of the above and any further ation may be obtained from the Electrical Engineer, Wal- ad, Broughton. Tenders, sealed and endorsed "Electric ," addressed to the Chairman of the Town Halls Com- , to be delivered to Mr. Saml. Brown, town clerk, by 2.

outh.—The Corporation invite tenders for the supply of city meters (alternating current) for the 12 months ending 31, 1898. Specification, with form of tender, may be d by bona fide meter manufacturers or their authorised on application to Mr. John H. Rider, borough electrical er, East-street, Plymouth. Sealed tenders, endorsed tricity Meters," must be delivered to Mr. J. H. Ellis, town Plymouth, not later than March 23.

Pancras.—The Vestry invite tenders for building a brick y, shaft about 240ft. from the foundations. Copies of specifi- , conditions of contract, and form of tender are to be obtained Electricity Department Offices, 57, Pratt-street, Camden N.W., on payment of a deposit of £1, which will be able on receipt of the specification accompanied by a bona ader. Tenders to be sent to Mr. C. H F. Barrett, vestry endorsed "Tender for Chimney," by 12 noon on March 17.

ast.—The Corporation invite tenders for the wiring of the olice cells Chichester-street. Specification, with schedule ts and form of tender, may be obtained on application to ctor A. H. M'Cowen, electrical engineer, Marquis-street, t, on payment of £1. 1s., which will be returned on receipt ona fide tender accompanied by the specification. Sealed n, endorsed "Tenders for Wiring of Police Cells," to be ed at the offices of Sir Samuel Black, town clerk, by 10 a.m. arch 9.

st Ham.—The Council invite tenders for wiring and fitting e following buildings, situated in the county borough of t Ham: (1) town hall and fire station, Stratford, E.; (2) s court West Ham-lane, E.; (3) Corporation stables, Abbey- , E.; (4) fire station, mortuary, and weights and measures n, Barking-road, Canning Town, E; (5) public conveniences, way, Stratford, E.; (6) fire brigade watchbox, Woodgrange- , Forest Gate, E. Tenders by March 8. Full particulars be found in our advertisement columns.

ndon, S.W.—The Secretary of State for War is prepared to e offers in writing, accompanied by competitive designs and ications for the supply of portable electric search-light atus. General particulars as to requirements can be obtained plication, either by letter or personally, to A. Major, director y contracts, War Office, Pall-mall, S W. The offers and must be delivered at the War Office, Pall-mall, London, by April 27, addressed to the Director of Army Contracts, marked on the outside "Designs for Search-Light Apparatus"

t Derby.—The Guardians invite tenders for the following in connection with the lighting of the Mill-road Infirmary: No. 1) two dry-back return-tube boilers, each to 4,000lb. of water per hour; (No. 2) three 50-b.h.p. engines and dynamos, one booster, two feed pumps one r heater, one switchboard, steam, etc., piping, tanks, etc.; (No. 3) one secondary battery of 900 ampere-hours' capacity; (No. 4) wiring of infirmary, administrative buildings, and nurses' home, and cable connections from main switchboards to above buildings. Tenders by March 8.

Coventry.—The Electric Lighting Committee of the Corporation will receive tenders for the supply and erection of the following plant for the extensions of the municipal electricity works: (Section A) engine-house plant—300-kw steam alternator and exciter; (B) separate exciting plant—25-kw. steam dynamo and accumulators; (C) surface-condensing plant—condenser, air-pump, circulating pump, and footplates, etc.; (D) pipework—steam, exhaust, suction, and discharge pipes, valves, oil separator, etc.; (E) switchboards and instruments—main H.T. switchboard, exciter and accumulator switchboards, step-switches, etc. Tenders by March 8.

Egremont (Cheshire).—The Wallasey Urban District Council invite tenders for the following works—viz., (*a*) engine, alternator, and exciter; (*b*) two Lancashire steam-boilers and one water-tube steam-boiler; (*c*) condensing apparatus. Copies of the specifications may be obtained on application to the engineer, Mr. J. H. Crowther, Gas and Water Works, Great Float, near Birkenhead. A charge of £2. 2s. will be made for copy of each specification, to be returned on receipt of a bona fide tender. Sealed tenders, on the form provided for the purpose, addressed to the Chairman of the Gas, Water, and Electricity Committee, and endorsed "Tender for Engine and Alternator," or any other contract, as the case may be, to be delivered at the office of Mr. H. W. Cook, clerk, Public Offices, Church-street, Egremont, Cheshire, by 4 p.m. on March 17. Contractors will be required to enter into a bond with approved sureties for the performance of contract.

Northwich.—The Weaver Navigation Trustees invite tenders for the construction and erection of the necessary electric power plant for lighting and working the new swingbridges at Northwich. The current will be supplied by the Northwich Electric Supply Company, and while the machinery will have to be constructed on the general lines laid down in the specification, and shown on the drawings, the details will be left largely to the discretion of the contractor, who will be expected to supply sufficient information and drawings to enable a decision to be arrived at as to the suitability of his proposals. The specification and drawings may be seen, and all further information obtained, from Mr. J. A. Saner, Engineer's Office, Weaver Navigation, Northwich, on and after Feb 14. Tenders and plans will have to be sent in, marked "Tender for Electric Plant," and addressed to the Clerk, Weaver Navigation Offices, Northwich, on or before March 5.

Shoreditch.—The Vestry are prepared to receive tenders for the following works for one year from March 26 next to March 25, 1899, inclusive—viz., electricity works department—(A) electric cables and sundries, (B) engineers' stores, and (C) ironmongery, tools, etc. Samples may be seen at the Electric Lighting Station, Coronet-street, Hoxton, N. Forms of tender for all the abovementioned articles can be obtained on application to Mr. H. Mansfield Robinson, clerk, Town Hall, Old-street, E.C. Tenders must be sent to the Clerk before 4 p.m. on March 8. Contractors or their agents must attend at the Vestry meeting at the Town Hall, Old-street, on March 8, at 6.30 p.m., and must agree to pay the trades union rate of wages observed at the date of the contract, and to observe the usual hours of labour recognised by the trade. Forms of tender, with any further information, may be obtained from the various departments of the Vestry or from the Clerk.

Watford.—The Urban District Council invite tenders for the supply and erection of the following plant: (Section A) generating plant, water tube boilers and fittings, economiser, feed pumps, injectors, etc., steam alternators and exciters, condenser, oil filter, fittings, etc., steam exhaust, blow-off and sundry pipes, valves, water tank, etc.; (B) switchboard and all connections; (C) overhead travelling crane; (D) conduits and mains for general supply; (E) public lighting and adaptation of existing public lamps; (F) transformers, sub-stations, and switching gear; (G) arc lamps and posts. Tenders may be sent in for any section or sections or for the whole of the sections, but not for part of a section. The ground plan of works, plan of streets, etc., and specifications, with forms of tender, may be obtained at the offices of Mr. W. C. C. Hawtayne, consulting engineer, Mansion House-chambers, 20, Bucklersbury, E.C., on payment of £5. 5s, which sum will be returned on receipt of a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting," must be addressed to Mr. H. Morten Turner, clerk to the Council, at the Council Offices, Watford, and be delivered on or before 12 noon on March 16.

Sophia (Bulgaria).—Her Majesty's Secretary of State for Foreign Affairs has received a despatch from her Majesty's Agent and Consul-General at Sophia to the effect that the Municipality of Sophia have issued a notice inviting tenders (*a*) for electric lighting of the town, town hall, and fire brigade barracks; (*b*) for an electric tramway for the town and surroundings. Only bona fide electrical firms are allowed to tender. Tenders must be in by March 5-17, at 11 a.m. A deposit certificate of the National Bank of Bulgaria of £6,000 must accompany each tender; also documents showing that the contracting firm has already successfully carried out similar works. If up to the 10th-22nd of March, at 10.30 a.m., a proposal of a reduction of at least 5 per cent. per kilowatt-hour of the lowest tender is received, a new adjudication will take place on the same day at 11 a.m. Specifications are to be obtained from the Mayor of the above town (8s. prepaid), where tenders are to be addressed. Further particulars may be obtained, and a copy of the specification and other papers may be inspected, on application at the

Commercial Department of the Foreign Office, between the hours of 11 and 5.

Pembroke (Ireland).—The Lighting Committee are prepared to receive tenders for the supply and erection of the following plant: (Section A) boiler-house plant—Lancashire boilers and accessories, mechanical stokers, feed pump, injector, economiser, electric motor; (B) engine-house plant—high-speed steam dynamos and accessories, oil-filter, steam, exhaust, feed, blow-off, and sundry pipes, valves, feed-water and storage tanks, etc.; (C) overhead travelling crane; (D) Switchboard and instruments; (E) accumulators; (F) underground work—trenching, cables, etc.; (G) public lamps—arc and incandescent street lamps and lamp-posts; (H) meters. The whole bound up in one specification. Tenderers are at liberty to tender for any one section, but not part of a section. Specification, with terms and conditions and forms of tender, may be obtained at the offices of Mr. Robert Hammond, M.I.E.E., the consulting engineer to the township, Ormond House, Great Trinity-lane, London, E.C., on payment of £5. 5s., which sum will be refunded on the return of the specification filled up with a bona fide tender. Duplicate copies of the specification, £1. 1s. each, not returnable. Tenders, sealed, and marked "Tender for Electricity Works," must be addressed to Mr. J. C. Manley, secretary, Pembroke, and be delivered by March 5.

RESULTS OF TENDERS.

Shoreditch.—The Lighting Committee have received three tenders for the construction of a sub-station at Clifton-street, that of Messrs. Wall and Co., amounting to £983, being accepted.

Aberdeen.—The Lodging-House Committee have accepted the offer of Messrs. P. C. Middleton and Co., amounting to £177. 13s. 5d., for fitting up the electric wires for the lighting of the Corporation lodging-house.

Bradford.—The Corporation have accepted the tender of Messrs. Cole, Marchant, and Marley, Bradford, to supply additional condensing apparatus at the new electricity works; the contract price being about £1,600.

Tipperary.—The following tenders have been received by the Guardians for the supply and fixing of electric bells in the workhouse and a speaking-tube connecting the Board-room with the porter's office: D. McCarthy, Tipperary, £33. 5s.; W. F. Deare, Tipperary, £30 (accepted).

Dover.—The Town Council have received the following tenders for compounding the two existing single-cylinder beam engines, with alternative tenders for supplying, fixing, and maintaining new engines in lieu thereof: J. Simpson and Co., Grosvenor-road, Pimlico, S.W., compounding existing engines, £3,650 (accepted); Fleming and Ferguson, Paisley, new engines, £12,500.

Bethnal Green.—The County Council have received the following tenders for work required to enable the painters' shop at the chief station to be utilised as an engine and boiler house for the electric light plant:

R. Harding and Son (accepted)	£107	9	0
J. Outhwaite and Son	117	0	0
D. G. Laing and Son	125	15	0
H. Cooke	166	8	0

BUSINESS NOTES.

Hanley.—The Town Council have raised the salaries and wages of their staff and workmen.

Scarborough.—The site for the dust destructor is still engaging the attention of the Council.

Newark.—The Town Council will not oppose the Bill promoted by the General Power Distributing Company.

Hastings.—The Council are still debating the advisability or otherwise of the proposed electric tramway schemes.

Heanor.—The Council have decided to join other councils in opposing the proposed Bill of the General Power Distributing Company.

British Electric Traction Company.—It is reported that the new issue of £100,000 was subscribed 6½ times over at a premium of 25 per cent.

Belfast.—The Corporation have decided that the extension of the lighting of the Knock and Sydenham districts be proceeded with without further delay.

Wrexham.—The Local Government Board decline to agree with the proposed purchase of Willow Brewery for utilisation as an electric light station, etc.

Huddersfield.—The Electric Lighting Committee have deferred consideration of an enquiry from the Elland District Council for terms of supply to that district.

St. Pancras.—Upon the recommendation of the Finance Committee, the London County Council have agreed to lend the St. Pancras Vestry £22,445 for electric lighting purposes.

Cape Electric Tramways, Limited.—The first ordinary (statutory) general meeting of the above named Company was held on Wednesday, Feb. 23, 1898, at Winchester House.

Shoreditch.—At the last Vestry meeting the Lighting Committee reported that the total applications for current already executed amount to the equivalent of 21,000 8-c.p. lamps.

Nottingham.—At a meeting of the Tramways Committee on the 22nd inst., it was decided to recommend to the Council for adoption in the city the overhead system of electric traction.

Lancaster.—The Electricity Committee have recomme
Town Council to apply to the Local Government Board
tion to borrow £10,000 to extend the electric light undert

Rotherhithe.—Delegates have been appointed to a
conference at the Guildhall as to the desirability of an
being held into the cost and efficiency of the telephone
London.

Bradford.—The Corporation, after consideration of co
with regard to the electricity meters at present in use, have
to adopt a new style of meter, which will cost about £2 each
the style at present in use.

Whitehaven.—The Electric Lighting Committee, it i
stood, have practically completed the acquisition of the
adjoining the central station on the West Strand, with a
extensions which are inevitable.

Appointment Vacant.—The Corporation of the bor
Morley require the services of an electrician-in-charge at
of £65 per annum, and a junior at £52 per annum. Pa
will be found in our advertisement columns.

**Telegraph Construction and Maintenance Co
Limited**.—The transfer books of this Company will b
from 21st inst. to 1st prox. inclusive, preparatory to the
of dividend to all shareholders on the register on 21st inst

Chelsea.—The Vestry have instructed its Lighting Co
to consult experts and report on the whole question of
of the Chelsea Electricity Supply Company's undertak
the possibility of obtaining a provisional order for a m
supply.

Ilkeston.—At a special meeting of the Town Cou
Council decided to fall into line with the local authoritie
district in opposing the proposals of the General Power Dist
Company to supply electricity to places within a radius of
from Worksop.

Basingstoke.—A proposition that the Urban District
take into consideration the advisability of applying to th
of Trade for a license or provisional order to supply el
within their district is under consideration by a special co
of the Town Council.

Stourbridge.—The British Electric Traction Company
to take the line *viâ* the Stewponey, but the Council (or
section of them) wish to have it constructed across th
farm, perhaps considering the aroma therefrom would
inducement to people to travel.

Newington.—The Vestry have approved of the plans
erection of the electric lighting and generating station in
street, Walworth, referred to in our last issue, and res
invite tenders for the erection of the work, and to app
London County Council for a loan.

Wolverhampton.—At the last Town Council meeting th
from the Markets Committee with respect to certain in
alterations and improvements, electric light, etc., at th
market and the market hall in Cheapside was presented.
meeting of the Council will be held to consider the report.

Mexico.—The central station of the Mexican Electric
Limited, has been so far advanced that the lighting of th
Mexico was commenced on the 14th inst., and proved a
success. The installations for the private lighting and th
of electrical power will probably be opened in the cours
summer.

Rowley.—The proposed provisional order promoted
Midland Electric Corporation for Power Distribution h
agreed to by the Council subject to the Corporation ente
an agreement to lay mains in three years' time in Hig
Cradley Heath, Halesowen-road, Old Hill; and Hig
Blackheath.

Bath.—At the last meeting of the Surveying Committe
stated, upon the suggestion that where new lamps we
placed the committee would consider whether they could
electric light instead of gas, the Electric Light Co
would be glad to consider any proposal to extend th
lighting by electricity.

Barnsley.—The Council have adopted the report of the
Light Committee published in our last, and the works
proceeded with if Mr. Miller's report is satisfactory. The
surveyor is to prepare and submit to the committee plans
erection in Beckett-square of the buildings required
proposed electric lighting works.

Eastern Telegraph Company, Limited.—An extra
general meeting of the shareholders of this Company will
at Winchester House, on March 3, at 2.30 p.m., for the p
confirming, as a special resolution, the resolution passe
extraordinary general meeting of the Company held on
the 15th inst., already reported by us.

Blackburn.—For some time past the work of prepa
plant in connection with the electric traction for the B
tramways has been going on apace at the electricity works,
street, and now we are informed that in the course of
fortnight outside operations will be commenced. It is
that the electric cars will be running next July.

Mansfield.—The Mayor reported to the Town Coun
last meeting having attended a meeting at Nottingha
respect to the Electrical Power Distributing Bill, and a
in opposition to the scheme was submitted and read
Deputy Town Clerk. The feeling of the Council was
factious opposition should be offered to the Bill.

mersmith.—At the last meeting of the Vestry, the com- ecommended the construction of two new sub-stations, one idge-road (Lime-grove) and the other in Goldhawk-road phen's-avenue), at an estimated cost of £250 each, to include ;, connecting up, and equipment.

-on-Trent.—At the last meeting of the Town Council it lved to support the application of the New Mutual Tele- yndicate, Limited, to the Postmaster-General for licenses, ib-committee was appointed to interview the manager of ional Telephone Company with regard to terms for a tele- ervice at the various Corporation departments.

aston.—The electric light has been introduced into St. ne's Church, the supply of energy being taken from the supply company's mains at a pressure of 220 volts. The planned and superintended by Messrs Henry Lea and Bennett's-hill, the contract having been let to Messrs. The light was used for the first time on Sunday last, and n great satisfaction.

owell.—At the last meeting of the Parish Council it was that the following resolution be sent to the Rural District "That the Crickhowell Parish Council is of opinion that ges for the use of gas, both for public and private pur- extremely high and a burden to the parishioners, and they desire that your Council will intervene in the matter r introducing the electric light or by erecting new gas-

—At the last meeting of the County Council, a recom- n was adopted that application should be made to the vernment Board for sanction to the borrowing of £26,822 sions of the county asylum, so as to accommodate 150 l beds, and for addition and the centralisation of the t, and power generating plant; £16,300 for buildings, chimney and increase of boiler-house; and £10,522 for

tems.—The Highways and Sewering Committee have construct a new main sewer and a subway for gas and ains, electric cables, etc., along Church street, at an l cost for the new sewer of £2,200, and that of the pro- bway for the gas and water mains £2,660, and it was that the latter scheme be adopted subject to an agreement Gas and Water Committees in respect to an apportionment t.

nd Guilds Technical College, Finsbury.—A special five lectures on "Electricity Meters" will be delivered J. Steele, Esq. A.I.E.E., on Thursday evenings from lock, beginning on March 3. The fee for the course is llabus of the course and programme of the College may ed at the College, Leonard street, City-road, or at the ce of the City and Guilds Institute, Gresham College, ll-street, E.C.

rham.—A special meeting of the Rotherham Town Council held with regard to the Bill of the General Power ing Company. A resolution was carried authorising n to the Bill, which seeks powers to construct works, oduce and supply electrical energy within the county of nd parts of the counties of Notts, Lincoln, and West f Yorkshire, the expenses of such opposition to be charged borough fund.

den.—The District Council, as a committee of the whole have under consideration a report recommending the ity of directly appointing an electrical engineer for the nd carrying out of the electric light works, after the design submitted to a high authority, with his ultimate retention ouncil as a permanent official for the maintenance of them. f thanks was recorded to the officials of the towns recently y the committee.

own.—The Town Commissioners have discussed the ment of an independent engineer to make plans and tions for the electric lighting scheme. The Chairman y should at first apply to the Board of Trade for on to lay down the cables. He also thought that what- gineer would be appointed should not be interfered with other body, and there should be no competition against egards private lighting.

gate.—At the quarterly meeting of the Town Council a as read from the New Mutual Telephone Syndicate, l, asking the Council to pass a resolution in the interests and industry for the fullest development of the telephone. they might have competition and facilities might be l to municipalities to control the telephone within their own s. A motion to support the same was agreed to unani- . An additional main cable for High Harrogate and extensions have been decided upon.

y of London and Brush Provincial Electric Lighting ny, Limited.—The directors of this Company have decided mmend payment of a dividend on the preference shares for months ended Dec. 31 last at the rate of 6 per cent. per less income tax, carrying forward £10,000 to next account. nsfer books and register of members will be closed from 4th prox., both days inclusive, preparatory to the payment dividend on the preference shares for the six months ended l. The ordinary general meeting will be held on 14th prox., n., at Winchester House.

wall.—At the monthly meeting of the Town Council a as read from Mr. E. J. Gunn, solicitor, Dingwall, agent proposed electric lighting company, stating that it was ble for the promoters of the company to comply with the request of supplying the specification of the proposed works, as the formation of the company must precede the preparation of the specifications. When the time arrived for carrying out the works, opportunity would be given to the Council to see the specifications; the Council had ample obligation that light of the specified illuminating power would be supplied. The Council approved generally of the terms in Mr. Gunn's letter.

Ramsgate.—At the last meeting of the Gas and Water Committee the subject of electric lighting was introduced, and letters were produced from many of the leading tradesmen and professional men in the town, stating it was their wish that electric light should be introduced into the district. Whether the Corporation or a company should do this would be a matter for future consideration. During the debate, the Town Clerk, in answer to the question how they stood with regard to the order, as they had decided to oppose the application of the promoters, said there would be a public enquiry at Ramsgate, and if the Council thought fit to modify their opposition they could then do so.

Yarmouth.—The *Yarmouth Independent* says, with reference to the purchase of the Gorleston tramways and the conversion of the stables into a generating station, as reported by us in our last: "One of the principal features in the scheme will be the utilisation of the surplus electric power for supplying the public and private electric lighting for Gorleston and Southtown—that is to say, if satisfactory arrangements can be made with the Corporation for such a purpose. Should the preliminary details be satisfactorily concluded between the Yarmouth Council and the tramways company, it is purposed to proceed to carry out the electric tramway scheme with every possible dispatch, even should the negotiations with the 'bus company fall through."

Salford.—At an adjourned meeting the following resolution was passed: "That the report of the Highway, Paving, and Tramways Committee be adopted, and that, as recommended by that committee, the Corporation shall, at the expiration of the present lease of the Salford tramways to the Manchester Carriage and Tramways Company, undertake the future working of such street tramways within the borough on the electric overhead wire system, and also to demand and take all the tolls, it being understood that the current for the working of the cars shall be supplied by the Electric Lighting Committee. Further, that the Highway, Paving, and Tramways Committee be instructed to prepare estimates of the cost of carrying out the scheme."

Southwark.—The St. George's Vestry have received a report of the Electric Lighting and Dust Disposal Committee recommending as follows: that application be made to the Board of Trade for a provisional order under the Electric Lighting Acts, 1882 and 1888, to enable the Vestry to supply electrical energy throughout the parish; that the requisite notices be given, and the deposits made for the above purpose at the times mentioned in the rules made by the Board of Trade with respect to applications for provisional orders; and that the Board of Trade be informed that it is the intention of this authority to lay down the necessary plant for the purpose of supplying electrical energy immediately the provisional order has been confirmed by Parliament.

Sheffield.—We understand that the solicitor acting for the Sheffield Electric Light and Power Company has acknowledged receipt of the resolution of the Parliamentary Committee fully acquitting the directors of improper secrecy or conduct in connection with the negotiations between the company and the Corporation, and has intimated that as soon as the Council confirm this resolution the directors will give all possible assistance to facilitate the transfer of the undertaking to the Corporation. At a meeting on the 23rd inst. the Council confirmed the special minutes of the Parliamentary Committee, in which was submitted a resolution exonerating the directors of the Electric Light and Power Company from any charges of unfair dealing that may have been brought against them.

Deal.—At the instigation of the Mutual Telephone Syndicate, the Council have adopted the following resolution: "That in the interests of trade, industry, and social convenience, it is essential that the fullest possible development of the telephone system in this country should be promoted. That in order to effect such development, the charge must be considerably reduced. That the best and cheapest service can only be secured by competition. That as the Treasury minute, dated May 23, 1892, provides as a matter of general policy, 'that competition shall not be prevented,' this Chamber earnestly requests the Postmaster-General to grant licenses to any municipalities or companies which comply with the requirements of the Treasury minute. That they desire particularly to support the claims for licenses made by the New Mutual Telephone Company, Limited, of Manchester, and by the Corporation of Glasgow."

Stirling.—Prof. Kennedy's report states that the maximum theoretical hydraulic horse-power of the water coming into Stirling from No. 3 reservoir is 26, from No. 4 reservoir 7, and from the Touch compensation water 7—in all, 40 theoretical hydraulic horse-power. The actual amount of this horse-power in the mains at Stirling for supplying light would not be more than half of this amount, however, and it might be considerably less. The total horse-power provided in his steam-power estimates was 320, which would, after making all allowances, deliver at least 233 e.h.p. at the lamps. The total cost of this plant would be between £8,000 and £8,500. If they put down turbines and dynamos at Touch they would have to spend about £1,600 at least, and probably considerably more, for the sake of delivering about 15 h.p. at the lamps. The capital expenditure on this power would therefore be about £107 per horse-power at the lamps as against about £35 for the steam plant.

Leamington.—Mr. Robert Hammond has issued a report to the members of the Electric Lighting Committee of the Corporation on the proposed electric undertaking. In regard to the position of the Corporation towards the Midland Electric Lighting Company, Mr. Hammond points out that it would be to the interests of the Corporation to arrange that the present works should continue their operations until the whole of the present consumers are transferred to the new mains of the Corporation. Mr. Hammond, in dealing with the financial prospects of the Corporation's undertaking, says that if 15 000 lights could be obtained the cost of production would not be more than 2·4d. per unit, and if the charge to consumers were 6d. per unit, plus meter rents and less discounts for prompt payments and to large consumers, there would be a profit on working account of £3,000 per annum, sufficient to provide for interest and the sinking fund on a capital of £50,000. By the operation of the sinking fund this capital would be entirely wiped off at the end of 25 years.

Dundee.—Under the scheme recently approved by the Town Council, workmen are now busily engaged making the necessary arrangements for the electric lighting of the central thoroughfares of the city. Eighteen large arc lamps are to be erected. Each of the 18 standards weighs 1¼ tons, stands 23ft. 6in. high, and costs £36. They are of the Edinburgh type, manufactured by Mackenzie Bros., of that city. The lamps are exactly 20ft. from the ground, and the light to be emitted will be equal to an actual 1,600 c.p. For maintenance £324 per annum will be required, being at the rate of £18 each. This expenditure, however, would be considerably greater were it not for the fact that it has been decided to extinguish half the lights each night at 11 o'clock, the practice to be followed being to put out each alternate lamp after the hour mentioned. It is expected that the whole installation will be completed and in efficient working order by about the middle of March, and to this end Mr. Tittensor, the electrical superintendent, is pushing forward matters with all possible dispatch.

Llandudno.—A special meeting of the Urban District Council was held on the 22nd inst. for the purpose of considering a report of a special committee on the proposed application to Parliament by a company for an Act to make a tramway to the top of the Great Orme's Head. The committee recommended that Clause 57 (2) of the Tramway Act should be amended in the proposed new Act so as to read as follows: "The Council may if by resolution passed at a special meeting they do decide within six months after the expiration of a period of 28 years from the passing of this Act, and within six months after the expiration of any subsequent period of seven years, or within three months after any order made by the Board of Trade under the Tramways Act, 1870, by notice in writing require the company to sell, and thereupon the company shall sell to them their undertaking upon terms of paying a price equal to 28 years' purchase of an aggregate dividend calculated at the rate of 4 per cent. on the total capital of the company for the time being actually invested in their undertaking." The report was adopted.

Barnet.—An offer of a firm of electricians, suggesting that the Urban District Council should transfer to them its electric lighting provisional order, is under the consideration of a committee. The firm undertakes to observe the provisions of the order, and to commence a public supply of electricity within a fixed time. The Council is to have the option of purchasing the concern at any time upon payment of such a sum as would return a total of 10 per cent. per annum upon the capital of the undertaking, after taking into account the profits earned from time to time. The committee have also to report upon a letter from the Mutual Telephone Syndicate, of Manchester, stating that the necessary capital had been raised for the purpose of competing with the National Telephone Company. As it was desirable to apply without delay to the Postmaster-General for a license, the syndicate hoped that public bodies would give their support to the movement. Failure to break down the present monopoly would mean, it was stated in the letter, a perpetuation, during the next 13 years, of an inefficient service at about double the cost for which a thoroughly efficient one, with all modern improvements, could be provided.

Dublin.—At a special meeting of the Municipal Council, the report (referred to in our last) on electric traction within the city was adopted, and the deeds embodied in the report were sealed. The formal agreement entered into between the three tramway companies—viz., the Dublin United Tramways Company, the Dublin United Tramways Company (1896), and the Dublin Southern District Tramways Company—and the Dublin Corporation provides that the companies named will not, without first receiving the sanction of the Corporation in writing, enter into contracts with the proposed Clontarf and Hill of Howth Tramway Company, or with any other body or person, for the supply of electric current which would pass through the streets of the city. In consideration of which the Corporation waives their objection to the employment of electric current, which may be generated at Clontarf for the haulage of the cars and the lighting of the same, and the lighting of the standards or posts of the Dublin United Tramways Company wherever it may be found necessary to do so from Annesley Bridge to Nelson's Pillar, always provided that the said three companies shall undertake not to employ this current for any other purpose whatsoever save those above mentioned, without first receiving the sanction of the Corporation, in writing, thereto, so as not to interfere with the city's electric lighting order.

Swansea.—At the last quarterly meeting of the City Borough Council, a resolution to proceed with the provisional lighting order and consult Mr. Manville was carried by a large majority. The erection of a dust destructor is to be discussed at another m The Mayor said the proposed agreement with the tramw pany (referred to in our last issue) provided that the pro the tramways and improvements company should be hand to the British Electric Traction Company, with all its ass liabilities. The "tramways" and the "improvements" c had separated as far as their balance-sheets were concerned capital of the tramways company would be £8,742, in £10 £984 preference shares of £10 each, plus debentures of £8,7 £1,650 and £10,500 debentures. The capital of the improv company was £8,742, of £10 each, and the loans on debent £12,860. 18s 4d. The whole of the amount paid to the tra company by the electric traction company was £53,550, a also undertook to pay off debentures of £10,400, and al liabilities of the company; and these latter could be spec be £600 to solicitors, £700 to the engineers, and £3,500 directors. So that to the tramways company they paid £ and to the improvements company they undertook to p mortgages of £12,860. 18s. 11d., and £1,082. 15s. in cash. mortgage, £3,000 is due from the improvements to the tra company. There was no doubt that these terms would be san by the shareholders.

Brighton.—The Corporation Lighting Committee, a meeting last week, passed the following resolution: "T condition attached to Mr. Arthur Wright's appointm manager of the Corporation electricity works, requiring give his whole time during business hours to the perform the duties assigned to him be waived, and that he be perm future to take private practice as an advising electrical e to other corporations, or to companies or persons outs borough." The same committee recommended that Mon road be lighted with 10 seven-ampere arc lamps, displac existing 20 incandescent standards, at an estimated capi of £550, and a capital outlay on the electricity account o Preston-road by 10 seven-ampere arc lamps, 110 yards apa placing the existing 21 incandescent standards, at an es capital cost of £550, and a capital outlay on the electricity of £435; that certain other existing lamp-posts be fitted w 20-c.p. lamps in Newcastle lanterns in place of the pres 10 c.p. lamps, at a total cost of £207. 10s. 9d. The co also recommended that application be made to the Local ment Board for sanction to borrow a sum of £1,190 on the fund account, for a period of 15 years, and a sum of £705 electricity works account for a period of 25 years, to de cost of the work. After considerable discussion a vote wa upon the matter, and it was decided that the report sh referred back to the committee.

Glasgow.—It has been known for some time that the Corporation have purchased ground both on the north sid river and also on the south side for extensive new el supply works. Since Mr. Chamen's appointment as engineer he has been busily engaged in the formatio scheme for these works, and having now grasped the situ does not intend to let the grass grow under his feet, a urging his committee to immediately place extensive orde sees that in order to cope with next winter's load the outp Waterloo-street station will be quite inadequate, notwith the assistance afforded by the two large new sub-stations a accumulators in getting over the "peak." A start is to before the end of the month with clearing the site for station on the north side of the river at Port Dundas a hoped that temporary plant will be able to be at once la of such a nature that it will be able to be eventually ut the permanent station; a temporary building will, if ne be erected, and the permanent building proceeded with as as possible. The Port Dundas station will be admirably as regards both its coal supply and water for condensing p it being placed on the banks of the Firth and Clyde Canal, t naturally be ample water for the latter purpose, and owin formation of the ground the buildings will be able to be so that the coal store placed over the boiler-room will be on with the canal, so that the supply can be directly delive it from the barges. There is also a rail service to supplem water service if necessary. The south side station wil conveniently placed as regards railway facilities, althoug not have the double advantage of water as well.

Bristol.—The electrical engineer (Mr. Faraday Proct has visited several cities during the past week, presented h to the Sanitary Committee on the 21st inst., and certain h negotiation with the tramway company were considered. end it was agreed to submit them to the company as a negotiation with a view to the committee recommen Council to sanction the extensions of the tramways and t electricity. These points are to be submitted to the co subjects for negotiation, but without prejudice in case th tion of the Corporation to the Bills proceeds. The heads of arrangement are: (1) The company to agree employé shall be employed for more than 60 hours p (2) The right to use electric traction to be confined t tramways to be specified in the Bill, and the system o traction to be used to be also specified. (3) The Corpo have the right, but not to be compellable, to purchase the power station. If the power station is purchased, the are not to have the right of jointly using it for working t not purchased by the Corporation. The company are have the right of the joint use of posts, wires, tram other works connected with tramways purchased by the tion for working or conveying electrical energy to tramways not purchased by the Corporation. (4) The p

d overhead wires to be subject to the approval of the ion without appeal, as in the Act of 1894. (5) The power rporation over the execution and maintenance of works in ts to be the same as in the Act of 1894. (6) The company ohibited from supplying electric current to other com- r persons within the city. (7) The Corporation to have to use the company's posts for supporting public electric (8) The company not to be entitled to require the Cor- to supply them with electricity. (9) No alteration to be the dates at which the Corporation's power to purchase tramways will arise. (10) The date at which the Corpora- wer to purchase the power station and proposed exten l arise to be the same as for the present horse tramways. itional capital required by the company shall be raised in be sold by auction. (12) Where owners may be required rts only of scheduled properties, the onus of proof that can be severed from the remainder of the properties with- rial detriment thereto shall be on the company. (13) e arrangements be made for payment to the Corporation ual sum and for reduction of fares.

r.—At the last meeting of the Board of Works a letter from the Board of Trade to the effect that the Board's jecting to the application of the Brush Provincial Electric Company for the lighting of the district had been and also forwarding a copy of the following letter to m the company: "The County of London and Brush l Electric Lighting Company, Limited, Moorgate-court, to the Assistant-Secretary of the Board of Trade. Sir,— ng to our application for a provisional order for the east ricts of Whitechapel, Bethnal Green, and Poplar, I am with regard to Poplar that there is strong opposition on rd to the Board itself putting the provisional order it olds into effect, and that they have been advised by an engineer, who has been called in to report upon e matter, that they could not expect to make a profit running of a station for the district for some otwithstanding that they are opposing the grant ler to this company, who were prepared to lay mains strict within statutory period of two years from date of tion of the order.—I am, sir, yours obediently, A. J. engineer and manager." In the course of the discussion, ey said he thought they ought to take action at once. d an amendment to the effect that the report as brought e committee be sent to the Board of Trade. It was a arkable thing that the report had been able to get into s of the company. Who was the traitor? Was there any of the Board who felt that its interests were best concerned ging to the company the committee stages? The letter t have been sent by the company unless they had received rmation. He viewed it with a very great amount of sus- Ir. Valentine said that the letter of the company stated that taking would not pay for several years. He must contradict ause Mr. Williams said that in the second year of working ld make a small profit after repaying capital and interest vorking expenses. It was a most scandalous thing that e stages of any proceedings should leak out. It seemed to a system was going on with the Brush Company which t be tolerated by that or any other Board. The company persistently touting members to get them to support l there was no doubt that that touting had influenced because the company had got the expert's report. The nt was carried. The committee recommended that the e surveyor for the erection of an engine-house, with a at the north end of the destructor buildings be approved, Messrs. Goddard, Massey, and Warner be instructed to the work at their tender of £394. 10s., and that a 30-h.p. substituted for the 8-h.p. engine provided in the at a difference in price of £78, and placed in the engine- his was agreed to.

y.—At the meeting of the Vestry last week the report l in our last issue) of the joint committee recommending y to relinquish the lighting order, and to enter into a or a combined scheme of dust destruction and electric was introduced and discussed. Mr. Whitemore pointed amberwell had parted with its lighting order, and was g back the undertaking, and in buying back they were 33 for every £100 of capital laid down, and 5 per cent. ole capital besides. Instead of borrowing £250,000 now, of Hackney would have to borrow £335,000 in 12 years' ear after year they had been talking about doing the hemselves, and getting rid of the contractor, and now going to enter into a contract for a dozen years. Let mittee have the courage of their convictions, say they do the work, and leave it to others who could. They l down the contractors with guarantees as other parishes . Or if need be—although he did not favour that hey could retain the order, but not the responsibility. ld have a capable manager and make him responsible for Mr. Denham pointed out that the Vestry's loans had crept £89,000 in 1894 to £153,000 in 1898, and if they were at that rate the County Council would not accept their For four years not a penny profit would be made on the but in the meantime £24,000 would be saved on the The outlay would be at least a quarter of a million, and men had not sufficient time or knowledge to carry out a this kind. The committee of 30 went thoroughly into ion, and with one exception were of opinion that to do themselves would be fraught with many dangers and . Mr. Kyffin said their order was very nearly gone six years ago, and they had saved £5,000 a year by keeping it till now, and they could dictate the terms on which they would part with it. He believed this was too big a job for the Vestry properly to undertake. He had spent a lot of time trying to find out the results of the Shoreditch scheme, but Shoreditch did not know. It was easy to show a profit by charging the Scavenging Committee 3s. a load for the burning of refuse. A company would be able to provide the light in such a way that the Vestry could not attempt to do. In the scheme before them the committee had made every safeguard that foresight could suggest. The light, in quality and cheapness, and the engines, would have to be up-to-date and kept up-to date. Mr. Hosgood said he had with great regret come to the conclusion that the Vestry was not competent to put the order into proper execution. Party spirit so dominated the appointment of committees that round men were constantly put into square holes. Mr. Wells Holland did not think the terms of the committee's report were advantageous enough to the Vestry. There were clauses in it which no reasonable man would accept. They ought not to bind themselves for 12 years. Inventions might be brought out which would revolutionise the whole thing. Something might be said for the other schemes rejected by the committee, and he moved that the whole question be considered in committee by the whole Vestry. After some further debate, the Vestry by 60 votes to 10 rescinded their old resolution to keep the electric lighting order in their own hands, and decided to discuss the situation in committee at a subsequent meeting.

PROVISIONAL PATENTS, 1898.

FEBRUARY 14.

3645. **Arrangement for transmitting telegraphic messages in contrary directions simultaneously over a single wire.** Max Bernstein, proprietor of the firm of Joh. Fredr. Wallmann and Co., 111, Hatton-garden, London. (Complete specification.)

3695. **Improvements in magnetic circuits or parts of circuits.** Ernest Wilson, 64, St. John's-park, Blackheath, London.

FEBRUARY 15.

3731. **Transmitting drawings, pictures, sketches, and the like by telegraph or telephone.** James Miller Martin, 115, St. Vincent-street, Glasgow.

3749. **A method of oxidation and bleaching by means of electrolysis.** John Gustaf Adolf Rhodin, 17, St. Ann's-square, Manchester.

3783. **A new or improved method of and apparatus for generating electricity.** Charles O'Donnell Barrows and Charles Henry Smith, 70, Chancery-lane, London.

3796. **Improved means for displacing, dispersing, or extinguishing arcs formed in breaking electrical circuits.** Sidney Howe Short, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

3802. **Improvements in or connected with electrical conductors.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

3805. **Improvements in electrical switch apparatus.** Thomas Herbert Minshall, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

3806. **Improvements in apparatus for making and breaking electric circuits at predetermined times.** Hans Otto Swoboda, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

FEBRUARY 16.

3838. **Improvements in electric accumulators.** Alfred Webb, 4, Corporation-street, Manchester.

3841. **Improvements in the method of and means employed for connecting electric glow lamps to main conductors.** Friedrich Palm, Penny Bank-chambers, Halifax. (Complete specification.)

3850. **Improvements in holders for electric glow lamps.** William Geipel, Frederick M. T. Lange, and William Rossi Saltrick, 68, Victoria-street, Westminster, London.

3902. **Improvements in devices for protecting electric incandescent lamps from the action of moisture.** Henri Beau and M. Bertrand-Taillet, 45, Southampton-buildings, Chancery-lane, London.

3905. **Improvements in suspension devices for electric and other lamps.** Paulin Gabriel Pasquet, 45, Southampton-buildings, Chancery-lane, London.

3924. **Improved fastening for the heads of electric glow lamps.** Johann Kremenezky, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

3925. **Improvements in electric safety fuses and lamp connections.** Henry Charles Gover and John Miles Moffat, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

FEBRUARY 17.

3960. **Improvements in electric switches.** John Williams and William Miller Walters, 4, Clayton-square, Liverpool.

3993. **Improvements in or relating to electric ignition devices for internal-combustion engines.** Alfred Julius Boult, 111, Hatton-garden, London. (La Société Nouvelle des Etablissements Décauville Ainé, France.)
(Complete specification.)

4002. A new and improved telephone support and an automatic circuit controller. Luis Duque, 20, High Holborn, London.

4004. Improvements in switches for altering the speed and direction of revolution of electric motors and for altering the course of the electrical current round field magnets. William Rowland Edwards and Septimus Felix Beevor, 65, Chancery-lane, London.

4046. Improvements in or connected with the distribution of electricity on the three-wire system with the neutral wire at earth potential. Alexander Bewicke Blackburn, Wilfrid L. Spence, and Ernest Sherwood Woollard Moore, 47, Lincoln's-inn-fields, London.

February 18.

4058. Improved means for use in connection with electric and other suspended lamps and the like for raising and lowering same. Edmund Bamford, Charles Seddon, and Sam Jackson, Market-place, Huddersfield.

4075. Improvements in methods and apparatus for electro-thermally treating materials more particularly for the manufacture of calcium carbide and other carbides and the reduction of ores. Hudson Maxim, 377, Norwood-road, London.

4114. Improvements in telegraphic apparatus. Frederick William Golby, 36, Chancery-lane. (Bruno Fidler, Austria.)

4121. Improvements in telephones, telegraphs, and other forms of electrical signalling. Ernest Wilson and Herbert Godsal, King's College, Strand, London.

4139. Improvements in or relating to electric arc lamps. Cecil Milton Hepworth, 111, Hatton-garden, London.

February 19.

4150. Improvements in electrical accumulators or storage batteries. Thomas William Allan and Allan and Adamson, Limited, 154, St. Vincent-street, Glasgow.

4176. Improvements in the distribution of electricity over electric railways. Michelangelo Cattori, 37, Chancery-lane, London. (Complete specification.)

4202. Improvements relating to the displayal of words or devices by electrical illumination. Walter John Hubert Jones, 18, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1897.

2478. Electric battery cases to render the contents of the cells unspillable, to facilitate the introduction of the electrolyte into the cells, to enable the level of the liquid to be easily ascertained, and to facilitate inspection of the interior. Fabbro.

2582. Means for use in operating successively two or more electrical switches or sets of switches. Parker.

3526. Apparatus for the electro-deposition of metals. Hartley. (Zingeem, partly.)

4755. Electromotor-propelled vehicles. Morris and Salom.

5224. Electric arc lamps. Gaynor.

6305. Telephone installations and apparatus therefor. Siemens Bros. and Co., Limited. (Siemens and Halske.)

18871. Electromagnetic contact systems for electric railways. Grunow, McElroy, and McElroy.

20521. Electrical signalling apparatus and circuits. Owen, Williams, and Donaldson.

24382. Generation of multiphase currents and multiphase electromotive forces from single-phase currents and single-phase electromotive forces and to the utilisation of the same. Tischendörfer.

26306. Switching gear for transformers, reactance coils, storage batteries, and the like. The British Thomson-Houston Company, Limited, and Hobart.

26657. Device for guiding the carbons in electric arc lamps. Holsten und Elektrische Bogenlampenfabrik Naeck und Holsten Gesellschaft mit Beschränkter Haftung.

26660. Electric arc lamp. Holsten und Elektrische Bogenlampenfabrik Naeck und Holsten Gesellschaft mit Beschränkter Haftung.

27129. Electrolytic method of and apparatus for saponification. Nodon, Bretonneau, and Shée.

28480. Application of electric propulsion on railways and tramways. Vojácek.

28921. Switching apparatus for transformers for alternating-current systems of electrical distribution. Oxley.

28926. Electric switch apparatus and electric wire binding posts. Gilbert.

29585. Methods of and means for regulating alternating-current dynamo-electric machines or distributing systems. The British Thomson-Houston Company, Limited. (Rice.)

29588. Method of and means for braking alternating-current induction motors. The British Thomson-Houston Company, Limited. (Rice.)

29835. Electric heaters. Porter.

TRAFFIC RECEIPTS.

Dover Tramways.—The traffic receipts for the week ending February 19 were £104. 13s. 9d. The total receipts for the year 1898 are £747. 17s. 11d. The mileage open at present is 2½ miles.

Bristol Tramways.—The traffic returns for the week ending February 11 were £2,296. 3s. 9d., compared with £2,120. 15s. 5d. for the corresponding period of last year, being an increase of £175. 8s. 4d.

Birmingham Tramways.—The traffic receipts for the week ending February 19 were £3,525. 19s. 7d., as compared with £3,322. 13s. 7d. in the corresponding week in 1897, being an increase of £203. 6s. 0d.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended February 20 amounted to £1,320, as compared with £1,320 in the corresponding week of the previous year, the two amounts being identical.

City and South London Railway.—The returns for the week ended February 20 were £1,051, compared with £1,044 for the corresponding period of last year, being an increase of £7. The total receipts for the half-year amount to £8,565, compared with £8,717 for the corresponding period last year, being a decrease of £152.

South Staffordshire Tramways.—The traffic returns for the week ending February 18 were £607. 1s. 5d., as compared with £620. 6s. 8d. in the corresponding week of the previous year. The aggregate receipts for the year are £4,145. 0s. 2d., as against £3,932. 17s. 2d. in the corresponding period of the previous year.

S.D. United Tramways.—The traffic receipts for the week ending February 18 were £375. 7s. 0d., as compared with £484 1s. 8d. in the corresponding week in the previous year, being a decrease of £98. 14s. 8d. The number of passengers carried was 65,874 in 1898 and 73,303 in 1897. The aggregate returns up to date are £2,863. 12s. 8d., as compared with £2,947. 10s. 8d. last year, being a decrease of £83. 18s. 0d. The mileage open is the same as last year—viz., 8 miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	[illegible]
Brush Company, Ordinary	2	[illegible]
—— Non. Cum., 6 per cent. Pref.	2	[illegible]
—— 4½ per cent. Debenture Stock	100	[illegible]
—— 4½ per cent. 2nd Debenture Stock	100	[illegible]
Callender's Cable Company, Debentures	100	110-113
—— Ordinary	5	9-10
Central London Railway, Ordinary	10	10½-11
—— "	6	[illegible]
—— Pref. Half-Shares	1	[illegible]
—— " "	5	[illegible]
Charing Cross and Strand	5	[illegible]
—— 4½ per cent. Cum. Pref.	5	[illegible]
Chelsea Electricity Company	5	[illegible]
—— 4½ per cent. Debentures	100	[illegible]
City of London, Ordinary	10	[illegible]
—— Prov. Cert.	10	[illegible]
—— 6 per cent. Cumulative Pref.	10	[illegible]
—— 5 per cent. Debenture Stock	100	[illegible]
City and South London Railway, Consolidated Ordinary	100	[illegible]
—— 4 per cent. Debenture Stock	100	[illegible]
—— 5 per cent. Pref. Shares	10	[illegible]
—— " " " '96	10	[illegible]
County of London and Brush Provincial Co., Ordinary	10	[illegible]
—— 6 per cent. Cum. Pref.	10	[illegible]
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	[illegible]
—— 5 per cent. Debentures	—	[illegible]
Edison and Swan United Ordinary	3	[illegible]
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	[illegible]
Electric Construction, Limited	2	[illegible]
—— 7 per cent. Cumulative Pref.	2	[illegible]
Elmore's Copper Depositing	1	[illegible]
Elmore's Wire Company	2	[illegible]
W. T. Henley's Telegraph Works, Ordinary	10	[illegible]
—— 7 per cent. Preference	10	[illegible]
—— 4½ per cent. Debentures	100	113-117
House-to-House Company, Ordinary	5	[illegible]
—— 7 per cent. Preference	5	[illegible]
India Rubber and Gutta Percha Works	10	[illegible]
—— 4½ per cent. Debentures	100	[illegible]
Kensington and Knightsbridge Ordinary	5	[illegible]
—— 6 per cent. Pref.	5	[illegible]
London Electric Supply, Ordinary	5	[illegible]
Metropolitan Electric Supply, Limited, Ord. No. 101-50,000	10	[illegible]
—— " " " 50,001-82,500	10	[illegible]
—— 4½ per cent. First Mortgage Debenture Stock	100	[illegible]
National Telephone, Ordinary	5	[illegible]
—— 6 per cent. Cum. First Pref.	10	[illegible]
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref., No. 1-119,234	5	[illegible]
—— " " " 119,235-250,000	5	[illegible]
—— 3½ per cent. Deb. Stock, Red.	100	[illegible]
Notting Hill Company	10	[illegible]
Oriental, Limited, £1 shares	1	[illegible]
—— £5 Shares	5	[illegible]
—— £4½ shares	4½	[illegible]
Oriental Telephone and Electric Company	1	[illegible]
Royal Electrical Company of Montreal	—	[illegible]
—— 4½ per cent. First Shares Mortgage Debentures	100	[illegible]
South London Electric Supply, Ordinary	2	[illegible]
St. James's and Pall Mall, Limited, Ordinary	5	[illegible]
—— 7 per cent. Pref.	5	10-11
—— 4 per cent. Deb. Stock, Red.	100	107-110
Telegraph Construction and Maintenance	12	[illegible]
—— 5 per cent. Bonds	100	[illegible]
Waterloo and City Railway, Ordinary	5	[illegible]
Westminster Electric Supply, Ordinary	5	[illegible]
Yorkshire House-to-House	5	[illegible]

NOTES.

ss Telegraphy.—The Italian Government red a Marconi plant to be used as an experiment r ship "Messagero."

Exhibition.—It is proposed to join to the nal Exhibition of Commerce to be held in Lyons th to May, 1898, a special exhibition of acetylene ars. A local committee is to be the governing

ic Light in Railway Carriages.—We d that the railway carriages on the East and nction and Stratford-on-Avon, Towcester, and unction Railways are now lighted by electricity. ight is much appreciated by the travelling public, of the system on which it is effected are not yet

irmingham Electrical Exhibition.—An nd general trades exhibition is to be opened at y Hall, Birmingham, on the 19th inst., by the r of that town. The exhibition has been well by electrical firms, judging from the well-known he list of exhibitors sent to us. It will remain April 30.

tion Internationale d'Automobiles.—An named as above will be opened in Paris on 898, in the Tuileries Garden, and will remain July 3. The exhibition is organised by the Club of France. Full details of the admission, c., can be obtained from Messrs. F. Thévin and 4, place de l'Opéra, Paris.

al Engineers (Royal Engineers) Volun- e headquarters of the corps, at 13, Victoria-stminster, are now open during the week excepted) from 11 to 4, between which hours rmation in reference to the corps can be given . On Monday and Thursday evenings, at 8 p.m., s officers are in attendance for the purpose of applications and enrolling recruits.

tional Photographic Exhibition.—H.R.H. of Wales has graciously consented to open the at the Crystal Palace. Intending exhibitors are te that the date of opening of the exhibition by Highness has been fixed by him for Monday, and not Wednesday, April 27, as originally . The latest date for the reception of exhibits ction will, therefore, be two days earlier than tated.

Chamber of Commerce. — The annual the Chamber will take place at the Hotel Cecil y, March 22, at 6.30 for 7 p.m. The chair is to by Sir Albert K. Rollit, D.C.L., LL.D., M.P., In addition to the above, we are informed that nd last monthly dinner of the 1897-98 session lace on Tuesday, March 15, at 6.15 for 6.30 p.m., rocadero Restaurant, Shaftesbury-avenue, W. ct for discussion will be "Adulteration and ntation."

ooks.—Messrs. Whittaker will publish very e following books: "Alternate Currents in translated from the French of Loppe and by F. J. Moffett, A.I.E.E., electrical engineer to of Lagos, West Africa; "Electrolytic Methods of translated and adapted from the German of Dr. B. by J. B. C. Kershaw, F.I.C.; and a volume on hy," by S. Bottone, a well-known writer for on kindred subjects; and the same publishers will also issue, in conjunction with the General Electric Company, "A Popular Guide to Commercial Telephony," by M. Byng, M.I.E.E., and F. G. Bell.

Merchandise Marks. — A memorandum has been recently issued by H.M.'s Customs in regard to the marking of goods imported for home consumption. This memorandum gives detailed illustrations of the methods of marking which will meet the requirements of the Customs, and will remove many of the anomalies which have formed the subject of protests from time to time. The first paragraph of the memorandum is as follows: "Foreign goods imported into the United Kingdom which do not bear any marks whatever, either on the goods themselves or on the packages or wrappers containing them, are not required to bear any qualifying statement or indication, such as 'Made abroad,' 'Made in Germany,' etc."

Australian Land Lines.—From a Reuter's telegram we learn that a joint deputation from the Melbourne Chamber of Commerce and the Melbourne Chamber of Mines waited recently upon the Hon. J. G. Duffy, the Postmaster-General, and strongly protested against the delays to which cable messages were liable. The deputation furnished evidence that these delays were almost entirely traceable to the South Australian lines. Mr. Duffy, in the course of his reply, announced that the Eastern Telegraph Extension Company had offered to extend the proposed new Cape cable from the Cape to Mauritius, and thence to Albany and Adelaide, provided the Australian Governments would agree to renew their present subsidy of £32,400 per annum for 20 years.

The Conductivity of Aluminium.—Some careful tests as to the effects of impurities on the electrical conductivity of aluminium have recently been communicated to the Franklin Institute. The results show that with 1½ per cent. impurity the specific conductivity of the aluminium was 55 per cent. that of copper. If the impurity were decreased to 1 per cent., this figure rose to 59 per cent., while for ½ per cent. of impurity the conductivity is 61 per cent. that of copper. Finally, with absolutely pure aluminium, a specific conductivity of 67 per cent. that of copper is obtained. So if the price of this new metal of commerce, when pure, can be reduced until it costs one-third less than copper, it can compete commercially with this latter metal as an electric conductor.

Great Gooseberries in March. — The Vienna correspondent of the *Daily Chronicle* says a wonderful invention has just been made in Austria, consisting of an apparatus called "Fernseher" (far seer). The apparatus renders visible an object, with all its colours, situated "round the corner" at a great distance, by means of the transformation of light waves into electric waves. In other words, the machine conducts optic appearances along electric wires and renders them visible in another place. The owners of the patent which has been taken out are boasting that it will be the *clou* of the Paris Exhibition. The inventor is a poor Polish village schoolmaster named Szczepanik. The apparatus is in the shape of a telephone box. We wonder the correspondent survived the introduction to a gentleman with such a name.

Municipal Authorities as Traders.—The case of the Leicester Corporation *v.* Warren Hill, reported elsewhere in this issue, raised the question as to whether corporations are entitled to enter into trade competition with the ratepayers. The judgment is not to hand at the time of writing this, but the London County Council has had no doubt on the subject. If the Progressive party are returned to power by yesterday's election, and allow their extreme members free head, Leicester will be put into the

shade in such matters. Even then the legal question may be raised, and perhaps the law may stem the tide of municipal bakeries, clothing establishments, and general stores, established to cater more for the employés than the community. This last stigma cannot be cast at the Leicester Corporation, as their electricity department is conducted on thorough business principles.

Railway Accidents as a Profession.—The *Street Railway Review* gives the following account of a professional contortionist who has chosen for a vocation the dislocating of his hip joint when the circumstances are favourable to securing a verdict for damages against a railroad company. Some months ago a man fell on the platform of a passenger station near Indianapolis, having caught his heel in a crack, and the result was a dislocated hip. The company settled for £440 and attorney's fees, and extended courtesies in the way of furnishing transportation for the man and his nurse, etc. Quite recently a similar accident occurred in Virginia, and a claim of damages presented. The man had been seen the day before hunting about the platform for a hole in which to catch his heel, and a traveller who was present recognised him as the victim of the "accident" in Indiana. The Virginia road did not settle his claim, and the Indianapolis company want his present address.

The Phonograph.—The Edison-Bell Company are introducing into this country some new and cheaper types of phonographs, which they hope will be taken up commercially. Much stress is laid by the company upon the penny-in-the-slot machines, for which there seems wide possibilities ahead, and upon the new clockwork motor instrument. A representative of the *Financial News* has ascertained a further point of interest in respect to these phonographs. That is that the new machines are to be largely used for the purpose of teaching foreign languages. Already a complete course in French has been transferred to cylinders by a member of the Academie Française, and these cylinders will presently be obtainable for 4s. or 5s. by students who prefer to perfect themselves, both in grammar and pronunciation, with the aid of the phonograph. Schools in future will thus be able to dispense with the services of the foreign-language master, as far as pronunciation is concerned, and no doubt the phonograph would keep the boys in almost as good order.

An Electric Fog Signal.—An electric fog signalling apparatus is being tried on the railways at Wimbledon and Clapham. The *Daily Mail's* description of the apparatus is as follows: "It consists of a large wheel placed at the side of the line near a station, and containing round its circumference 32 barrels, each holding two cartridges. A second rail laid down near the apparatus is depressed by the passing train, and in its turn pulls back and then releases a hammer, which strikes a cap and explodes the two cartridges. By means of a rod attached the machine is automatically reset when the train has passed, and the hammer returns into position to fire the next barrel. It is connected by electricity with the signals, and the man in the box can set or disconnect it by touching a button. The disconnection is worked by a magnet, which draws down the hammer and prevents firing. Moreover, a telltale in the box shows the signalman exactly when the train fires the cartridges, and if the line is clear he presses a button, which rings a gong close to the engine. The train can thus proceed without loss of time, and often without slackening."

A Large Dynamo.—What our New York namesake says is the largest generator for electric traction work ever built is now under construction at the works of the General Electric Company at Schenectady. When finished, it will be installed at the Logan-street Station of the Louisville Railway Company, Louisville, Ky. On account of its la[rge] diameter the armature of this generator cannot be tra[ns]ported over the railroads in its completed state, either e[nd] or on its side. The generator will, therefore, be built in Louisville. The completed machine will have 22 pol[es,] an output of 2,400 kw., or 3,000 h.p., and will be driv[en] at a speed of 75 revolutions per minute by a 4,000-h. cross-compound engine, to be furnished by the Allis Co[m]pany. The generator will be constructed to stand an ov[er]load of about one-third, so that the capacity in case emergencies may equal 3,200 kw. The principal dimensi[ons] of the machine will be as follows: diameter of field fram[e,] 19ft.; width of field frame, 4ft. 1in.; diameter of armatu[re,] 12ft. 9in.; diameter of commutator, 9ft. 3in.; diameter [of] shaft, 2ft. 3in.; total weight of armature and commutat[or,] 83,000lb.; width of armature, 5ft.; width of commutat[or,] 21in.; total width of generator, 77in. The total weight [of] generator complete is 174,000lb.

Lightning and Earthquake Damages to Buil[d]ings.—The increase in height of a building increases [the] liability of its being struck by lightning, and also [the] danger from earthquakes. The use of steel in [such] buildings tends to prevent damage from both the a[bove] causes, and the question is well taken up by Mr. W. L. Jenney in this month's number of *Cassier's Magazine*. [The] author points out the obvious fact that the iron framew[ork] acts as a most efficient lightning conductor. Thus, w[hen] the Home Insurance Building in Chicago was struck [by] lightning on one corner some time ago, the only inj[ury] was the displacement of a few bricks where the light[ning] entered the cornice to reach the steel, through which [it] was taken off harmlessly. There is no record of [a] person ever having been injured by lightning when i[n a] steel or iron frame building, or when on board of a stee[l or] iron ship. Earthquakes, also, are less likely to throw d[own] buildings with steel frames, although the stone or b[rick] facing may be damaged. The author advises putting additional ribs in the partitions and external walls to wh[ich] the masonry is firmly anchored. In such a building [in a] locality liable to earthquake shocks all the partitions sho[uld] be of concrete, with steel rods embedded in it.

Electrical Mining Machinery.—An interest[ing] visit of mining and electrical engineers was paid to [the] works of Messrs. Ernest Scott and Mountain last Satur[day] to inspect a typical collection of electrical mining pl[ant.] The greatest novelty, perhaps, was an electrical coal-cutt[ing] machine for the Digby Colliery Company, fitted wit[h a] disc of a suitable diameter, to cut 4ft. 6in. deep, actu[ated] by a motor of 30 h.p. Another exhibit that attra[cted] much attention was the set of 14in. by 18in. three-th[row] mining pumps (high lift), capable of delivering 500 gall[ons] per minute against a head of 750ft. This was for [the] Arniston Coal Company, as were two 200-unit generat[ors] for driving pumping machinery, and three 80-h.p. mot[ors] for the same purpose. Great interest was taken in [the] electric locomotive, fitted with a 25-h.p. motor and suit[able] for a 2ft. gauge. It is suitable for mines or for contract[ors'] underground work. It is the fifth or sixth (the oth[ers] being in use) built for Messrs. Walter Scott and Co., [the] Newcastle contractors, in connection with their work for [the] London Central Railway Company. There were two ventilating fans, with motors combined, capable of deliv[er]ing 10,000 cubic feet of air per minute at 4in. air press[ure,] and a number of electrically-driven mining pumps [were] on view.

Municipal Electric Lighting.—Mr. James Rossiter sends us a pamphlet, of which he is the auth[or,] entitled "Notes on Municipal Electric Lighting." [We can] hardly understand the general purport of the pamph[let]

which consists of a few statements on the general condition of municipal electric lighting and a series of tables. The tables are averages of the cost of generation, capital expenditure, units sold per annum, etc., of different-sized municipal stations. As the author justly states, the figures are the means of a number of station results after abnormally high and low returns have been left out. No difference is made between direct-current and alternate-current stations, and, of course, the local conditions are merged in taking the average. The results are interesting, but perhaps more interesting than useful. They tend to discourage the establishing of small stations, as the average figures show that such small stations must charge high prices at first to make the works self-supporting. The figures given, as price per unit, are higher in this case than those obtained at, at least, three stations we know of where even on lower prices profit is earned. In fact, while recognising the author's careful work, we object to averages for such purpose, and consider it better to work to single returns where local conditions agree.

Electricity v. Incandescent Gas.—On numerous prospectuses issued recently we have learned that the incandescent gaslight had taken the lead, both for interior lighting and street lamps, and that competition on the part of electricity was impossible. Paper facts are not conclusive, and hence we do not undertake here to criticise the figures in these prospectuses, but only assure those persons responsible for drafting them that they will not see many happy days if they are held responsible for the fulfilment of the figures given. The incandescent gas mantles give a good light when new, but this does not last, and we have noticed a most marked falling-off in the staying power of the mantles lately. Perhaps, however, the evidence of change over from one system to the other is wanted. In this respect the Army and Navy Stores lead the way. For many years they have been lighted throughout by incandescent gas burners, and the directors should know the advantages as well as the disadvantages of the system. Still, they are now discarding these burners in favour of the enclosed arc lamps, with a marked benefit in the appearance of the various departments. We understand that the atmosphere after a busy day is also much purer. This instance is one of many; and central-station engineers and the public are now beginning to reap the benefits and profits derived from larger outputs and decreased prices per unit.

Electric Signalling on Railways.—A correspondent to the *Times*, writing on American railways, says that the English signalling system is on the whole unequalled in the world may be taken for granted. But our system grew up a generation back, and rests on the employment of human agents, who may be stupid, or go to sleep, possibly even may strike. The Americans began later, and, profiting by our experience, have begun, so to speak, on a higher plane. At all the most modern termini—in Boston, Jersey City, Philadelphia, St. Louis, and many more—our heavy levers, needing a strong man to pull them over, are replaced by small handles like bell handles that a lady could move with finger and thumb. The actual movement of the switches and signal arms is done by compressed air, which is released or cut off by an electric current. Out in the open country, where there are no complicated shunting movements to be effected, the signalmen disappear altogether, and the trains as they pass over the line signal each to its successor with unfailing precision that (*a*) the section in front is occupied, or (*b*) that the section in front is clear, but the section next but one occupied, or (*c*) that at least two sections ahead are clear. It is commonly, and, the correspondent believes, truly reported, that the Board of Trade is, to speak within the mark, not anxious to encourage automatic signalling here. In view of the great perfection which the system has now reached in America, and the rapidly rising expenses of English railways, it is, he submits, high time that in the public interest this obstructive attitude should be modified.

Self-Charging Electric Traction.—It is well known that to succeed nowadays in any branch of industry means specialisation and hard work. This, carried to excess, tends to brain fag and incoherence. The British Motor Company appears to be suffering in this way, judging from their recent notice to the public. From this we learn that "During the last two years the British Motor Company has been steadily acquiring the latest forms of motor and electric traction now so much in vogue abroad. A great change in the systems of traction in this country is rapidly approaching. The British Motor Company, Limited, have recently acquired the self-charging system of the well-known electrician, Mr. L. Epstein. Epstein's system entirely does away with all the great disadvantages hitherto felt as to the charging of accumulators for tramcars, electric cabs, and other vehicles. By this system the celebrated Daimler motor is brought into requisition, and while the electricity ignites the charge in the motor, the motor charges the electricity. The motor is a very small one, and is kept as a valuable reservoir of power, which can at any time be turned on to charge the electric accumulators." The advantages of this self-charging apparatus are said to be "no noise of a steam-engine," "no smoke," "no steam," "no cinders nor sparks," "no accumulator losses." This seems very funny as accumulators are used, and we note that "no smell" is not claimed. Seriously, it would be better to get a technical man to write such notices, as the above disjointed and ill-worded description is not creditable to the company. The fact that "the motor charges the electricity" is perhaps the best example of what we mean.

Eagles as Short-Circuits.—The *Journal of Electricity* of San Francisco contains an account of a fault on a 10,000-volt transmission line caused by a pair of eagles. It occurred on the line of the San Joaquin Electric Company, which was so badly shorted that the supply was interrupted. Linemen were sent out at once to ascertain the cause of the trouble and repair the broken circuit, and after having gone over several miles of line, they reached a mountain top about five miles from the power-house, where the break was discovered. As to the cause of it, there were found the scant relics of two grey eagles, consisting merely of one skull and four feet and parts of legs. Two of the talons were clutched tightly to the line wires in literal realisation of the grip of death, while the remaining two feet and parts of legs were free from the marks of roasting, or rather from the burning to a crisp, that characterised the feet that clutched the wires. Not a vestige of the bodies or feathers of either bird, nor of the head of one of them, could be found. Another interesting specimen was found, however, which shows the terrific heat of the electric arc. The soil along the pole line at the place indicated consists of pure granitic sand, which, wherever the wire touched the ground, had become melted into glass, and even a piece of quartz had been fused and run in together with the glass. The circumstance of the accident suggests a theory for it, as evidently the two eagles alighted on different legs of the three-phase circuit within close proximity to each other, that they actually came into contact, and in so doing formed a short-circuit, which not only incinerated the eagles, but threw the wires into short-circuit and burned them off.

Berly's Universal Electrical Directory, 1898.—The new red book has just reached us, and we note that

it is larger than ever. We have not counted the names and addresses collected, but the compilers, who ought to know, assure us that the British alphabetical section now contains about 9,918 distinct names, the Continental section 7,872 names, the American section 4,080 names, and the Colonial section 1,924 names. This makes a grand total of 23,794 entries, and gives approximately 1,136 names of individuals and firms more than were contained in the book for 1897. For simplicity and facility of reference the directory is divided into four groups—namely, British, Continental, American, and Colonial—which are again subdivided into alphabetical and classified sections. A geographical section is given for the British engineers, which, under the heading of the various towns, gives the electrical engineers in those towns and their addresses. This will make the directory a useful travelling companion for those few engineers who like to look up their electrical brethren when on holiday. If there is a fault to be found with this new directory, it is that the trades are too much classified, and hence well-known contracting firms do not appear under some headings. This, we know, is a financial matter, but take, for instance, the classified trade of "Catalogues and Price-Lists." We find on reference that these are not printers of the commodity in question, and that apparently only nine electrical firms issue catalogues. Again, under "Central-Station Contractors," we miss a number of well-known names. We think it would be advisable to restrict the headings, and to thus get the entries more complete under each. The present volume is a most useful one, and well worth the price charged (6s.).

Wave Motors.—The idea of harnessing the waves of the sea is not new, but the difficulties arising from a rough sea are not easily overcome. The *Street Railway Review* publishes details of some experiments which have been carried on in California to determine the merits of various wave motors. The installation was made at a point on the ocean beach three miles north of Redondo, and about 18 miles from Los Angeles, to which has been given the name Potencia. A wharf 26ft. wide was built out to a distance of 350ft., at which point the swells usually begin to break, and three motor floats placed at the other end. The energy of the waves is utilised by means of floats, which operate vertical hydraulic compressors, or pump cylinders, which are in turn connected with a large storage pressure tank of heavy steel. The movement of the waves raises and lowers these floats, and in doing so pumps fresh water from a small reservoir into the pump cylinders, and forces it into the storage pressure tank, where by compressing the air contained in the tank the water becomes subjected to a very high pressure. It flows out of the tank through nozzle, and impinges upon the buckets of a Pelton waterwheel, by which is driven the dynamo or other machine to be operated. From the waterwheel the water flows back to the reservoir from which it was originally taken. The accumulated pressure in the pressure tank exerts itself upon the pump pistons, so as to offset the weight of the floats tending to draw such pistons down; the result is that, during storm periods, the floats ride upon the crest of the waves and are not permitted to drop into the trough of the sea. Mr. Wright is the first inventor to overcome this difficulty with wave motors, which has heretofore been considered insurmountable. By reports of tests made on 16 consecutive days in December last, during which the condition of the sea and weather varied from calm to stormy, and the number of waves per minute from three to eight, the power developed varied from 2·3 h.p. to 3·5 h.p. per float; this is the power developed at the waterwheel. It is stated that the variations in the power developed we to varying conditions under which the motor was The cost of these works are not given, but enginee have examined the plant report that properly const floats might be relied upon to develop 5 h.p. each.

The Formation of Ozone.—Messrs. W. A. stone and W. T. Evans read a paper before the Ch Society on the 17th ultimo on "Observations Influence of the Silent Discharge of Electricity on spheric Air." They found that when air is submitted action of the silent discharge it first contracts to a r able extent, and then re-expands rapidly until it nearly occupies its original volume. The residue con trace of nitric peroxide. The following are some chief conclusions arrived at from a study of the phenomena. Oxygen, when diluted in nitrogen, as air, yields a very large proportion of ozone; 80 to cent. of the oxygen present may readily be ozonised presence of moisture, and if great care be taken as as 98 per cent. of the oxygen may be converted into If the ozonising of the oxygen be not pressed too f nitric peroxide will be formed, but at a certain which probably coincides, or nearly coincides, wit point at which the amount of ozone is at its maxi nitric peroxide is formed. In the presence of nitri oxide, ozone is rapidly destroyed by the silent disc and its destruction is accompanied by a consid destruction of nitric peroxide. The presence of vapour promotes the formation of ozone, but retard of nitric peroxide. It was found to be impossib ozonise the oxygen of air in the presence of a tra nitric peroxide. About 13,300 volts were used a spark gap in this experiment. In answer to a que Mr. Shenstone said one could not be sure that no acid had been formed when the nitric peroxide disapp in the presence of water, but this could hardly occurred with the dried gas, and the behaviour of and damp gases seemed to correspond. Moreover gas was always remeasured after the ozone had destroyed, and the amount of permanent contraction di support the idea that the nitric peroxide had been t considerable extent converted into nitric acid. W indebted to the *Proceedings* of the Chemical Society f above abstract.

New York Lighting.—The following interesting are from the *Electrical World's* summary of the a report of the Edison Electric Illuminating Compa New York. The ratio of operating expenses, incl both station and general expenses, but not depreci charges, to gross station earnings, is 49½ per cent against 52 per cent. for the previous year. The dec in the cost of current reported in the previous yea been continued. The economy obtained from the pany's engines—non-condensing—has been such as to surprise among electrical engineers. During the co year it is proposed to further increase operating econ by running the large direct-connected engines as densing engines by the aid of condensing and water co apparatus to be installed at both the Duane and Tw sixth-street stations. In order to broaden the field o company, the directors thought it wise to lower prices and insure increase in value for the securities rather than inc the rate of dividend. Accordingly, a wholesale rate for buildings based on the electrical unit of the kilowatt was adopted, which has successfully met the compe of isolated plants. Discounts for long-hour averag of lamps have been extended during the last part o year to monthly bills of £12 or more instead of £5 heretofore, which, it is expected, will cause many custo

been using gas and electricity to replace the gas by electricity. The adoption of the enclosed ias greatly stimulated arc lighting on the low-rstem. The number of low-tension arc lights sed during the year from 3,225 to 4,775. Two and eighty-five street lamp-posts of special and sign were installed during the year, and the has been asked to place about 300 more during the ar. The number of customers on Dec. 31, 1897, i, an increase of $11\frac{1}{2}$ per cent. for the year. The f incandescent lamps was 346,723, an increase of nt. The number of arc lights 4,775, an increase r cent. The number of motors (horse-power) n increase of $21\frac{1}{2}$ per cent. Total equivalent 96,370, an increase of $21\frac{1}{3}$ per cent. The high-mpanies operated under the supervision of the mpany had on their station service Dec. 31, 1897, candescent and 2,426 arc lights, and 16 h.p. in The mileage of the underground mains on Dec. 31 79 miles net. The net increase of the system in uptown and downtown districts was 12·46 miles.

ning Water-Power Plants.—Mr. Mark A. on Dec. 14 last, read a thoroughly good treatise sed government of water-power plant before the section of the Franklin Institute. He commenced of the early attempts at governing. These he devices that would slowly move the wheel gates great a change was perceptible in the speed of Such a device was called a governor until the engineer of recent years discovered that his r was safer if he ignored entirely the so-called el governor. He describes the following accident r pipe about 3,800ft. long, used to carry water outlet of a reservoir on a mountain top to the se on the San Joaquin River. The head in this 1,410ft., and the pipe was made amply heavy for dinary strains that come in in the manipulation of r. Before the plant was ready for actual operation at the bottom of the pipe was accidentally opened, a 4in. stream of water to escape. The pressure hich ordinarily showed 610lb. per square inch, 0. The valve was then quickly closed by the , when the pressure-gauge pointer ran up to —*i.e.*, 1,000lb. per square inch. Immediately this was a great writhing in the pipe lines, n a rupture at a point 700ft. above the power-It seems that the top section of the pipe r horizontal, and that the column of water l at the bend at the end of this section. The the top section then moved, and the collision it and the water left in after the valve was sed the rupture. In this instance all thought of g by varying the flow was abandoned, and the f water shifted on and off the wheel as required. or proceeds to consider how safety can be attained, ses the use of large flywheels on the revolving that energy is stored so that gradual changes l are obtained. The quantity of flywheel equired with definite sudden alteration of load is y the author by S in the following formula:

where the time necessary to add power to over-

e increased friction in penstock, plus the time y to add power to overcome the inertia of the l flow, plus the time necessary to add power for the l, is represented by T. The power necessary to the increased friction, plus the power necessary to e the inertia in giving increased velocity to the plus the power necessary to carry the increased load at speed, is represented by L. The variation allowable in speed in terms that are a fractional part of normal speed is represented by F.

Rail Bonds.—Perfection has not as yet been reached by a long way in the matter of rail bonds for completing the return circuit of electric tramways and railways past the joints, which the want of a continuous rail still inflicts upon the engineer. Some are good, and when put in carefully and well looked after, they will last for almost as long as, say, one-quarter the average life of a good steel rail itself. Other bonds have been nothing but a nuisance since they were first devised. Development in the design of bonds does not strike one as having been very rapid, and in many respects we are not practically much further advanced than the soldered iron-wire stage. Of course, the bonding requirements are different for tramways and for railways. The latter, having their joints more or less exposed, are best bonded underneath the fishplate by one or other of the flat copper types with copper heads secured by rivets to the rail webs, or by such a device as the "plastic" bond, which is well spoken of and has good qualities, the chief drawback to its use being the fact that its joint surface depends to some extent upon the ordinary fishplate bolts. The latter, therefore, do double duty: they secure the fishplates and tighten up the bond joint. No good engineer likes to make one set of bolts fulfil two purposes like this, and the slacking back of fishplate fastenings ought not to affect the excellence of rail bonding. Probably the most used of all bonds for tramway work is that known as the Chicago, but this has its drawbacks, too. The German form of it is in some respects superior, inasmuch as no holding-up tool is required, the steel plug being driven in on the same side of the rail as the bond itself. But the head of this bond ought to be split and made with a shoulder to fit into the hole in rail web, otherwise a careless workman, with a plug slightly too large, may easily crack the head and loosen the bond hold. The careful annealing that these bonds require in manufacture, after the ends are upset, must add considerably to the first cost. The general run of bonds fastened by soldered sleeves, sleeve plugs or channel pins, spring caps, or screw nipples are all more or less unmechanical, and without any real excellence of electrical contact. Even the solid copper riveted bond is more likely to work loose than those of the Chicago type; and the only one with screwed nut joint that possesses any special merit is the bond now being used on the Metropolitan Traction Company's conduit lines in New York. Provided that security is given for the nut to be locked (and there ought to be no difficulty in this), a bond of this form has decidedly more advantages and is of a better mechanical type than any yet brought out. There is no hammering required or other rough treatment of metal essentially somewhat brittle, and provided only that the first cost can be kept down, this bond ought to prove much superior to those of the Chicago type, especially when large currents pass along the line, and large bonds are therefore required. The labour of closing up a heavy Chicago bond is very considerable, and usually two are inserted at each joint, where one of the taper screw-plug type would suffice. The question of a protecting coat of paint upon rail bonds—often advocated but seldom used—(we have seen bare bonds put down only a few weeks thickly covered with verdigris round the joints), and also the question of welding or casting rail joints are too extensive and important to take up just now; but it would be well for every tramway manager to remember them and post himself upon every detail concerning these matters. We shall hope to help him in this as time goes on.

NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

[*Copyright.*]

LXXXV.

Before quitting the subject of afluidic accumulators, the method adopted by M. Lambotte, of Brussels, should be noticed. This inventor mixes finely-powdered oxide of lead with the ordinary dilute sulphuric acid, until the latter acquires the consistency of a thick syrup; so that the cell may be laid on its side for some minutes without any loss of electrolyte. The elements are of the grid form, with adherent active material. The non-adherent oxide does not, it is stated, take part in the reactions; and the internal resistance of the cell is but little diminished. It is evident, however, that a slow conversion of oxide of lead into sulphate must occur; and there seems to be no reason why sulphate, instead of oxide of lead, should not be used in the first instance. It has been proposed to make a trial, on a tramline in the vicinity of Charleroi, of accumulators mounted on this system. My own experiments have, however, led me to the conclusion that a pasty electrolyte, within which any evolved gas becomes imprisoned, is but ill-adapted to the purpose in view, and that far better results are obtained with a granular absorbent, through which the electrolyte can move with comparative freedom.

It may be mentioned also that M. Hurteaux has used as an absorbent for the acid electrolyte a substance known as *cofferdum*.

LXXXVI.

Density of current, or current in fractions of an ampere per square inch or square centimetre of surface (either positive or negative), is a very important consideration in connection with storage batteries. As, in the case of very porous or irregularly corroded electrodes, it is often impossible to arrive at the real extent of metallic surface, and as this, moreover, may be very different in the two electrodes, it is generally both convenient and necessary to take the cross-sectional area (a) of the prism of electrolyte between two plates instead of the metallic surface of one of the latter. Thus, calling n the number of plates* in a cell or battery of given construction, the expression for density of current is—

$$\Delta = \frac{I}{a(n-1)}.$$

But in some cases, where the area of metallic surface can be ascertained, it is interesting to know the density of current in relation to this surface (s), which then replaces (a) in the above formula.

The practical importance of this question of density, as well as most of the data hitherto obtained in relation to it, are both set forth in the following correspondence:

Office of the Engineer-in-Chief, G.P.O. (West),
London, E.C., Sept. 13, 1897.

D. G. Fitz-Gerald, Esq.,
94, Loughborough-road, Brixton, SW.

Dear Mr. Fitz-Gerald,

Secondary Cell Working.

I wish to find out, if possible, the proper density of current per square inch or per square centimetre of plate that will charge an accumulator with the greatest advantage. What rule do you follow with your cells, and has the result been arrived at by theoretical considerations or decided by experience? If you can give me any information on the point I shall feel obliged.—Yours faithfully, (Signed) W. H. PREECE.

Sept. 16, 1897.

Dear Mr. Preece,—Referring to your letter of the 13th inst., I do not think that your question as to the best density—*i.e.*, the highest safe density—of current in charging can be answered either *ex cathedrâ* or categorically.

The safe density depends partly on mechanical conditions (adherence, cohesion, porosity), partly on electrical conditions (conductivity), and partly on electro-chemical conditions ("foisonnement" or increase of volume).

If the active material is very porous, and also deficient in conductivity, it becomes charged from beneath—outwards from the support, and is readily detached from the lat charging current is sufficiently strong to evolve metallic surface. When the contrary conditions be difficult to detach the active material from the with a current that will rapidly evolve gas from the active material. In this case the limit of dens economic considerations only.

Taking as unit of density the ampere per squ maximum safe density in the case of the E.P.S practically found to be somewhat less than ·040, t density of the maximum safe discharge curren found to be about 14 per cent. higher than the m charging current.

In the case of the E.P.S. (E) cell the maxim density was ·046, and the maximum safe charge about ·041.

Reckenzaun, in his automotric tramcar work, us current density of ·055 and a maximum density of cells were very much overworked.

The Electric Construction Corporation directed t to charge with a density of ·026 only.

In the case of the Epstein cell, neglecting the of surface produced by grooving, it has been clai and even ·103, are safe densities of current.

In the case of the Tudor cell, neglecting th surface by grooving, a current density of ·27 can The real density, however, is about ·038. Latt probably been exceeded.

The I.E.S. Company, with their A. 11 cell, able to charge and discharge with current densitie ·12. My own experience tends to show that wit an increasing proportion of the "active mater ineffective.

Personally, I have had no experience of the Fa which appears to be an imitation of, but an impro the I.E.S. cell.

On the Paris tramlines they have been working from ·056 to ·194; but, at the latter rate, at least, plates quickly deteriorate.

I know of a battery, with grids holding a lithano material, which can certainly be charged and disch injury with a current density of ·207, and whi withstand currents of much higher density.—You

DESMOND G. FI

Penrhos, Carnarvon, Sept

My Dear Fitz-Gerald,—I am very much oblig your letter of yesterday's date. It gives me all th I wanted. I had no data by me, and found mysel determine the best current to charge up some ba "Blot" cells I have down here. I used a densi sectional area of fluid, and found it worked very They are 200 ampere-hour cells, and 600 ampere- density desulphated and charged them splendidl now in excellent order. . . .

We want to prevent sulphating when cells are id down here have been idle for seven months :—Si

(Signed) W. I

LXXXVII.

Density of current, as may be supposed, inf great extent the rate of discharge of a storage l the ratio $\left(\frac{I}{W}\right)$ of current to weight. Indeed, that the capacity of a plate varies as its wei latter as its thickness, then Δ and $\frac{I}{W}$ tend equivalent values, varying as the reciprocal of (of discharge. Thus, if

a = the area of (one side of) a plate;
n = the number of plates;
t and t = the thicknesses respectively of the negative supports—supposed to sheet lead;
τ and τ_1 = the thickness of the layers of p spongy lead active material respec
I = current in amperes;
C = capacity in ampere hours,

the capacity of a cell will vary as

$$\tau a(n-1) = I + \theta = \Delta a(n-1)\theta,$$

bearing in mind, however, that the apparent capacity increases in practice less rapidly than rapidly than θ in the last expression. The we of a given specific gravity in the cell will capacity.

* Two terminal surfaces, the equivalent of one plate, are inactive, leaving $n-1$ active plates.

g the containing box or recipient, the weight uld be

$$+\frac{n+1}{2}t+(n-1)\tau k+(n+1)\tau_1 k_1+(n-1)\tau k_{11}\Big]$$

tants k and k_1 allow for the differences in vity, and k_{11} should give a concrete value to rying as the weight of peroxide active material).

; the value of n to be very considerable, the etween $n+1$ and $n-1$ may be regarded as We may further simplify the expression by and by assuming that the weight and capacity f given area (a) varies simply as its thickness. rive at a simplified approximate value for the orage cells—viz.,

$$W = a\,n\,t\,(1+k).$$

varies as $\Delta\,a\,n$ approximately. Consequently, arge may be expressed as

$$\frac{I}{W}=\frac{\Delta\,a\,n}{a\,n\,t\,(1+k}=\frac{\Delta}{t\,(1+k)}.$$

tes of a given thickness, the rate of discharge approximately as the density of current.

also perceive, without any algebra, that when of current may safely be augmented we may weight of an accumulator of given capacity. ce, the rate of discharge may safely be doubled, re the area ($a\,n$) of the supports, whilst doubling ses (τ and τ_1) of the layers of active material. lan is adopted, however, we may soon reach a especially when the vertical dimension of the ge—at which their conductivity is insufficient. this objection and to allow of the use of very ts, I have found it necessary to devise a system contact; each contact discharging a compara- l area of surface. A more difficult problem, ength succeeded in solving to my own satisfac- protect the thin lead supports, in the case of e element, from the corrosion which otherwise heir destruction within a very limited period.

t object with the skilled constructor should be plates which, without any adventitious aid, will h rates of discharge without disintegration and active material. With the spongy-lead element has been successfully carried into effect by nufacturers, though I have found nothing to s produced by the electro-deposition of metallic plain or perforated lead supports—the deposited suitably consolidated during the process. In f peroxide plates of the Planté type, the same been very successfully realised, as in the case of elements of this description. In the case of oxide plates, however, I know of only one case— above—in which a very high rate of discharge tained without apparent detriment. *En attendant* sure of success with unprotected plates, the tained by enclosing a plate, or a conductor g by active material, in a perforated envelope y considerable interest and importance.

LXXXVIII.

ritish patent No. 3,039, 1882, granted to C. P. of Paris, one of the claims is for "the use of caoutchouc durci) or other suitable material adhering to, and holding the polar plates of the couples for the purpose of obtaining a perfect of the covered parts of the plates and the gidity of the said plates."

in this nor in any other of the claims is the use ted ebonite, or other rigid material pierced with mentioned; but in the body of the specification which appears to me unintelligible) reference is 'two plates of lead, each entirely covered with an thickness of ebonite," but of which "the working owever, are not covered with the ebonite, being med therein, such frames projecting beyond the rfaces," and also to "a rigid plate perforated ltitude of small holes." The meaning of the inventor appears to be that the lead plates are firmly secured, during the process of baking or vulcanising the caoutchouc, to the bottom of a shallow box of ebonite. Two of the boxes thus formed are filled, the one with a powder of lead and the other with a powder of the peroxide of this metal. Over each layer of powder is placed "a woollen cloth, a piece of felt, or other spongy and unattackable material," and over this is placed the "plate, perforated with a multitude of small holes," the latter being secured to the element with indiarubber bands. The two boxes, charged respectively with peroxide of lead and the spongy metal, when immersed in an electrolyte, of course constituted a voltaic couple, of which the active materials when exhausted could be replaced.

Further on in the specification, it is stated that "Fig. 3 of the drawings represents a double element, the cavities of which are filled with powders held in place by the felts, the perforated plates, and the indiarubber bands," Outside of the perforated plates are shown "plates of porous earthenware placed between the elements of the couples to prevent polarisation by hydrogen" (!) In this case a single lead plate, of which both surfaces were utilised, appears to have been fixed by its edges to a frame of ebonite. The surfaces were then successively covered with *one* of the powders, either spongy lead or peroxide, according to the nature of the element; and the active material was held in position by felt and by the perforated plates.

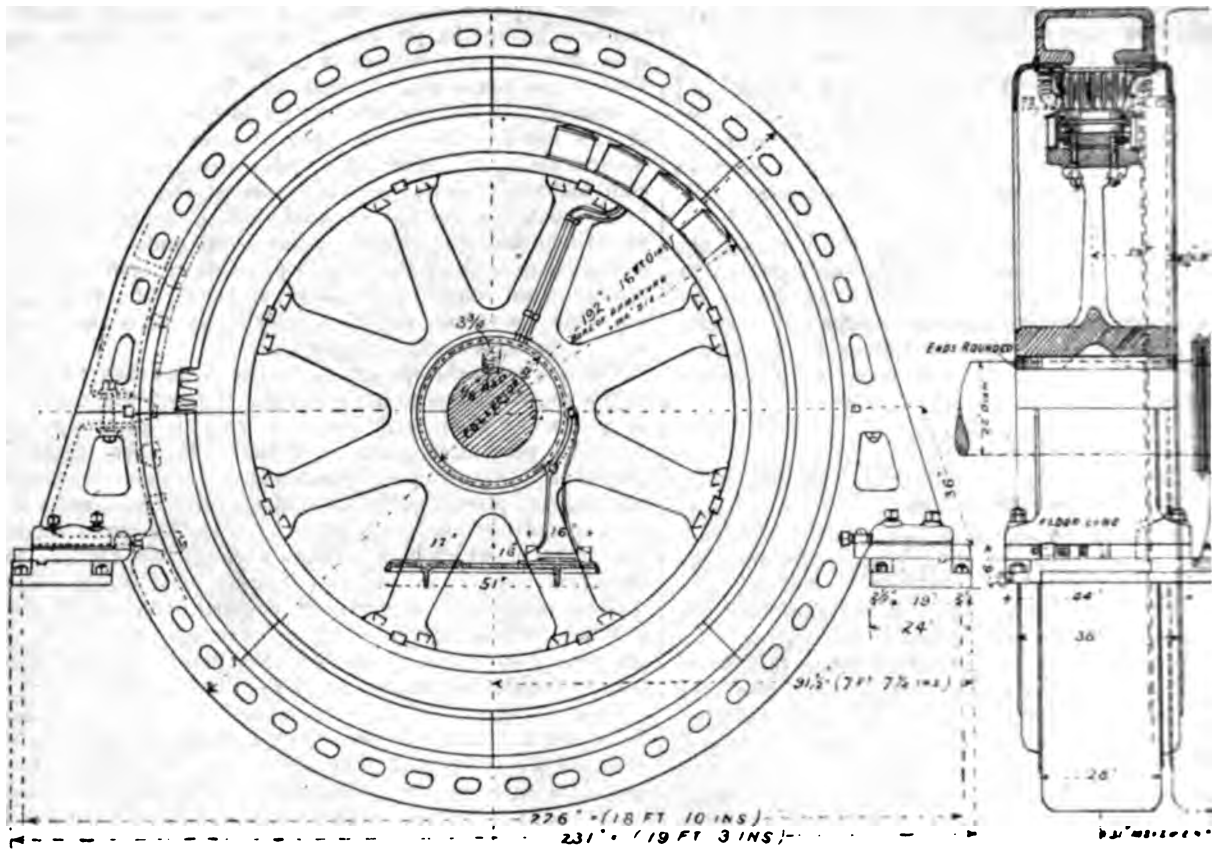
I am anxious to render what credit may be due to M. Nézeraux as an early inventor in connection with elements enclosed by perforated diaphragms, but I cannot congratulate him on the possession of the very desirable quality of *clarté* in his descriptions, nor of accurate notions in regard to the prevention of polarisation.

THE CENTRAL LONDON RAILWAY.

The construction of this most important line is now well under way, and the design of the electric machinery required for its equipment has also been approved. The contract for this part of the work has been placed in the hands of the British Thomson-Houston Company, from whom we have obtained the following details and drawings. To recapitulate the general facts about the railway, the total length of the line is about 6½ miles of double track, each track being in a separate tunnel. These tunnels are being constructed on the now well-known Greathead shield system, which has proved so effective in allowing of excavation without causing the ground above to sink. On these lines it is intended to run a 2½-minute service, with trains of seven carriages each, with a total seating capacity of 336. These trains will weigh about 105 tons, or with the locomotives about 147 tons. The average speed of the trains, including the stoppages, is to be 14 miles per hour. This will effect a very great saving of time over that taken by the 'bus traffic now serving the route.

The electric plant required for the railway has been designed by Mr. H. F. Parshall. The electric energy required will be generated by three-phase dynamos in the power-house at the Shepherd's Bush end of the line. The voltage at the terminals between any two wires will be 5,000. The current at this potential will be conveyed by two triple concentric feeders to sub-stations along the line of route. In these sub-stations the current will be first reduced by ordinary transformers from 5,000 to 330 volts, and then transformed into direct current for the line by rotary transformers. We propose to describe the electric machinery somewhat in detail before taking up the general arrangements of the plant in the generating station.

The Three-Phase Generators.—These are shown in Figs. 1 and 2, and are of what we now call the flywheel type. These machines will be direct coupled to Reynolds-Corliss cross-compound condensing engines running at 94 revolutions per minute. They will then give 1,300 i.h.p. each. Their high and low pressure cylinders are respectively 24in. and 46in. diameter, and they have 48in. stroke. The engines are capable of being run non-



FIGS. 1 AND 2.—Three-phase Generator for the Central London Railway - 850 kw. at 94 revolutions.

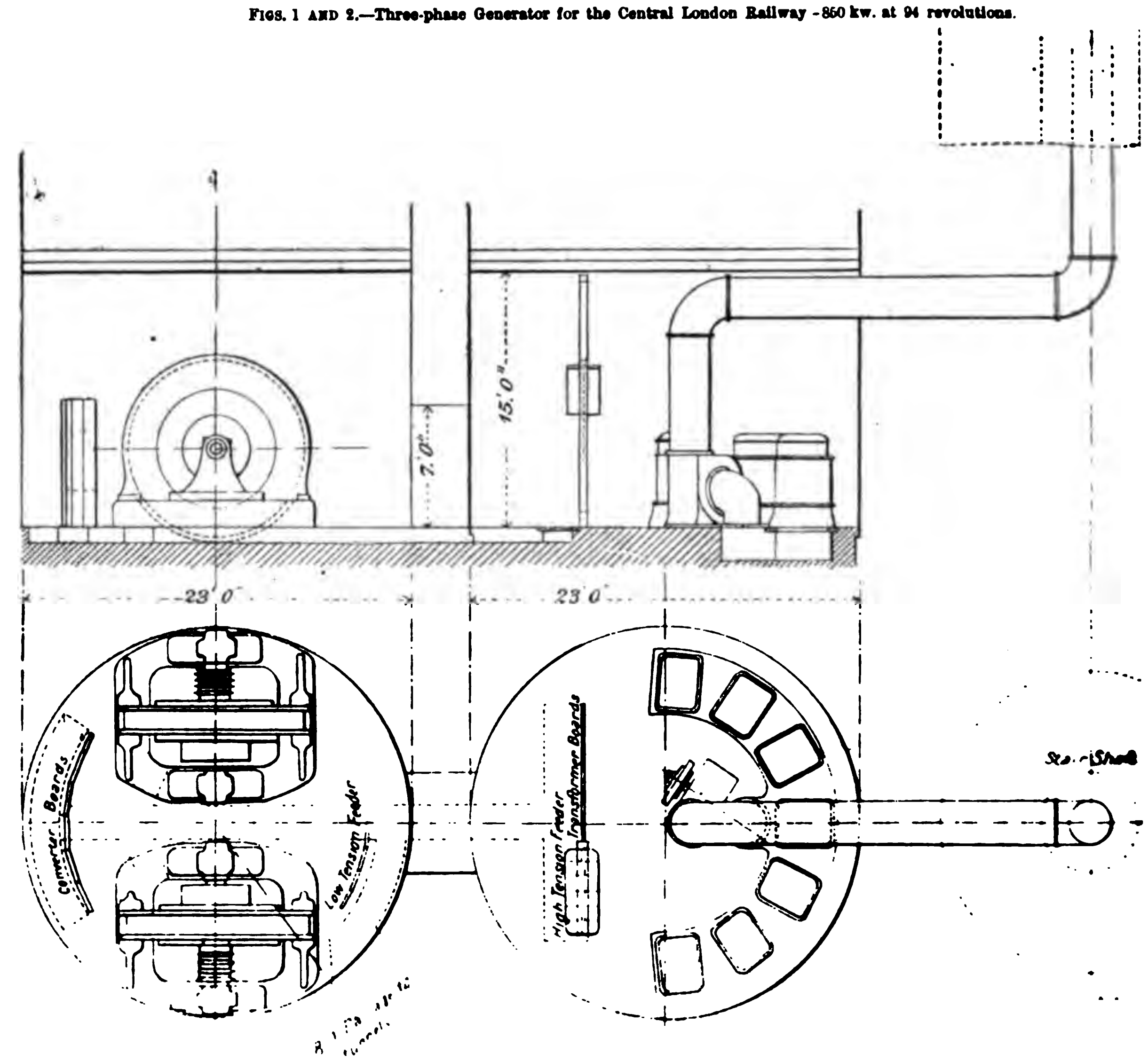


FIG. 3.—Arrangement of Sub-Station Plants on the Central London Railway.

condensing, and either high or low pressure side can be run independently. In the ordinary way the engines will exhaust into an independent combined jet condenser and air-pump of sufficient capacity to take the

itity of steam. The condensing and injection water be forced to the top of four Barnard cooling towers, tower being furnished with two fans driven by electric

in the illustration comes between the low and high pressure lines of cylinders. This flywheel is built up in eight sections, and weighs about 45 tons. The field magnets of

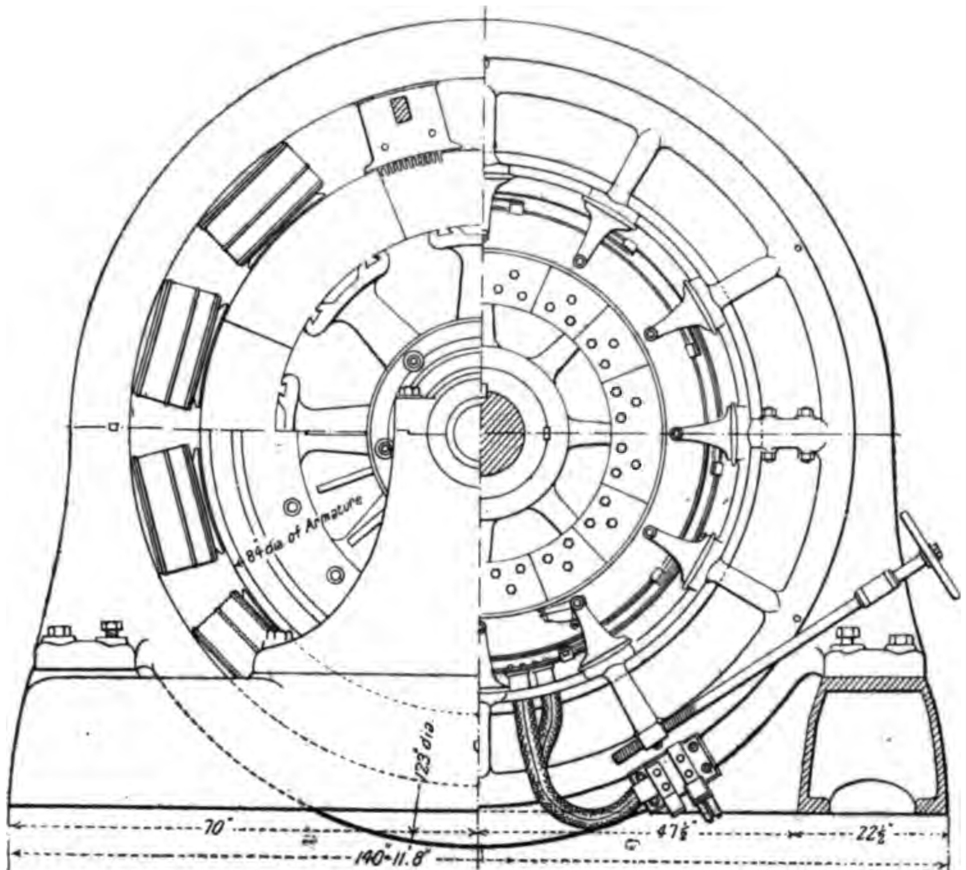


FIG. 4.—Elevation of 900-kw. Rotary Transformer.

rs. The engines are guaranteed to have a consumption ½lb. of steam per indicated horse-power when develop-

the three-phase generators are attached to this flywheel, the cores of the magnets being laminated. There are

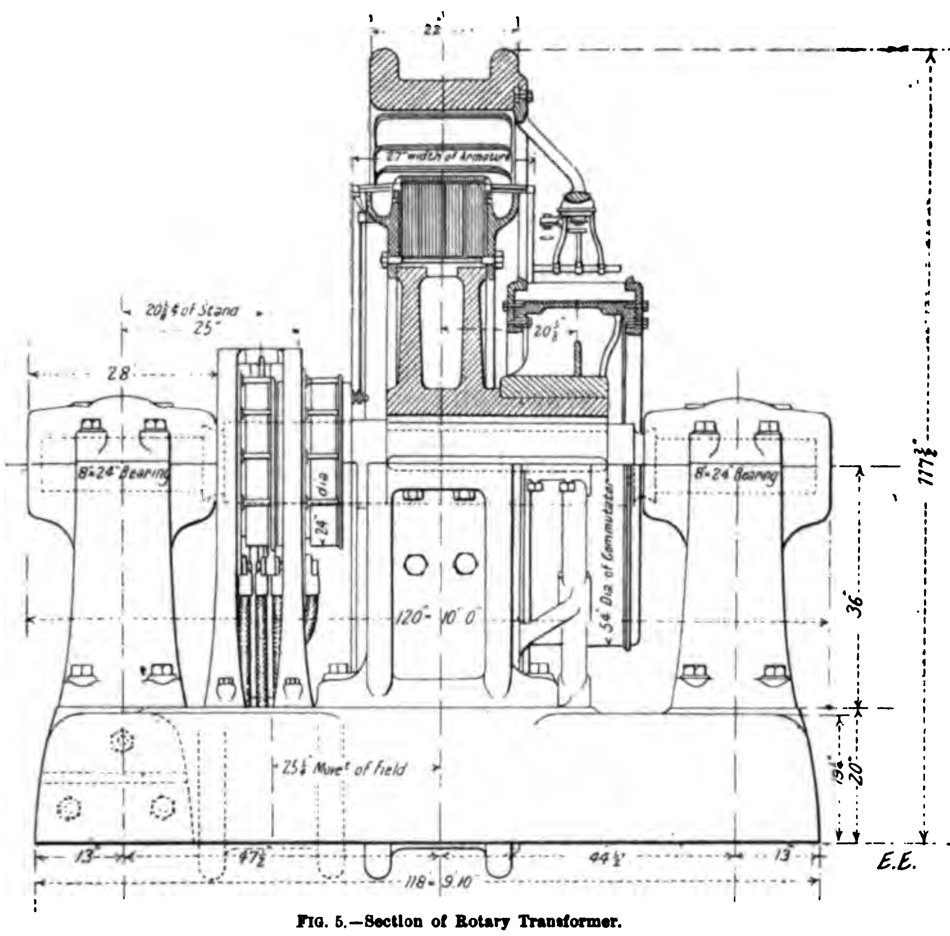


FIG. 5.—Section of Rotary Transformer.

g 1,000 i.h.p., and running condensing with a 26½in. vacuum. The engines are horizontal, and the steel flywheel seen

32 such cores, which, at the speed of 94 revolutions per minute, give a frequency of 25 complete periods per second. The stationary armature is also built of laminated

iron, with slots left for the coils. In this case overlapping coils are used. Ventilating ducts are left through the body of the armature to keep down the heating. The total weight of these generators is about 36 tons. The output of the machines is 850 kw. The guaranteed efficiency at full load is 95 per cent., and the energy required for excitation must not exceed 16 kw., or 1·9 per cent. The armature diameter is exactly 12ft., and the other dimensions can be seen from the illustrations.

The Sub-Station Electrical Plant.—The arrangement of these sub-stations can be seen in Fig. 3, while Figs. 4 and 5 give details of the rotary transformers. There are to be three of these sub-stations constructed in the lower portions of the lift shafts at the Davies-street, Notting Hill-gate, and Post Office Stations respectively. Additional plant is also to be installed at the Marble Arch Station, but this will at present be only of the nature of a spare, and will not be run regularly. The Notting Hill-gate and Davies-street sub-stations will contain only one rotary converter in each station, with necessary transformers and switchboards. At the Marble Arch and Post Office sub-stations there will be two of the rotary converters in each, as shown in the sketch. The step-down transformers (shown in the lift shafts) reduce the line potential from 5,000 volts to 330 volts. These are of the air-blast type, but instead of following the usual plan of forcing the air through the transformers, the air is drawn through by an electric fan. The hot air is expelled through the sheet-steel pipe running up the centre of the spiral staircase of the stations, as shown. This provides ample ventilation for the sub-stations, as well as effectively cooling the transformers. The weight of each transformer will be 8,000lb.

The rotary transformers are capable of converting 900 kw. from three-phase currents at 330 to direct current at about 500 volts. They have, as seen in the illustration, 12 poles, and will run at the given frequency at a speed of about 250 revolutions per minute. They are synchronous machines, but provision is made for starting them up from the three-phase side. The armature is practically a direct-current dynamo, parallel wound, with two conductors per slot. This winding is then tapped at three places, and connect to the three slide rings of the three-phase side of the transformer. This construction gives great economy in weight as compared with two distinct machines—*i.e.*, a three-phase motor and direct-current dynamo—bolted on the same shaft, as used at Dublin. The diameter of the armature is 84in., and the width over connectors 27in. It will be noticed that in both the rotary transformers and large generators the stationary member can be racked to one side for examination.

(To be continued.)

THE WAVE-LENGTH OF LIGHT AS A STANDARD OF LENGTH.

BY E. EDSER, A.R.C.S.

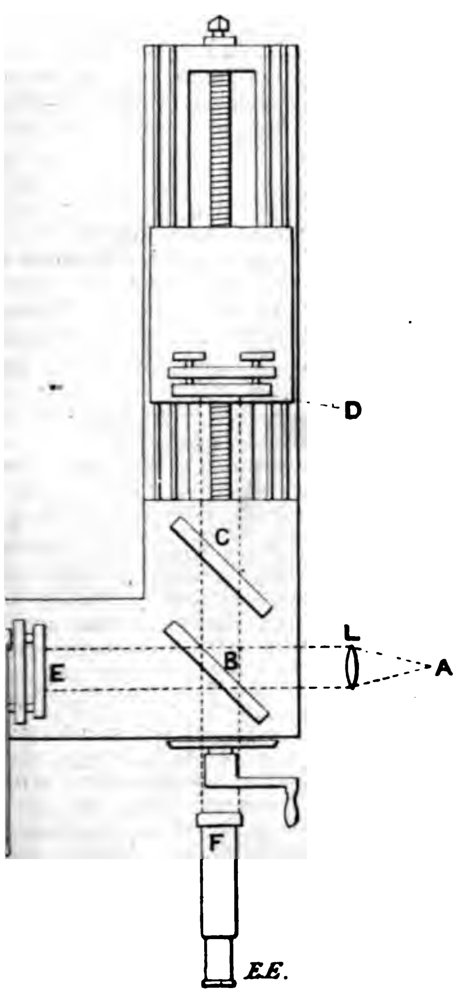
A curious chapter in the history of commercial progress is that relating to the standards of weight and measurement which have been adopted in various countries at different epochs. Crude as many of these were—such as the barleycorn as a unit of length, and the grain as a unit of mass, both relating to properties of a grain of wheat—they have been proved in late years to have been derived from properties of material bodies which are far more constant than one would at first sight expect. Each standard was doubtless the result of much observation and thought, and all the standards that have been heretofore proposed or adopted have been selected in accordance with one or other of two principles. Some natural phenomenon which is more or less invariable in its manifestations, under known conditions, may be utilised to define a certain standard. Thus the length of a grain of wheat, which formed the basis of one system of measurement, has been proved, by measurements made on wheat grains found in ancient Egyptian tombs, to have remained practically constant through several thousand years. The advantage of this species of standard is that the phenomenon on which it depends occurs so generally that there is fear of not being able to reproduce it when necessary; disadvantage generally lies in its want of definiteness. T plan which has been adopted, on the other hand, by mo modern civilised countries is to create some arbitra standard, which must subsequently be carefully preserve whilst copies of it only are used for actual measureme This being the case, the preservation of the origin standard becomes a matter of the utmost importance. past ages, when measurements depending on the unit length were chiefly confined to determining the dimensio of a piece of cloth or the size of a field, a ver accurately defined standard was unnecessary; but at th present day, when the scientific and commercial uni of electrical measurement are based on the fundament units of length, mass, and time, it is far otherwise; an any damage to the standard of length might introdu incalculable confusion into subsequent scientific measur ments. Although subsidiary electrical standards have bee constructed, it is probable that continual redeterminatio of these in terms of the fundamental units will always b necessary; thus Prof. Ayrton has lately pointed out so very peculiar deteriorations in certain standard resistanc coils.

By an Act of Parliament passed in 1824, it was enacte that the distance between the centres of the two points i the gold studs in a certain brass bar in the custody of th clerk of the House of Commons, at a temperature 62deg. F., should be the standard yard; and suggeste that if any injury occurred to this bar it might be replac by observations on the seconds pendulum. When, howeve during the fire at the Houses of Parliament in 1834, th bar was actually injured, it was found impossible to repr duce the standard yard by the suggested method, an recourse at last was necessary to the various known copie It is questionable to what degree of accuracy the standar yard was finally reproduced. This instance suggests th great advantage that would accrue if some naturall occurring and easily reproduceable phenomenon could b used to define the standard of length.

It was first suggested by Maxwell that the wave-lengt corresponding to some line in the spectrum might be us as a standard of length. The only method at that tim available for determining wave-lengths with accuracy w in connection with experiments on diffraction; and the involved so much uncertainty and difficulty that th method could hardly be considered a perfect one. It w left to Michelson to devise a piece of apparatus which cou be applied with ease and certainty to this purpose. Th following is a description of this apparatus (see diagram).

Light from a point, A, after being rendered parallel b the lens, L, falls on the thinly-silvered surface of a pla plate of glass, B. The thickness of the silver is such th half the incident light is reflected along the path B C the remainder being transmitted through the glass plate, along the path B E. E and D are two plane glass pla the surfaces on which the light falls being silvered a polished, so that the incident light is reflected in each ca along the path by which it came. The two rays recombi at B, and pass to an observing telescope at F. In order render the two paths for the light as nearly equivalent possible, a plate of glass, C, of the same thickness as is placed in the path B D; the light originally reflected fro B will pass twice through this plate and once through before reaching the telescope, the light originally tra mitted passing three times in all through B. When t two paths, B C D and B E, are made very nearly equ brilliant interference bands will become visible to an e looking through the telescope. The formation of the bands in the simplest case may be thus explained. Looki through the telescope, the image of the silvered surface E in the thinly-silvered mirror, B, is seen, together wi the real surface of D. When these surfaces are broug into approximate coincidence, bands similar in colour Newton's rings will be observed. As the two surfaces a rendered more nearly parallel, the bands will become wid The mirror E may be adjusted for parallelism by mea of screws shown in the diagram; the mirror D can moved parallel to itself along the path B C D by means an accurately-made screw, also shown.

that the light at A comprises only one wave- hen as the mirror D is moved parallel to itself, rence bands will be seen to move inwards or oward the central band. Let us suppose the to be that due to the red line of cadmium, its h being approximately $6 \cdot 44 \times 10^{-5}$ cm. Then in a dark band should move in or out to the posi- rly occupied by the next band, the mirror D oved through a distance of $\frac{1}{2} \times 6 \cdot 44 \times 10^{-5}$ cm. It y to adjust D to one-tenth of this distance—*i.e.*, $\frac{1}{1000000}$in. in English measure. If the number ence bands that pass across the cross-wires of pe during one complete revolution of the screw , it follows that the pitch of the screw may be l to within $\frac{1}{1000000}$in. We can consequently e screw in terms of wave-lengths of light, and standards at present existing were destroyed helson has determined the wave-length of the ne, with an error of not more than one in twenty terms of the standard metre at Paris), they might ated with accuracy from this for a similar piece s.



e light at A is not wholly of one wave-length the bands which can be obtained, and therefore the rough which D may be moved without the bands invisible, will be limited. The reason of this is ppose that light of two different but nearly -lengths is originated at A. There will really s of bands formed, but when the path B C D is E these two sets of bands will be very nearly . Suppose, now, that a dark band is focussed on wires of the observing telescope. Let 1,000 hs of one of the components of the light be ,001 wave-lengths of the other component. When moved through 250 wave-lengths of the first t, there will again be a black band on the cross- to this component. But D will have been moved 250 + ¼ wave-lengths of the second component; tly there will be a bright band due to this com- he cross-wires. If the two components are equal in the bands will now have disappeared, but will reappear on moving D still further. If the components are unequal, there will be points of maximum and minimum distinctness for the interference bands. By experiments on the visibility of the bands, Michelson has been able to determine that many lines in the spectrum which were formerly considered to be homogeneous really consist of two or more lines.

With white light, which consists of a great number of different wave-lengths, only a few bands (from 16 to 20) are visible. They are, however, extremely bright and beautifully coloured, surpassing in this respect most other optical phenomena except, perhaps, diffraction fringes.

INSTITUTION OF ELECTRICAL ENGINEERS, Feb. 24.

On the Manufacture of Lamps and other Apparatus for 200-Volt Circuits.

BY G. BINSWANGER BYNG, MEMBER.

In the progress of electrical industry manufacturers have become accustomed to sudden demands arising from a discovery or a successful experiment, and I purpose to deal with apparatus which manufacturers are called upon to make to meet the requirements of the latest innovation—*i.e.*, the distribution at a potential of 200 to 230 volts. Central-station engineers have thus arranged their three-wire system, relying upon makers to successfully alter lamps and minor fittings incidental to such a change. Their expectations have been fulfilled in a measure only. The ultimate success of the high-pressure system will depend largely upon the verdict of the consumer, and he will give it in its favour only if his fittings, in points of efficiency, economy, safety, convenience, and appearance, approach the standard which he can obtain by means of the lower-voltage system. It is therefore of importance that the central-station engineer should assist the manufacturer to arrive at such perfection. His instructions, so far, have hardly gone beyond the demand to supply him with fittings to conform in appearance to the 100-volt system. It is true each central station has issued rules, but they are of little help to the manufacturer, and their very disconformity shows that there is neither unanimity nor correlation of ideas between the engineers in charge. What is wanted is to have a thorough interchange of opinion of engineers, contractors, and manufacturers. The latter would then know theoretically how far they may satisfactorily depart from the present practice, and thus save much time and money in adventitious experiments, and this also might tend to produce some degree of standardisation—much to be desired in the interest of all who have the success of the new system at heart. With this object in view I bring this paper before you, and I think I can best serve the purpose by describing the chief appliances now upon the market, or under manufacture at my works, pointing out the existing deficiencies, and giving you my views upon the attainment, as far as possible, of higher perfection.

Incandescent Lamps.

Most important in connection with this subject is the incandescent lamp. The lamp manufacturers have been compelled to supply 200-volt lamps at a given candle-power and efficiency in the same size bulbs as are used for 100-volt lamps. With flashed carbon the manufacturers meet with the great practical difficulty of properly disposing their long thin 200-volt filament in the same space as their shorter and thicker 100-volt filament, and therefore most of them solve this problem by resorting to a filament of much higher specific resistance than would be given by the flashing operation.

Unflashed Filaments.—Such a lamp is ready to the maker's hand by simply taking his ordinary carbon filament as it exists before being flashed—that is to say, before it is reduced by a fresh layer of carbon being deposited on the surface of the original filament. The higher specific resistance of an unflashed carbon enables one to easily get over the difficulty of size of bulb, as such a filament will give the necessary resistance by taking a shorter length. Such filaments have also a greater emissivity per cubic millimetre owing to the darker and rougher nature of their surface than that of flashed filaments, consequently they require a less amount of surface per candle-power, and therefore the mass of an unflashed filament, at a given candle-power and efficiency, is less than that of the flashed filament. The filaments of high-voltage lamps largely used to-day are therefore, in other words, faster converters of energy into heat and light than flashed filaments of the same candle-power and efficiency, although the watts supplied to each be the same. On comparing the behaviour of such 200-volt lamps with that of 100-volt lamps, the roughest of tests shows that there is a far more rapid falling off of candle-power during life with the former than the latter. At the same time

the efficiency of an unflashed lamp decreases in a given number of hours by a far greater percentage than is the case with the flashed lamp. Mr. Robertson has made a series of life and efficiency tests on high-voltage lamps. They show that in the average unflashed 200-volt 16-c.p. lamp the percentage loss of candle-power in 600 hours is about 42 per cent., and the average drop of efficiency is about 35 per cent. These two quantities seem to cover the chief practical merits desirable in an incandescent electric lamp—*i.e.*, the lamp which has the best percentage retention of original candle-power during its life, together with the best average percentage retention (or increase) of original efficiency during its life. These tests show that these most desirable points, which have been worked on diligently for the last 13 years, have had to be thrown on one side in order to bring about the possibility of using the same-sized bulb for a given candle-power at 200 volts as at 100 volts. Tests of the behaviour of unflashed high-voltage lamps show that such lamps sometimes increase in candle-power during the first 100 hours or so. This also happens with badly carbonised or badly flashed 100-volt lamps (noted by Prof. Ayrton in some of his recent lamp tests), owing to the initial lowering of their resistance in consequence of their not having been properly carbonised in the first instance; and this is often accompanied by a great alteration in the character of the surface (emissivity) of the filament. The carbonising or baking process is therefore still going on in the lamp, and the two above-mentioned changes coming together mask the fact that a great deterioration of the filament has taken place; but a period is quickly reached when this fact is no longer masked. This period is when there is no further decrease of resistance; but the surface deterioration still goes on, and thus soon brings about a large percentage fall of candle-power, and on the slightest increase of voltage there is now a tendency to increase resistance. These changes seem to be initially owing to the fact that the (unflashed) high specific resistance carbon is far more volatile than is the case with a good flashed carbon. A microscopical examination of a flashed and unflashed filament after each have been running 500 hours shows that the surface of the flashed filament is still quite smooth and shiny, whereas the surface of the unflashed filament has become very dull, sooty, and often full of small pit-holes. These pit-holes and soot form a large increase of surface, which therefore increases the emissivity of the filament, and consequently lessens its candle-power, as the watts supplied keep the same. The property of an unflashed filament becoming so rapidly less efficient (increasing in watts per candle-power) acts as a preservative, because the increased emissivity lowers the temperature. This lowering of temperature decreases both the tendency to volatilise and also to further great change of resistance. This power of self-preservation leads to such a filament giving some satisfaction to the general public, for the latter is satisfied sometimes when it obtains a good average, or sometimes an excessively long-life lamp; but this is very false economy, as it is only purchased by a very great falling off in actual efficiency. Mr. Robertson's experience with carbon filaments seems to point to the fact that it is impossible to obtain a carbon filament of high specific resistance without its being accompanied by at least the defect of greater volatility. In other words, the lowest specific resistance carbon is the best, because it is less liable to evaporation, and therefore it gives the best retention of original candle-power and efficiency, and it is also generally mechanically stronger. The specific resistance of many of the present types of 200-volt lamps is about 3,500 to 5,000 microhms per cubic centimetre, whereas it is easy to obtain flashed carbons whose specific resistance is as low as 2,400 microhms per centimetre, and even as low as 300 is possible, but not practicable.

Gases.—Another important consideration to bear in mind as to whether the high or low specific resistance carbon is the best is that the high specific resistance filaments retain their occluded gases in a far more persistent degree than is the case with the low specific resistance flashed filaments. It is probable that the occluded gases arising from the carbonisation of the filament are by means of the flashing process driven off to a large extent, and, in addition, the more dense and impervious nature of the flashed surface prevents the filament from absorbing the gases during its subsequent handling or treatment. This absorption is a property possessed by all carbon bodies in some proportion, varying with their density. This greater power of unflashed carbon to absorb gases and to retain what it has absorbed than is possessed by flashed carbon leads in many instances to sudden deterioration of the vacuum in a finished lamp, accompanied by short-circuiting as soon as the pressure and the condition of the residual gases in the bulb has reached its most conductive point. The consensus of opinion at the present day of the average types of high-voltage lamps undoubtedly points to the fact that a large percentage are expected to short-circuit as soon as they are put up, and I have heard several engineers say that they expect about one in twelve to go in this way. From these causes, and others relating to the treatment of filament pointed out above, there seems to be no doubt that the average 200-volt lamps have a shorter life than 100-volt lamps. The above experiences have led Mr. Robertson to design all high-voltage lamps that are not

restricted by size with well-flashed carbon filaments, an
lamps compare favourably with lower-voltage lamps.

Horizontal Burning.—Another question which is
important in considering 200-volt lamps is that of ho
burning, and contractors should take special notice of
There is no doubt whatever that almost all the pres
200-volt lamps are only suitable for burning in a
position. As soon as any other position is adopted d
become prominent. The long thin filament soon drops
the bulb and cracks it. Also electrostatic attractions,
to higher voltage, cannot be resisted by the long thin fil
and this is an additional cause of the filament approachi
bulb. The effect of electrostatic attractions on long
filaments is even noticeable with lamps burning in a v
position. Such lamps have to be designed with the obj
making their filaments more rigid, and to be thus a
withstand the effects of gravity and electrostatic attra
exerted by the charge on the bulb; and this is the chief
which makes high-efficiency 200-volt lamps so difficult to pr
There is, therefore, a tendency, in trying to avoid the d
just mentioned, to make 200-volt lamps as low in efficien
possible.

Leading-in Wires.—Another fault that exists with the
of the present forms of high-voltage lamps is that, owing t
same size bulb being retained, no greater separation c
given between the leading-in wires of the lamp. This
special difficulty with high-voltage lamps which contain
filaments, as in this case the same size cap is used, and
wires are passed through the sealing point instead of two,
they are, therefore, more crowded together. This questi
distance apart of leading-in wires is a vital one, both in
manufacture of the lamp and in its after use. In the ca
unflashed carbons this becomes a still greater defect, owi
small distance combined with probably greater gaseous e
tion. The higher the voltage, the sooner are these defects
manifest. Even with 100-volt lamps there is, under ce
conditions, a tendency for current to jump across from po
pole, owing to the remanent gases in the bulb attaining a
state of conductivity. The greatest conductivity of the rem
cases which lead to sudden short-circuiting appears to be
the pressure is about 0·01mm. But, by reason of a conti
discharge taking place in all lamps, there seems to be a tend
for the residual gaseous molecules to arrange themselves
straight path between each pole. Through such a path
charge will take place even in a better vacuum than 0·0
This leakage current (sometimes called the "Edison ef
which leads to short-circuiting is very prominent d
manufacture of high-voltage lamps, and to avoid it gr
care is required as the voltage increases. If the
of a bulb for a high-voltage lamp is to be restricte
the present dimensions, there is no doubt that the best
would still be that which has a single filament, were it no
other vital questions step in. Electrostatic effects also inc
with the voltage, and several most promising patterns of la
from all other points of view, have had to be put on one si
this account. As to the best forms of cap for high-vo
lamps, preference will naturally be given to those in whic
poles can be kept furthest apart. If a B.C. or E.S. cap
on a larger scale, there is no doubt that considerable be
would accrue. The simplest holder, with the least m
parts and for always making the best contact, is undoub
the Edison screw, which, in the cases of excessive vibra
can be made with a locking device. The slightest wa
insulation in the cap between the poles eventually leads
large leakage current between them or the cap and one o
poles, and in many cases this is suddenly established to s
large degree as to result in the complete fusion of the lamp
and sometimes the holder. In such cases a non-metallic
cap seems to offer great advantages, and has, in my experi
removed complaints on this score.

Standard Voltage.—From a lampmaker's point of vi
fixed standard of voltage and efficiency would only lead
increased cost in manufacture, and the present practi
varying efficiencies with voltages, running in the case of
voltage lamps from 95 to 120, and in the case of high-vo
lamps from 200 to 230, tends to keep the lamp at a lowe
than if these efficiencies or limits of voltage were more restri
On the other hand, voltages which lie outside these limi
a source of great expense to the manufacturer. It
therefore tend to cheapen lamps if a standard of voltage
adopted which lay exclusively between the above or
smaller limits, but at varying efficiencies.

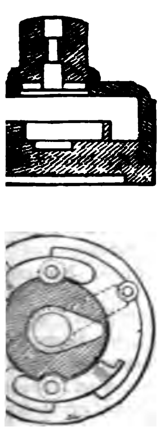
Combination Filaments.—In order to get over the diffi
of size of bulb, etc., many filaments (beyond the unflashed
carbon derived from cellulose in some form) have been
duced which have a high specific resistance. This can a
obtained by using a less dense form of carbon than has hit
been found most satisfactory in low-voltage lamps. A fo
high specific resistance filament that has been tried is
the carbon has been admixed with various oxides, borates
silicates of the earths. In addition to mixtures, electrolyti
chemical deposits of these bodies on the surface of carbon

tried ; but although it is a simple matter to obtain rbons containing these bodies either incorporated with m or on the surface thereon, it is quite another matter a finished lamp containing these bodies in a form to practicable use. The difficulties met with are apparent as the lamp is incandesced while undergoing exhaus- f such lamps be incandesced to a temperature g about five watts per candle-power, there is a separation by evaporation of these bodies from the nd their resulting deposition on the surface of the lamp e temperature of incandescence of the filament in order n any advantage which might be derived from the scence" of the rarer earths is apparently greater than s per candle-power ; and as, as above stated, it has been possible to so evacuate a lamp as to leave any of the scent" bodies incorporated with the filament at tempera- er than five watts per candle-power, the object sought nsequently defeated. From the above it seems that, present knowledge, the best form of 200-volt lamp is h has a well-flashed low specific resistance pure carbon in a large bulb, with a well-insulated moisture-proof ing the poles to be placed at a reasonable distance t should consist of a single filament, and be so disposed b that it can withstand the disturbing effects of gravity ostatic charges on the bulb. I wish to mention here o-director, Mr. Robertson, has given me great assistance marks I have made upon lamps.

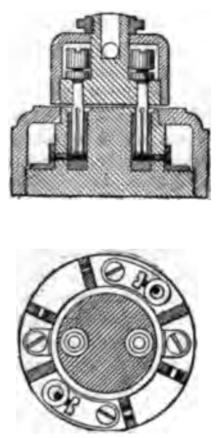
SWITCHES.

now to the matter of adapting switches, wall plugs, es, lampholders, and minor fittings. I do not appre- difficulty in changing existing types from the present

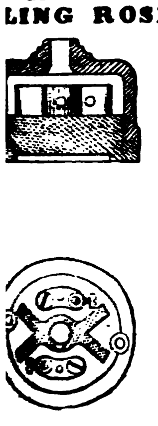
H.V.
BLE BREAK
SWITCH



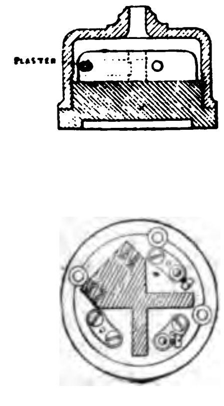
H.V.
WALL PLUG



H.V.
LING ROSE

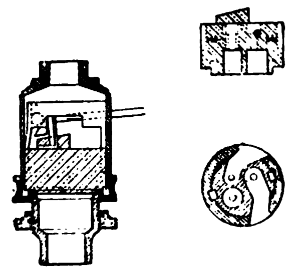


H.V.
CEILING ROSE
LINED CUT-OUT

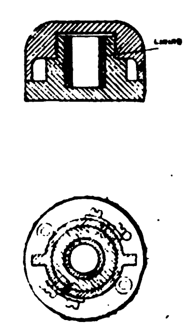


of use to conform to the higher standard, yet main- he same appearance and size, and, when sufficiently in , approximately the same cost. The chief alteration is the increased break, and better insulation of the s. In smaller articles, such as combined switches and es, the difficulty, if any, is more apparent. A bearing upon the subjects involving the use and con- of double-pole switches, length of break, standardisa- terminals, position of fuses, the carrying capacity of , etc., would be to my mind of great value. Without upon the subject of switches to an undue extent, I some specimens of different types I find to be satis- practice. Here (1) is a switch to take the place of ry link or tumbler switch, and (2) here is an ordi- nary double-break china switch. You will notice the forma- tion of the china base, and the separation and action of the metallic parts, which are arranged to produce a long break and perfect insulation, so that an arc cannot be maintained if estab- lished, nor can a shock be communicated to the operator. I have also placed there enlarged drawings of wall sockets and ceiling roses to illustrate my further remarks under this heading. It is not necessary to go deeply into the subject of fixtures such as electroliers, pendants, etc., but in connection therewith I wish to refer to the question whether it is advisable to recom- mend the use of two or more low-voltage lamps in series on a 200-volt circuit. Within my own experience I know of several installations fitted originally with 200-volt lamps that have by reason of greater expense for current and an inferior light been rewired for two 100-volt lamps in series with satisfactory results. It is within the province of manufacturers to materially assist wiremen by designing fittings specially adapted to series wiring, such as series holders, ball fittings, brackets, or electroliers with

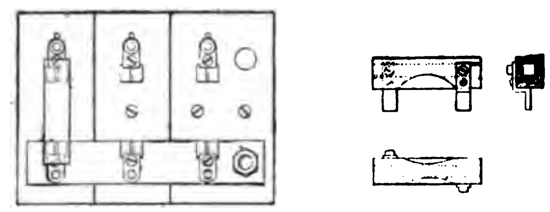
H.V.
KEY SOCKET



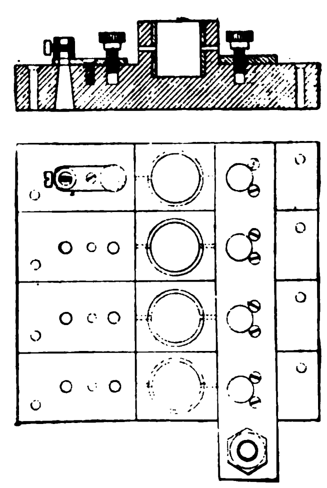
H.V.
CHINA CUT-OUT
LINED CHAMBER



H.V. CUT OUT BOARD
SPRING CLIPS FOR HOLLOW CHINA FUSE HOLDERS



H.V. CUT-OUT BOARD
WITH LINED CHAMBERS



arms in multiples of two, and such a practice might be extended with advantage to many other details.

The question of fuses for higher voltage requires more careful investigation, and would repay thorough discussion. Central-station engineers agree to differ upon the various points of efficiency, as evidenced by the different rules issued for our guidance. Some lay stress upon increasing the length of fuse wires, others insist upon ventilation holes, and in some cases the height of covers are to be increased. But there is no unanimity between them, and none of these rules, in my opinion, indicate the right direction. I have made some extensive experiments, and believe that the results are of interest to the profession generally. When a circuit is opened by the disruption of a fuse, the combined metallic vapours and hot air produced by

the high temperature of the resulting arc may extend and maintain it so as to bridge over the terminals, which, melting and becoming volatilised, feed the arc, and rapidly increase the temperature. I find, in practice, that under these conditions the china base supporting the fuse and terminals is easily volatilised also, and not only contributes towards the maintenance of the arc, but is ruptured as if by explosion, tending to set fire to any inflammable surroundings. This rupture has hitherto, I believe, erroneously been attributed to the expansion of air confined by the cover; hence the ventilation holes, which, according to my opinion, are useless. The same experiments tend to prove the fallacy of using a long fuse wire, with the concomitant disadvantages of finding space for it, and also difficulty in renewal; and I feel sure that full efficiency may be attained with a short fuse.

My deductions from the aforesaid experiments are that (1) it is essential to arrange a fuse wire so that it will break at a definite part of its length—*i.e.*, approximately, the centre; (2) the arc formed on breaking the fuse must be so confined that it cannot be maintained so as to damage the terminals, base, or cover.

I will now describe how I have carried out these essential points in china cut-out boxes, which are the general type of fusible cut-outs used in house installations in this country. These fuses are arranged on china bases, or in groups upon cut-out boards, and their carrying capacity varies from 1 to 100 amperes. In all these I provide what I call a "fuse chamber"—*i.e.*, a round china wall forming a central hole, from ½in. to 1in. in diameter—and this is pierced with two holes near to the terminals, which are fixed on the base outside the wall. The wire is threaded through the holes from one terminal to the other, passing through the fuse chamber. Both ends of the fuse wire are supported by a material which is a better heat conductor than air, whilst it is free in the central fuse chamber. Thus the same current raises the temperature of the fuse wire within the fuse chamber more rapidly than at the supported ends, therefore the disruption takes place there, and the resulting arc is enclosed. I find, however, that china as an isolator is not sufficient, because of its tendency to volatilise under the high temperatures—a fact I have already mentioned. Therefore I line the interior of the chamber with another material which is a better heat conductor and less liable to fracture, and I find that ordinary plaster of Paris is most convenient for this purpose, although several other substances may be equally efficient. Fuses constructed on this principle require but a short length of wire, and are perfectly safe on high voltages, and the general appearance and size does not differ to any great extent from those now in common use. The principle once established of surrounding part of the length of fuse wire with a substance that is a better conductor of heat than air, we can easily construct any other type of fuse upon the same principle. Fuse wires enclosed in glass tubes filled with plaster or cement, but with a free central space for fusion, for instance, fulfil the same conditions. I find that such fuses have been patented by Mr. Mordey in 1890. The mere fact of enclosing a fusible wire in a non-conducting refractory filling would not fulfil the essential functions of a perfect fuse as I have described without a clear space at or about the centre for disruption. Mr. Mordey describes such a space in his specification, but it is for the purpose of observation only, and it is not clear from the tenor of the specification that the inventor had this purpose of the localisation of fusion in mind. Mr. Miller, of Kensington, has also altered the ordinary Edison fuse by substituting thin copper wire, and partly filling the centre with asbestos fibre. So far as localising the point of disruption and confining the arc, this fuse acts very well, although copper or alloyed fuses are not perfect under any circumstances by reason of the maintenance of a dull red heat under normal load.

Arc Lamps.

Coming now to the subject of arc lamps in relation to the higher pressure, I do not see that with alternating currents the increased potential materially affects the consumer. The practice may bring a single-parallel system into vogue, with economy coils—an alteration which will, in my belief, increase the commercial efficiency of alternating arcs. But the disadvantages are apparent in the case of a continuous-current circuit. For instance, in small installations of one or two lamps on the 100-volt circuit, these must be doubled on the 200-volt circuit, or useless resistances interposed. To equalise the conditions it has been proposed to substitute low-current lamps—say four five-ampere instead of two 10-ampere lamps. As this substitute has been advocated by one of the foremost central-station engineers, and many others will possibly follow him, it may be useful and not out of place to prove that both in theory and practice low-current arc lamps are deficient in points of economy and efficiency. It is generally accepted that the current density of an arc is independent of its size; assuming this as correct, the area of an arc must be proportional to the current, and the cooling surface proportional to its diameter. This is the case with the cooling surface of the carbons, if these are used of areas proportional to the current taken by the lamp. Thus the

cooling effect of the atmosphere will have a direct
the diameter of the arc and to the square root of
Therefore, for illumination, large arcs are more ef
small ones, and the practical arc is attained when th
increasing the number of light centres balances the
of small arcs. This gives, in practice, an ar
10 amperes. Small arcs worked under same conditio
unsteady than large ones, which is due to the fact th
arc of a given length the E.M.F. decreases as
increases. An experiment in which a fixed lengt
5 amperes and 44 volts was suddenly increased fron
showed:

Normal	5 amperes	....
Sudden increase from	5 to 6 amperes	....
" "	5 to 7 "	....
" "	5 to 8 "	....
" "	5 to 9 "	....
" "	5 to 10 "	....

So an arc, or series of arcs, with a total voltage ap
to the E.M.F. of the circuit is unstable and fl
probably due to the disproportionate variations of
surface, coupled with the decreased resistance o
higher temperatures. If the arc flares, the current w
unless there is sufficient resistance in series to reduce
across the arc at a greater rate than the above fig
Certainly the mechanism tends to lengthen the ar
advantage because the movement continues until
decreases to the normal value, and the accelera
extinguish the arc unless an interposed resistance
a rapid increase of the voltage across the arc. Such
is necessary to compensate the "negative resistan
arc, which may be more appropriately termed
cooling surface per ampere." An additional resistan
is necessary to ensure steadiness. It follows, the
five-ampere lamps must be worked on a higher
"pumping" will ensue. The possible current th
lamps on 200 volts, allowing 40 volts across each
times the normal; with five lamps on 230 volts,
the normal; while with four lamps on 230
only 3·3 times the normal. Therefore, when
lamps are used upon a 230-volt circuit, it is bet
four with steady long arcs than five with unsteady
It is probable that the enclosed arc lamp will be b
prominence in this direction, offering certainly many
but I would point out that in practice the current
largely increased, because of the frangibility of the
envelope under an accession of temperature. If
surface be increased so that the temperature of
surrounding the arc remain about the same, the
the lamp is considerably reduced.

Adverting to the manufacture and installing ar
meet the contingencies of the high voltage, we have
that, if the carbons run short or the slides stick in
the carbons in the other lamps close together, and the
of the circuit is maintained across the shunt coil of tha
lamp. The possible troubles are that the shunt coil i
and that the carbon-holders are damaged with the
flaring of the arc before it breaks. It would hardly b
to make magnets to stand such overload. Of cour
instal a cut-out and equivalent resistance to each l
this expedient is very costly, and presents the further
of finding suitable room near the lamp or making
tained with the lamp, and of teaching the consume
full current can be used although the lamps are
Some sort of cut-outs must be installed, and I am
that there is a field for inventors in this directio
indicate how I have endeavoured to meet these diffic
as is generally the case, one pair of carbons burn at
rate than the others, the slide in that lamp will
stop first, and the stumps will burn away until the
enough to break the arc. I append a table showing
of five trials:

Four 10-Ampere Lamps on 200-Volt Circ
+carbon 18*mm. cored*, −11*mm. solid.*

(1)	Arc flared and was extinguished at	[illegible]
(2)	" " " "	[illegible]
(3)	" " " "	[illegible]
(4)	" " " "	[illegible]
(5)	Current switched off when arc was at	2

In the first four trials the arc broke while flaring—
say, it travelled up the side of the carbon and ignited
dust, taking a spiral course, this course being conti
the length is too great for the voltage. The arc only
point of the carbon when there is sufficient dust to r
and counteract its increasing length; thus, when the
dust fails, the arc is extinguished before it can re
points. During trial No. 5 the carbon became pointe
temperature rose to the extent of freeing the surface
hence the arc did not leave the crater. We may de

desirability of maintaining a considerable gap between on-holders, exceeding even 3in. For absolute safety it to extinguish the arc automatically. Now, an automatic s useless, because it is necessarily controlled by the l across the lamp, and could not discriminate between eased voltage caused by the carbons burning short and sed by the extinction of a flare, and since this may at any time the arc could not be re-formed even when ons came together. The circuit, in fact, would be inert, arc would have to be re-established by hand.

fficient cut-out must extinguish the arc, and simul-y cut the shunt coil out of the circuit, the mechanism lamp also being free that the carbons may travel . The shunt must on no account be cut out whilst the on, since it could not then compensate the series coil w the carbons together. For the protection of the il I have used a temperature fuse, made of an alloy melting point of 210deg. F., and having sufficient l area to be independent of the amount of current traverse it. The carbons could be held apart several before fusion took place. Although a decided advantage ned over a plain lead fuse, and the shunt coil was ly protected, the carbon-holders were not protected, fuse required renewing each time it became ruptured. ef difficulty in constructing an automatic "cut-in" and it" lies in the necessity for a rapid make or break, to ration and sparking. My system may be briefly explained, the arc is first short-circuited through a shunt path, and at by reducing the voltage across the terminals. This then broken by a quick-break switch, the same action g the shunt switch simultaneously, ready to fall upon its contact when the carbons touch, or are replenished. hanism is actuated by the main armature of the lamp, movements take place while the armature is below the point, so as not to interfere with the working of the You can see the actual working of this novel "cut-out" amp which I show here.

HEATING AND MOTORS.

fect of the increased pressure upon such applications ouse current as heating, cooking, etc., does not entail nt alteration structurally or electrically to need an re description. The resistances forming or causing the surfaces must be arranged to conform to the higher at the terminals, and it is mostly preferable to increase h rather than decrease the diameter of the resistance ut this fact presents some difficulty in such articles e space available is small. If the space is too limited, aratus can only be used in series, or in connection external resistance. With motors, the greatest also lies in adopting the smaller sizes, say from to $\frac{1}{8}$ h.p., to suit the altered conditions of higher A certain structural alteration is doubtless necessary ge a new winding to produce the same efficiency as re on a 100-volt circuit. In the larger sizes, I am, in facilitate keeping stock, using a double or differential which, when coupled in parallel, conforms to 100 volts , and with the same winding in series gives an equal r on a normal load at the 200-volt pressure.

iewing the subject of higher voltage generally from a nt of cost, I am of opinion that sufficient time and ce naturally resulting from an increased demand will cost of most fittings for 200 volts within the margin of the lower voltage—except, perhaps, a few cases, which I may instance incandescent lamps. These will ily always be more expensive, owing to increased cost nting of larger bulbs and extra supports, and also increased time of exhaustion and percentage breakage. must not overlook the fact that in the matter of wiring ust be a decided saving. The smaller sectional area uctor per lamp employed, without the necessity of d insulation, as also in a minor degree smaller con-and contacts, will in all probability compensate some pparent disadvantages, and may bring the balance of avour of the high-voltage system. I do not wish to e subject of cables and wires or wiring systems within e of my present paper, but I will only mention that in ion such matters as the establishment of revised wiring the use of twin wires, the smallest gauge allowable for mps, the best and cheapest system of wiring for high-supply, would be subjects well worthy of the immediate ation of, and an interchange of opinion between, rs and manufacturers.

DISCUSSION.

, E. Crompton, on being asked to open the discussion, he would rather speak later. He wished to say some-the question of arc lamps, but he was not then quite ready. oot said the author ought to be congratulated on having h a useful paper. There was a tendency nowadays to be minor details of electric lighting, and he was glad to manufacturers, or, at any rate, one manufacturer was waking up. There might be a saving in first cost by the 200-volt system. He gathered this from mistakes in getting out tenders for high-pressure fitting, as he knew of several firms who had tendered for 100-volt cable instead of 220-volt, and had had to re-tender, but they had lowered their prices in so doing. Also he regarded as detrimental the fact of there being no standards as to fuses. Where a fuse was used with an alternating current, there was less need for precautions than with a direct current. Mr. Byng led them to infer that high-voltage lamps were rather bad, but his own experience was quite the reverse. There was one point regarding the introduction of series lighting in houses: they could use up in this way the 100-volt lamps. In Tunbridge Wells, where the columns carried arc lamps with two 100-volt incandescent lamps in series for use when the arcs were switched off, they got all their lamps for nothing in this way, as they used the 100-volt consumers' lamps.

Mr. Mordey said he had not much experience of 200-volt lamps, but he had been watching with interest the effort to bring in 200-volt circuits. Might he be allowed to ask if the specific resistance of carbon should be considered without reference to the specific gravity? They would find that according as the specific gravity of carbon varied, so did its resistance. An unflashed filament was like a string of cinders, and it had much greater resistance in that form. In 1883 he had described how carbon acted just as metal, when finely divided. In the gasholders, carbon was to be found in the form of thin filaments hanging from the roof, and he had often wondered if these filaments could not be used for lamp filaments. The author had said that the success of the high pressure system depended on the consumers, and central-station engineers must not imagine that the jury sitting upon it was asleep. As to the central-station question, he thought the central station should take upon itself the whole burden of supplying lamps to consumers. He would mention a very valuable paper contributed by Prof. Robertson to the *Electrical Review* on the "Life of Lamps," on direct and alternating circuits, in which he said that there was a decided gain when the alternating current was used. He wished to thank the author for having made mention of his fuses. Both seemed to have arrived at practically the same conclusion as regarded safety fuses. He thought that, on the question of arc lamps, the point to be aimed at was to get the light out from the lamp. Having the carbons pretty far apart enabled them to attain this object in some degree. With regard to the statement that an automatic cut-out was required in arc lamps, he thought the old Brush cut-out answered all the purposes Mr. Byng considered necessary.

Mr. Raworth said he wished to thank Mr. Byng for his paper. Mr. Boot and his friends would not be so happy if they had to live with the lamps. The makers supplied him (the speaker) with lamps free on trial. He had some lamps, of which 25 per cent. went when the current was switched on, and another batch, of which ten in twelve went. A great many were broken when placed in a horizontal position, through the filament coming in contact with the side of the bulb. The lampmakers ought to be given time to try various methods of making high-voltage lamps. The consumers would not have this system if they understood that it cost them 25 per cent. more than they were now paying.

Mr. Shoolbred said he had had nothing much to do with the subject. In the early days 50-volt lamps were as much an experiment as these high-voltage ones were now. He had no doubt that the 200-volt lamp would become as common as the 100-volt. The question of motive power was now coming to the front. Owing to the difficulties which they had laboured under, they had not had the opportunity to discuss it earlier. It was brought up some years ago in that Institution, but the question dropped. It would be a good thing if some unanimity could be arrived at in the matter. He had been by no means disheartened by the difficulties in the way. There was no reason why there should not be larger bulbs to take the longer filament. Mr. Raworth had said that though the long bulbs would work all right when placed in a vertical position, the filament fell against the glass when placed horizontally. He had used several makes of lamps, and had not found that a difficulty existed in that direction. He agreed with Mr. Raworth that it was but a matter of time when these lamps would come in.

ISLE OF MAN TRAMWAYS AND ELECTRIC POWER COMPANY, LIMITED.

The report of the directors to be submitted to the annual meeting of the shareholders on the 10th inst. shows a balance of £11,144. 14s. 9d., after providing £6,500 for debenture interest. Dividends at the rate of 6 per cent. on the preference and 7 per cent. on the ordinary shares, both of the general undertaking of the Company, absorbing £10,850, are proposed. Of that amount, £5,662. 10s. has already been paid in interim dividends, and the balance of £304. 14s. 9d. is to be carried to profit and loss account for the current year. It is expected that the new electric tramway from Laxey to Ramsey, a further distance of $10\frac{1}{4}$ miles, which will connect the two most important towns and districts in the island, now in course of construction, and which will be worked as a separate undertaking, will be opened for next summer's traffic, and will bring a considerable increase of revenue on the Company's present lines. The Diamond Jubilee celebrations in England and the wet weather of August and September militated against the interests of the Company. Traffic otherwise would have shown a considerable increase without additional working expenses. The retiring directors, Messrs. Alexander Bruce and F. G. Callow, offer themselves for re-election.

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TO CORRESPONDENTS.

 Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

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THE VALUE OF A MAN.

The despairing cry of fond parents of la has been for a profession to which their s be apprenticed with a view to get value for rendered. At one time the profession of engineer proved a great attraction, and sco educated and trained with the hope of o good positions therein. As things go at the time, the position of engineer-in-charge of a station is one of the plums of the profession, b authorities believe in paying such an official l the wages of a good cook. A recent advertise doubt brought the authority issuing it a nu applications. The authority in question man to design and carry out the construc equipment of a central station. True, a co engineer has already reported on the subj suggested a scheme. If the consulting prepared the designs and superintended t of the station his fee would be a percen the outlay, and a resident engineer would b sary to work under his supervision. The rity would save the fee of the consulting and expect the resident engineer to do the two men, and thus save the cost of one. the idea, no doubt. We do not know the r of this authority, but could pretty well ima idiosyncrasy of each. It is not, however, n to discuss that point at any length. Bros the collective wisdom of Little Pedlington to this: "We want to erect works to cost then advertise for a man to design and c for £100 a year to start with. If the work cost £20,000, try one for £200 a year to st and a rise of £25 a year up to £300. Yo to get a good enough man for that. We do a Great George-street swell—we want a good practical man!" And they get him. The when finished is badly designed; it is equip apparatus supplied by firms whose travellers l most cheek, or an "Hail fellow, well met"; e is not obtained, even though each separate lin apparatus is good, because the apparatus is design as a whole—one part good in itself, suited to work with another part equally good The man may have the best intentions, bu not had the experience required to enable decide as to the best in the case. Th however, is not with the man. He giv than value for the money he gets. The with the authority, whose penny wise an foolish policy causes niggardliness where ge is required. It is far better to employ a co man to well design, construct, and equip in place even, with a much greater initial cost, obtain a worse system which would be less eco in the long run. A thousand pounds extra e at the start may be the saving of thousands the working years; similarly, the saving, or s saving, of an initial thousand may lead expenditure of many thousands in the Although the preacher has preached on t many times, the moral is hard to gra some councils still consider that be thing is cheap, it is good. We are n

of waste, but those who persist in the that you can get the best at the t price, whether in brains or in machinery, in n or in execution, are altogether mistaken. cannot get for £200 a thing whose ordinary et value is £1,000, unless you steal it—and that ; honest. Hence the design which costs £200 rth that amount, and no more. The inexpe- ed man who pretends to sell for £200 what xperienced man gets £1,000 for is a fraud. ay be argued that an authority may have 0 to spend, and no more, and must put ith the best it can get for the money. ed, even then it is better to obtain a really etent engineer and pay him his fee rather than t the outcome of a less experienced man. The side of the argument is that the young engi- nust have a start. Then let the start be in roper way—first, under the experienced, to of his experience; and then to walk for lf. If he does that he will not sell his services than their value, and an authority will not t from him for £100 something the market of which is at least £500.

AMPS AND FITTINGS FOR 200 VOLTS.

paper read by Mr. G. Binswanger Byng the Institution of Electrical Engineers last is a most practical and valuable one. It welcome innovation to find a manufacturer ting that difficulties exist in the present ds of coping with the requirements of the voltage. At the same time valuable hints how these faults may be overcome are by the author, whom we congratulate on neral tone of his paper. Leaving the incan- it lamp question on one side, not because it nportant, but for want of space, we propose ring that part of the paper devoted to s." These are often unsatisfactory on one ed - volt circuits, and are liable to e somewhat dangerous at two hundred The author describes what he has to be a practical fuse, although it ges the regulations of municipal electrical eers. Safety has hitherto been sought in sed length and in ventilation. Mr. Byng ated a short fuse quite enclosed. He con- that it is essential to arrange a fuse wire t it will break at a definite part of its length— approximately, the centre—and that the arc d on breaking the fuse must be so con- that it cannot be maintained so as to ge the terminals, base, or cover. The on arises as to whether the past failures es will be overcome by the author's design. dering, firstly, the violent fractures of porcelain which have occurred. These have been said due to the rapid expansion of air inside the of the fuse. We think the more probable nation to be that the arc impinging on orcelain produces great local expansion, and the base or cover flies to pieces. This y is supported by Mr. Byng's own experi- ments, as we are informed that the first model of the new fuse was made in wood, and acted well. The model was then made in porcelain, but trouble ensued until the plaster of Paris lining was introduced. This, as is stated, is a better heat conductor, and is less liable to fracture. Still, if calculations are made, it will be seen that the expansion of air theory is not absurd, as pressures such as ninety to one hundred and fifty pounds per square inch might be obtained momentarily. The first essential laid down by Mr. Byng we most thoroughly endorse, but are not at all sure that his means will be permanently effective. Any fuse of soft and oxidisable material will give trouble in time under screw heads, and that without excess current. The whole subject is a most interesting one, and we shall be glad to receive correspondence on it from our country readers who have not the opportunity of speaking at the Institution next week. We would suggest to the author that a few experiments would add much to the interest of the gathering next week, and show conclusively the merits of different fuses.

FORTHCOMING EVENTS.

FRIDAY, MARCH 4.

Royal Institution.—At 9 p.m., "Some Recent Results of Physico-Chemical Inquiry," by Prof. T. E. Thorpe, LL.D., D.Sc., F.R.S., M.R.I.

Institution of Junior Engineers, Westminster Palace Hotel.—At 8 p.m., "An Outline of Patent Law and Practice," by Mr. Arthur H. Stanley, F.C.I.P.A., member.

MONDAY, MARCH 7.

Institution of Engineers.—Ordinary meeting at 7.30 p.m.

TUESDAY, MARCH 8.

Institution of Civil Engineers.—At 8 p.m., further discussion on "The Theory, Design, and Practical Working of Alternate-Current Motors," by Llewellyn B. Atkinson, Assoc.M.Inst.C.E.; and "Dublin Electric Tramway," by H. F. Parshall, M.Inst.C.E.; and, time permitting, paper to be read on "Calcium Carbide and Acetylene," by Henry Fowler, Assoc. M.Inst.C.E.

Royal Institution, Albemarle-street.—At 3 p.m., Prof. E. Ray Lankester, M.A., LL.D., F.R.S., on "The Simplest Living Things."

WEDNESDAY, MARCH 9.

Institution of Junior Engineers.—At 7.30 p.m. Joint meeting with Architectural Association at 9, Conduit-street, W. Papers on "Desirability of a Closer Relationship between Architect and the Engineer," by S. Beale, A.R.I.B.A., and Percy J. Waldram, P.A.S.I.

Society of Arts.—At 8 p.m., "Linde's Method of Producing Extreme Cold and Liquefying Air," by Prof. J. Ewing, F.R.S.

THURSDAY, MARCH 10.

Institution of Electrical Engineers.—At 8 p.m., discussion on Mr. G. Binswanger Byng's paper on "The Manufacture of Lamps and other Apparatus for 200-volt Circuits."

Royal Institution, Albemarle-street.—At 3 p.m., Tyndall Lecture, "Recent Researches in Magnetism and Diamagnetism" (Lecture I.), by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., M.R.I.

Finsbury Technical College.—At 8 p.m., L. J. Steele on "Electricity Meters"; second lecture of course of five.

FRIDAY, MARCH 11.

Physical Society.—At Burlington House, at 5 p.m.: (1) "On Dynamical Illustrations of Certain Optical Phenomena," by Prof. J. D. Everett, F.R.S.; (2) "On Properties of Liquid Mixtures," by R. A. Lehfeldt.

Institution of Civil Engineers.—Students' meeting, at 8 p.m., "The Drainage of Cottage Property," by H. C. Adams, Stud.Inst.C.E.

SATURDAY, MARCH 12.

Institution of Electrical Engineers.—Students' visit, at 10.30 a.m., to the stations of the Metropolitan Electric Supply Company.

Institution of Junior Engineers.—At the Westminster Palace Hotel, at 7.30 p.m., conversazione.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *two shillings and sixpence* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared, and should be written on one side of the paper only. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time.

QUESTIONS.

42. Give the advantages and disadvantages of using condensers in electric light stations; also discuss whether separate or combined condensers are best. Give approximate figure of saving effected.—P. G. M.

43. On a power transmission scheme, 500 h.p. has to be delivered to a station three miles from the power-house. Assuming a loss in the line of 50 h.p., compare the weight of copper required for lines, if direct current is used, with that for a three-phase transmission. The maximum voltage between the conductors to be 2,000 volts, and the power factor on the three-phase system 85 per cent.—P. T.

ANSWERS.

Question 36.—Describe, with sketches, what you consider to be the best system of main steam-pipes for central stations. Give reasons.

Best Answer to No. 36 (*awarded* 10*s*.).—Steam-mains for central-station work may be divided into two classes: (1) twin mains—a system in which there are two practically independent supplies from boilers to engines; (2) ring mains—a system in which the steam-main consists of a ring of piping which is fed at several points from the several boilers, and from which supply pipes are taken off for the different engines as required. An example of each system is given in Figs. 1 and 2 respectively.

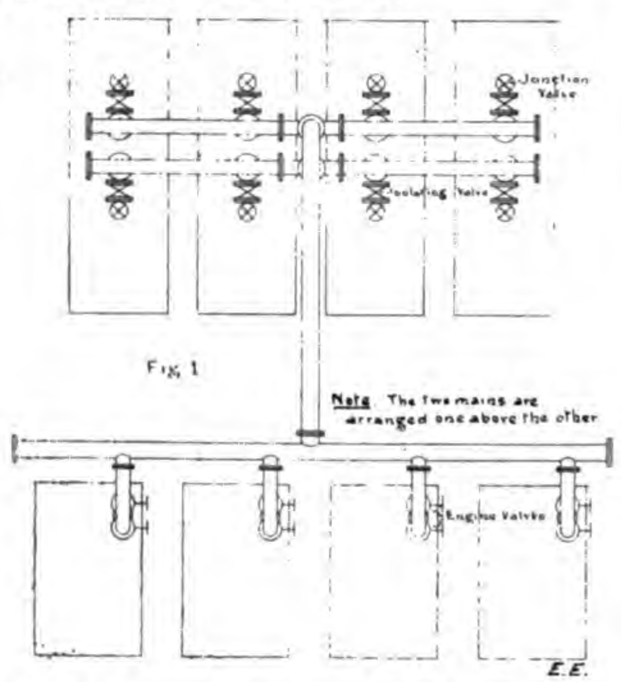


Fig. 1

The conditions of running a central station are such as to make it imperative that, in the event of anything happening to disable a portion of the steam-main, it shall not affect the running of the majority of the plant. This end is more or less attained by using either of the above systems. The twin system of mains probably better secures this end from one point of view, inasmuch as the two ways may be made almost independent from boiler to engine, but against this must be set off the increased liability to break down owing to the larger number of joints, etc. The greater first cost of this system is also a serious consideration. In designing a central station, however, it is not so much the relative merits of the two systems which de their suitability, but more the size and shape of t and consequent disposition of the machinery. Thi so, it becomes practically impossible to express any general preference for either system. When consid of space make it advisable to arrange the engines in row down one side of the engine-room, as in Fig. the twin system is undoubtedly the better. On th hand, when the engines may conveniently be arra both sides of the engine-room, as in Fig. 2, then t system has the advantage.

The points to be considered in arranging a sati system of steam-mains are: (1) isolation of section of failure; (2) good drainage and consequent freed wet steam: (3) suitable method of suspension and connections to engines and boilers allowing the expand in any direction.

The first point can only be attained in the case main by fixing a valve on each inlet and outlet on t pipe, and also a valve in the main pipe itself betwe outlet, the inlets being so arranged that not more t shall be joined to any one section of main betw main valves. A glance at Fig. 1 will make th arrangement clear. In the case of the twin main sy anything happens to one run of pipes, it is sim down and the other one used.

The second condition is realised by having a number of drain pipes attached at suitable points.

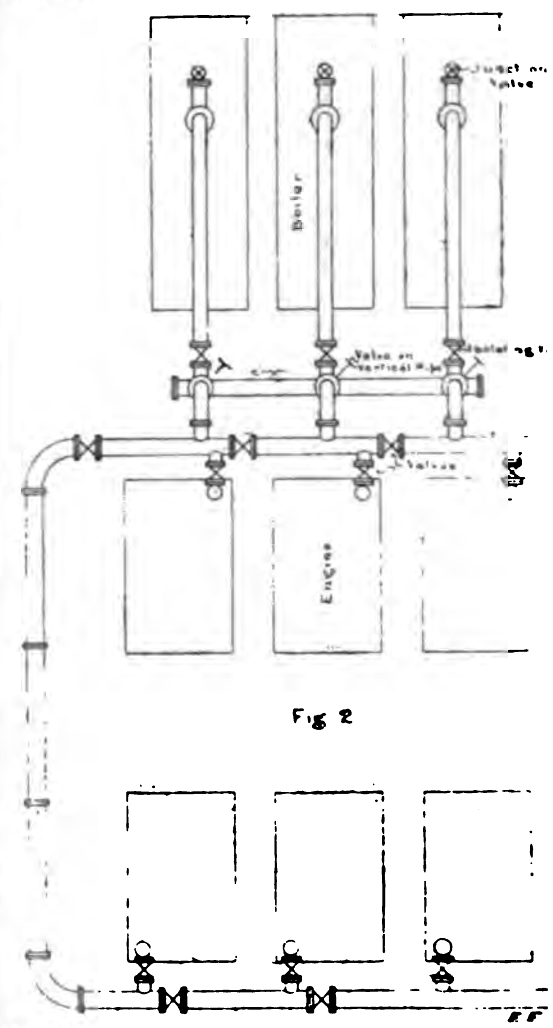


Fig. 2

should either be led back into the boiler (if th sufficient difference of levels to admit of the water back) or taken into steam-traps to prevent the wa sioned by leaving drains constantly open. It is to join the drains together in groups, each grou connected to a separate steam-trap, so that the the steam-main which is being worked shall not ba up those on the main, which is held in reserve. W site will permit, it is a very good plan to have th several feet above the boiler-level, and thereby to extent prevent water from being carried over. Figs. 1 and 2 the pipes are shown rising into th

Unfortunately, space will not permit of sections ven.

hird condition is satisfied either by supporting the rollers or, better still, by hanging them to brackets the walls. If the hanger is made about 2ft. long, it he pipes to move in any direction. All connections es should be made with a copper pipe having an nd to ensure sufficient springiness. It is as well to el flanges brazed on to the copper pipes.

egards the construction of the steam-main, steel ith electrically welded-on flanges are undoubtedly ray ahead of all other forms. All valves should be f the well-known types of full-way valves, as the ends in the ordinary valve mean a very considerable ressure when the steam has to pass through several. in inaccessible positions may be worked either by a heel and endless chain, or by a hand-wheel on a the end of which is a pinion gearing into the valve

No system of steam-mains is complete without an g or back-pressure valve fixed on the delivery of each These valves prevent steam being turned on to ty boiler. They have certainly been the means of g many serious accidents and much loss of life.

nclusion, the writer would, if all other circumstances vourable, most certainly prefer the ring main to any ystem on the grounds of less first cost, less main-, and greater simplicity. A single section may be shut out with this system in case of breakdown, with the twin system the whole main must be d.—A. A.

er to No. 36 (*awarded* 2*s.* 6d.).—In designing steam-rrangements for central electric lighting stations, ief points to bear in mind are: (1) to so arrange pes as to secure a continuous supply of steam to the in the event of a pipe bursting or a joint leaking; make it possible to supply any engine from any ; (3) the pipes should be provided with suitable and so supported that the bends can take up the ion and contraction of the pipes, otherwise expansion rill have to be used; (4) the valves should be of the y parallel slide type.

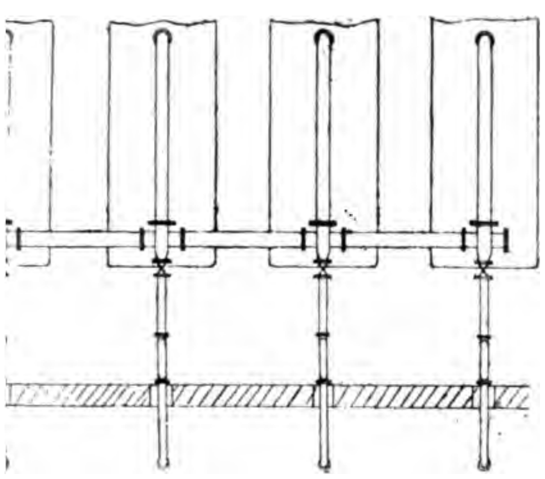
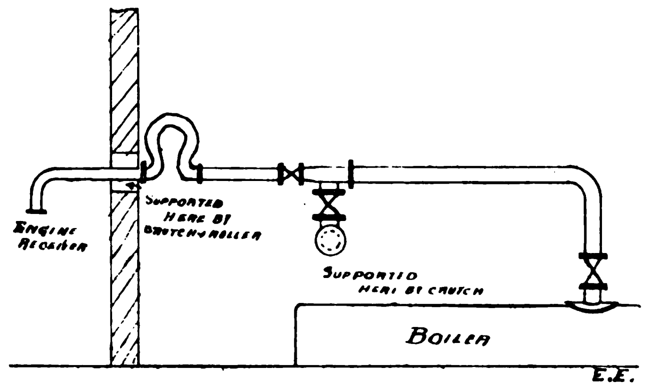


FIG. 1.—Plan.

e are two systems used for distributing the steam to gines: (1) by the ring system; (2) by the single-stem. Probably the ring system is the one which in the majority of central stations at the present, as be one most likely to keep up a supply of steam to ines in case of a breakdown. This system is open objections: (1) expense; (2) the condensation of in the ring. Both of these objections are to a extent remedied by adopting the single-main as shown in Figs. 1 and 2. The valves are so d in this system that in the ordinary course of g the boilers are feeding into and the engines taking om the main. By closing the valve, which is shown just above the main the boiler would supply the direct in each case, thus cutting out the main er; this is what would be done in the case of a m in the main. Of course, it would be necessary off the supply of steam to the engines while the main was thus being thrown out of use, but in all probability the same thing would have to be done if the same breakdown had occurred in the ring system, as, owing to the escaping steam, it would be almost impossible to see which section to cut out. Another advantage for this system is the simplicity of supporting the pipes. The main is supported by a cast-iron crutch placed on each boiler, and the branch pipes to the engines are provided with rollers mounted on cast-iron crutches and fixed on the wall boxes which are placed in the wall between the boiler and engine house. This does away with any hanging brackets,



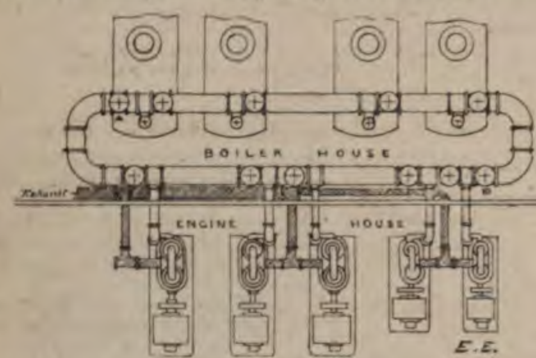
ELEVATION
FIG. 2.

which are more expensive and would not allow so free a movement for the pipes. In the event of more boilers being put down, thus necessitating the extending of the main, it would be advisable to put in a bend similar to the one shown in the branch pipes to engines, and also a valve to divide the length of main. It must be understood that the sketches show only how the valves are to be arranged to keep up the supply of steam to the engines, and that bends are necessary to take up the expansion and contraction, but the bends must be designed to suit the relative position of the engines and boilers, and need not of necessity take the form shown. It is sometimes an advantage, and is done in most cases where the pumps, etc., are driven by steam, to supply them by means of an auxiliary pipe connected to each boiler through a separate junction valve. This pipe is also useful for warming-up boilers which have been out of use.—T. A.

Answer to No. 36 (*awarded* 2*s.* 6*d.*).—The main steam-pipes in a central station should be so arranged that failure at any point may not cut off or seriously affect the supply of steam. Choice lies between three systems—viz. (*a*) main and branches in duplicate; (*b*) ring main, with a separate branch to each boiler and to each engine; and (*c*) the double ring main—*i.e.*, two complete ring mains, into one of which the boilers feed, and the other supplies the engines and a sufficient number of connections between the two.

The first of these is no better than the simple ring main, and has more joints and valves, which are therefore unnecessary complications. The last is the most perfect system, but it is doubtful whether it is worth the increased outlay and expense of repairs and upkeep, which will be practically doubled, when a single ring main with proper care and attention should be sufficient enough. This brings us to the conclusion that for simplicity, cheapness, both of first cost and upkeep, and efficiency, the single ring main is the best. The following arrangement (see diagram) is recommended: The main is carried over boilers, the whole of it being on the boiler-house to reduce condensation; a separate connection is brought to it from each boiler, and a branch taken from it through the engine-room wall to each engine and a valve placed between every branch, so that steam can be cut off from any section for repairs; also valves at A and B allowing the copper bends to be shut off when necessary without putting any one of the boilers or engines out of service, which is important, as these are rather weak parts, the brazing at the flanges being liable to give way. The engines are in pairs, so that the stop-valves are conveniently close, and one branch to the exhaust

main is common to two. To prevent water collecting and causing water-hammer effects, or, worse, getting into the cylinders, the pipes should be sloped towards the engines, and lead into separators fixed on the engine beds. A better plan would be perhaps to adopt the American method, and run a small pipe with a fall to the boilers beneath the main pipe, and connected to it at intervals by short vertical pipes, care being taken to insert at the end a check valve, which will pass water into the boiler but not out. All valves should be of large size, especially the main valves of boilers,



so that steam does not pass at too high a speed, and fitted with an arrangement to show whether they are open or shut, particularly the engine exhaust valves. The feed pumps should be electrically driven. In stations where space is limited, and it is found that the boiler and engine houses cannot be built side by side, this arrangement would have to be modified and the main ring carried along engine-room wall; or if, for lack of space, the engines have to be placed in a double row, it would be best to complete the ring by carrying it round all the four sides of the engine-room.—F. H.

[N.B.—We have noticed in several answers to the above a tendency to general description rather than the expression of opinion as to which is the best system. Will "F. H." kindly forward us his address?—Ed. *E. E.*]

Question 37.—**Discuss the advantages and disadvantages of high and low frequency respectively for an alternating-current supply to lamps and motors from a central station.**

Best Answer to No. 37 *(awarded* 10*s.)*.—It is to be understood that a frequency of 45 to 50 is low, and, say, 100 to 120 high. It is impossible to go much below 45 ∽ per second, as arc and incandescent lamps do not burn steadily, and the cost of transformers, etc., would be too heavy. On the other hand, very high frequencies exclude single-phase motors, as they will not start, and induction troubles increase rapidly as the frequency increases.

In discussing the advantages and disadvantages of the two frequencies for general work, it will be well to state the conditions governing plant. In the first place, the dynamo is to be considered. If we are to get a large power from an armature, we have to pass the induction through it many times. It follows from this that the higher the speed of poles passing an armature coil, the more power we can obtain from it. If we have low frequency, we, of necessity, must have a small output from a machine of a given diameter and running at a certain speed. So alternators are large and expensive for low frequency, if the efficiency is to be maintained. The same rules apply to transformers. They are alternators in which the field magnet does not move relatively to the armature, but in which the induction of the field magnet (the primary) is varied, and so *it* (the induction) moves relatively to the secondary. It is assumed in the above that the iron is run at the same induction. As a matter of fact, you would run low-frequency machines at a higher induction, as otherwise the iron would be excessively heavy. It is evident, then, that, as regards plant, everything is in favour of a high frequency. In coming to mains there is usually little difference. If there is a long-distance transmission the self-induction of the line will be the cause of a serious drop in volts, which, although it may not mean loss of energy directly, will certainly indirectly cause a loss, owing to the fact that more current will have to be delivered to

do a given amount of work, and the copper loss
increased. It is certain that if the capital outlay
formers is to be high—*i.e.*, if house transformers
used—it will be better to have a high frequen
sub-stations are adopted there will not be much a
gained by a high frequency, as one can afford to
greater percentage on an item which is a small p
of the total cost.

It is a very moot point if single-phase alt
currents should be used in any district where
expected, as single-phase motors are, even with a f
of 80, hardly satisfactory. They will not start
load, and if overloaded they drop out and stop,
if they do not do this they regulate badly. If a
speed is required the best motor is certainly a syn
one, which *must* run at a constant speed *if* the f
supplied is constant. It almost never is, as a
fact, owing to the large drop of voltage on most al
at heavy load, which is usually taken up by incre
speed instead of strengthening the alternator field
is needed, because alternators require their full
current at about half load, as a rule, otherwise
magnets would be heavy, or saturated and wastef
power factor, which is low if the lag of curre
apparatus is high, is of course much worse w
frequencies in all motors, synchronous or other
there will be heavier copper losses in consequence.

Summing up from the point of view of pow
thing is in favour of low frequencies; from th
outlay point of view it is better to have a high fr
When we come to incandescent lighting, of course
sumer does not mind whether the frequency is 50
it makes no difference. With arc lamps very little
of the efficiencies of high and low frequency lamps
subject is certainly worth a separate question, as s
interesting information would be obtained. On th
I would say that the frequency question must be
decided in every district. If residential, use high fr
if some power is expected, reduce the frequency
45; and if much power is expected, do not use sin
currents for the power, at least.—W. Fennell.

Answer to No. 37 (*awarded* 2*s.* 6*d.*).—The perio
a current depends (1) on the number of revolu
second of the alternator, (2) on the number of
current is reversed per revolution. The latter de
the number of alternate poles round the mach
increase the frequency of the current, it is
necessary either to run the machine faster or c
its construction. The former plan involves the
(*a*) of a high-speed engine, or (*b*) of gearing. In
is loss of power in transmission. In (*a*) there i
and expense in fitting and repairing, as bearings
valves, etc., wear out quickly and require high-cla
And whether (*a*) or (*b*) be used, the alternator beari
be well watched. Adding to the number of altern
round the machine avoids the foregoing difficul
such complication makes the machine's first cost
and is only really useful when a large output per
is wanted, as otherwise the parts become too sm
easily made and repaired. As far as the alternat
cerned, therefore, a low frequency is better, as
simplicity, durability, low first cost, and low mai
cost. Similar arguments apply to motors workin
alternate-current mains. Except in polyphase circ
will be synchronous. Very few consumers requ
speed low-power motors. They want one that i
durable, cheap, and easily kept in order. From t
considerations, these conditions are more fully sat
a motor running on a low-frequency circuit than
high-frequency, as, without a complicated constr
low speed may be obtained with power which
directly applied to the work to be done. It can
shown that a motor will develop its maximum pow
the volts required to overcome its self-induction
to the volts required to overcome its counter E.M
E.M.F. of self-induction with high frequencies
greater than any counter E.M.F. developed at
speeds. So that maximum power of a motor
nearly obtained with a low than with a high fr

On the other hand, the lamp load must be considered. During one alternation the current is insufficient to light the lamp for at least half the time. The filament heats and cools slowly, and on this the constancy of the light depends. If the frequency of the current be too low, the lamp's brilliancy will die away before the next impulse comes, and flickering will ensue. If alternating arc lighting is undertaken by the station, a high frequency is even more desirable than when only incandescent lamps are used, as the light of an arc fluctuates very much more than that of an incandescent during a period. The uniform effect depends on the persistence of vision. If the frequency is too low, the eye can detect the interval between one impulse and the next. As a central station at present depends largely on its lamp load, this is the most important part to be considered. In practice, where both lighting and power are wanted, a compromise is usually effected. In England, where the load consists chiefly of lamps, the frequency most commonly used is 100 or 80. On the Continent, where power is more used, the lower frequency of 40 is often adopted.—J. A. SEAGER.

PHYSICAL SOCIETY.

The last ordinary meeting was held at Eton College, Mr. Shelford Bidwell in the chair.

The President informed the society of the resignation of one of its hon. secretaries, Mr. T. H. Blakesley, M.A. In doing so, he alluded to the many important services rendered to the society by Mr. Blakesley, and he expressed the society's deep and general regret that Mr. Blakesley should now feel unable to continue them. The council elected Mr. W. Watson, B.Sc., to the office of hon. secretary.

Prof. T. C. Porter, in whose laboratory the meeting was held, said it gave him very great pleasure to welcome the Physical Society. Eton had been most properly called "the English home of ancient classical learning." For the education of youth, classics had proved itself of cardinal value. He believed that other Fellows of the Physical Society, with himself, desired that this revered tradition of classics should be maintained at Eton; at the same time, they would agree with him that there was no better supplement to classics than a fair knowledge of the natural sciences. Prof. Porter then gave a lecture illustrated by lantern photographs, on "**Observations on the Peak of Teneriffe.**" He also described his method for measuring the diameter of the earth. The method consists in observing the shadow cast by the peak upon the sea, and measuring the time that elapses between the moment when the apex of the shadow touches the sea horizon, and the instant when it is eclipsed by the shadow of night. Prof. Porter called attention to a phenomenon hitherto unnoticed—*i.e.*, that the heated air ascending from the peak casts a shadow, seen as a faint prolongation of that of the peak; it rises obliquely from the apex. A photograph was exhibited, taken on a quarter-plate, in which is visible the curvature of the horizon as viewed from the summit of the peak. An interesting series of unique photographs, illustrating the conformation of the peak and the phenomena of sunrise and twilight in that latitude, was also shown. In regard to twilight, he noticed that the first approach of night, as observed looking eastward, is marked by a dark border of about 5 deg. width, followed by a sky somewhat lighter.

The lecturer discussed also "**A New Theory of Geyser Action.**" The theories of Bunsen and others failed to explain why the geyser throat appears almost completely full at the end of an eruption. This immediate refilling is the more remarkable when it is remembered that some geysers of the Yellowstone region discharge a million and a half gallons at each eruption, and that the eruptions may occur at five-minute intervals. Moreover, the theories generally accepted assume steeper temperature gradients than those in a region like Yellowstone. Prof. Porter suggests that the phenomena are better explained on the assumption of an arrangement of strata such as exists in artesian-well districts, the throat or shaft of the geyser being in the position of a well communicating with a subterranean stream—the "tube" of the geyser. From the disturbed nature of the region, the tube of the geyser follows a waved course; the "shaft" rises from the crest of the terminal wave; the other crests may be steam-traps. Since a basin-like formation is characteristic of all geyser regions, it is fair to assume that the end of the tube remote from the shaft is an outcrop in the hills that form the sides of the basin. By means of this outcrop, water continually flows into the tube. Where the tube does not sink deeply enough to attain the temperature necessary for the generation of steam, a quietly-flowing hot spring is the result. But if, at any point, the tube descends to underground temperatures sufficiently great, steam is formed, and is trapped at the highest point of a bend. Ultimately this steam checks the flow of water until the accumulated head of cool water from the hills overcomes the resistance, condenses the steam, and re-establishes liquid continuity. Urged by the pressure behind it, the steam is impelled towards the geyser throat; it forces the hot water before it until equilibrium is again restored in the tube.

Prof. Porter afterwards exhibited "**A Method for Viewing Lantern Projections in Stereoscopic Relief.**" A slotted disc rotates in front of two lanterns. These project two stereoscopic views in rapid alternation upon a screen in such a way that the two projections are approximately superposed. In the rim of the disc other slots are cut, through which the observer looks. The arrangement of slots is such that the right or left eye is only able to see the screen at the moment when its own picture—*i.e.*, the picture from the right or left lantern—is on the screen. When the rotation is sufficiently rapid the views appear as one, without "flicker." in stereoscopic relief.

The President proposed votes of thanks, and the meeting was adjourned until March 11.

LEGAL INTELLIGENCE.

LEICESTER CORPORATION v. WARREN HILL.

We are indebted to the *Liverpool Daily Post* for the following report of a case of some importance to electrical engineers, heard at the Leicester County Court on the 24th ult. before his Honour Judge Wightman Wood. It was an action in which the Mayor and Corporation of Leicester sued H. Warren Hill, electrician, King-street, Leicester, to recover £4. 19s., the price of goods sold and delivered.

Mr. W. Simpson appeared for the Corporation, and the defendant was represented by Mr. Harold Newell (instructed by Mr. Chas. Squire).

Mr. Simpson explained at the outset that so far as the actual facts of the purchase were concerned there was no dispute between the parties. Defendant purchased a number of appliances on Sept. 15, 1895, from the electrical department of the Corporation, but declined to pay for them on the ground that the Corporation were trading *ultra vires*. There were altogether eight items in the purchase, and in respect of the first item 10s. 6d. had been paid into court. The point was whether the Corporation were entitled to sell and recover the price of articles and apparatus used in connection with the supply of electricity.

His Honour: Does the defence set up mean that the Corporation were trading *ultra vires* on this particular occasion?

Mr. Newell: That is so.

Mr. Simpson: He contends that the Corporation has no legal right of action against him.

His Honour: In other words, he says he need not pay for the articles he purchased?

Mr. Newell: Not in point of law; though in point of equity you may say you must restore them in their original condition.

Mr. Simpson proceeded to lay before his Honour the various clauses of the Acts of Parliament under which the Corporation supplied electricity, and maintained they had the power to trade in electrical appliances. The first Act was the Electric Lighting Act of 1882, under which corporations were authorised to supply electricity either by license from the Board of Trade or by means of a provisional order, the latter being obtained for Leicester. Section 10 of that Act gave them the power "generally to do all such acts and things as might be necessary and incidental to such supply." This, it was contended, conferred upon them the right to sell lamps or appliances which were incidental to the supply of electricity. Mr Simpson also quoted from the Act of 1890, and put in a printed form of account supplied by the Board of Trade to corporations, in which occurred the items "sale and repair of lamps," and "sale and repair of other apparatus," clearly indicating that those items were such as came within the scope of their trading powers. So far as the general law touching these powers was concerned, it provided that "anything reasonably connected with the primary object" was sanctioned, unless it could be shown by the defendant that it was outside altogether, and quite remote from the original intention. In conclusion, Mr. Simpson said he was entitled to throw upon the defendant the onus of proving that the Corporation were acting *ultra vires*.

Mr. Newell said he should accept the onus of doing so. This was a public Corporation, and held delegated powers. It had in its possession a fund derived from the public, and the particular purposes for which that fund should be used were clearly defined by statute. He should submit that under the statute of 1882 and the provisional order under which the Corporation acted, the only power they possessed was to supply electrical energy. But the Corporation had deviated altogether from that power, and were selling lamps and appliances which were not necessarily connected with the supply of electrical energy. They had become traders and shopkeepers, and had thereby damaged the local tradesmen, with whom they were unfairly competing. The Corporation competed with the local tradesmen by means of the very rates which those men partially contributed.

His Honour: I suppose this case is brought to try that principle?

Mr. Newell: Yes, that is so. The defendant in this case by no means wishes to shirk any legal liability with regard to this as a debt.

His Honour: I didn't know that—so many people come here who do. Then it is really to test the principle on behalf of the private traders?

Mr. Newell: It is, your Honour. They are here to ask you to say that the Corporation in selling these lamps are going outside their powers. The lamps are quite a distinct industry. Proceeding, learned counsel said the Corporation not only claimed to sell appliances to those to whom they supplied the electric light,

but to sell them to anybody. The defendant who bought these lamps was a trader, and himself supplied lamps abroad.

His Honour: But he is also a householder.

Mr. Newell said it was well known that Mr. Hill had not the electric light in his house. He (Mr. Newell) contended that in this matter the plaintiffs were in the position of a statutory corporation, and could only exercise the powers conferred by their charter.

Mr. Simpson remarked that their charter dated from Elizabeth

His Honour: You may be quite sure the charter of Elizabeth said nothing about the electric light. Do you say that before the passing of the Electric Light Act of 1882 the Corporation had no power to trade?

Mr. Newell: I should say not.

His Honour: Is there any authority that they shall not trade?

Mr. Newell: Where they go beyond such powers as they have in the charter that charter is revocable. I think the point your Honour puts does not arise in this case.

The **Judge:** Surely it does arise. The Corporation have traded; a man buys some lamps from them, and you say that contract of sale, so made between them and him, is void because they had no power to enter into such a contract. Is it the case that they had no such power before this Electric Light Act passed? If they had the power before, your contention must be that this Act of 1882 takes it away; if they had not the power, your argument must be that this Act does not give it to them. I want you to say which it is. What I am not satisfied about yet is that they had no general power, apart from this Act.

Mr. Newell: If they had the power before why should a statute be obtained granting that power?

The **Judge:** Oh, the statute does much more than that. What I want is an authority that they had not the power before.

Mr. Newell went on to quote from Bryce with the object of showing that corporations possessed only the capacities given at their inception. The authorities generally expressed very great doubt as to whether corporations had the power to trade.

The **Judge:** It seems to me there are two points to consider. One is whether is whether the sale of these articles was reasonably incidental to the supply of electricity; the other is whether the defence of *ultra vires* can be raised on an executed sale.

Mr. Newell gave numerous quotations from the Act of 1882, with the object of showing that the supply of the electrical energy was the gist of the whole power given to the Corporation, and that they had no power to charge for anything else but the energy. But even if supplying the energy carried with it the power to sell appliances where electricity was supplied, the Corporation were still wrong in this case, because they claimed to be able to sell appliances to anybody, apart from supplying them with electricity. He therefore submitted two points—first, that the Corporation could not supply lamps at all, because it was an independent industry; and second, that if they could, they could only sell them to those who had received their supply of electricity.

His Honour thought if the Corporation were entitled to supply lamps at all they could not be expected to ascertain whether every customer had or had not been supplied with their electric light. If they were entitled to sell at all it seemed to him they were entitled to sell to stray persons, because that would be a mere incident to their selling at all

Mr. Newell: If your Honour holds against me I shall have to ask your permission to appeal.

His Honour: Yes, you may appeal if I am against you.

Mr. Newell said this was a serious matter to the private traders, whose business was being injured.

His Honour: Are the Corporation underselling them?

Mr. Simpson: No.

Mr. Newell: They have, I am instructed, taken two thirds of the trade.

His Honour: I will take time to consider my judgment. The matter is important, do doubt.

ELECTRICAL WORK ON COMMISSION.

In the Westminster County Court, on Friday last week, before his Honour Judge Lumley Smith, Q.C., the case of the Westminster Engineering Company *v.* Kent was tried, and the question raised as to what was the proper rate of commission to be paid for electrical orders obtained.

It appeared from the evidence called on behalf of the plaintiffs that the defendants, a firm of builders, were engaged in carrying out structural alterations at a large house at 19, Upper Grosvenor-street, W., and employed the plaintiff firm to carry out the electric wiring and installation. The whole of the work was duly carried out, and it was agreed that the defendant was entitled to a commission of 10 per cent. on the amount, but he had thought fit to charge 15 per cent., and it was in respect of the balance of 5 per cent. which had been overcharged that the present action was brought.

It was admitted by one of the plaintiffs' witnesses that there had been occasions when 15 per cent. had been allowed on electrical work, but it was only under exceptional circumstances, and was not agreed for in this instance.

For the defence, **Mr. J. F. Kent** was called, and said he was a builder in a very large way of business at Whitehead's-grove, Chelsea, and in the course of trade he was in a position to place a great number of orders with electrical engineers. He did so in this case under the full impression that he was to have 15 per cent. commission, and he considered it was the ordinary rate of remuneration.

His Honour said he was not very clear on the point, but on the whole he was not satisfied that 15 per cent. was agreed upon, and therefore judgment would be for the plaintiffs for t
the sum of £6. 5s. 10d., and costs.

THE TELEPHONE MONOPOLY.

In the Lord Chief Justice's Court on Monday,
Russell of Killowen and a special jury, the case of Fla
National Telephone Company, Limited, came on
The case raised the question whether the company wa
liable for not selecting the shortest route for the
effecting telephonic communication with those with
had entered into contract, and whether they were liabl
veniences resulting from delay in effecting the conne
plaintiff claimed that by reason of the desire of the
adopt a route upon which they were more likely t
scribers, his communication was stopped for 3¼ years,
consequence he had suffered serious inconvenience.
found that there had been unreasonable delay on the
defendant company, and awarded the plaintiff £5 dama
ment accordingly.—*Financial Times.*

COMPANIES' MEETINGS AND REP

CITY OF LONDON ELECTRIC LIGHTING CO LIMITED.

An ordinary general meeting of this Company w
Wednesday at Winchester House, E.C., Sir David Salo
presiding.

The **Chairman** said that they were no less prospero
when they met a year ago. On that occasion the B
mended a dividend of 10 per cent., and for this the
£5,000 from the premium fund towards deprecia
similar sum was taken last year. The revenue of t
in 1896 was aided by a sum of £5,000 derived b
investments, and that, with the £5,000 already
amounted to £10,000 in favour of the revenue o
The dividend then paid was 7 per cent., wher
that sum they now recommended a dividend of 10 per
was quite enough to show that the Company was
factory progress. If the business increased at the rat
doing, the Board proposed to pay an interim divide
would be but small. The number of customers now be
was 6,517, the number (equivalent) of 8 c.p. lamp
305,163, and 318,745 applied for. The great City f
damaged them to the extent of about £300, and they
to get some betterment with new premises. The
plant was not yet quite completed, but what was co
giving great satisfaction. They had had some
to using Thames water at their works, but thei
Mr. F. Bailey, had devised a means to overcome
the plant was placed on a condensing basis, it
great improvement. A large fan had been erected at
and by creating a much better draught in the flues
them the necessity for building another chimney. W
a matter outside their report, they might remembe
Act of Parliament, and a contract with the Com
Sewers, they had been able to supply electricity wi
of London. The Commission of Sewers had now bee
by the City Corporation. They hoped they would
their new colleagues as well as they did with the old.
Corporation tried to prevent them having their just
would bring the matter into the Law Courts. Th
been anything of this yet, however, and he hoped the
be. The price per unit had been lowered, as the
by the sliding scale given them—viz., rates for electr
lighting purposes when measured by meter: for the f
consumed in each and every quarter per 8-c.p. lamp f
Board of Trade unit; for the next four units consumed
every quarter per 8 c.p. lamp fixed, 6d. per Board of
for the next two units consumed in each and every
8-c.p. lamp fixed, 5d. per Board of Trade unit; for
sumed in each and every quarter per 8-c.p. lamp fixe
above-mentioned 12 units, 4d. per Board of Trade
scale was applicable to all consumers who dealt
the Company, exclusive of those with whom, under
conditions, special agreements had already been
and was subject to each consumer who proposed
or otherwise alter the number of his lamps givi
written notice to the Company of such alterat
the consumer paying all amounts which might be due
pany within 14 days of the rendering of the acc
which he would be liable to pay 7d. per unit for the
consumption then owing. Each quarter would be
rately on its own basis, and when an account was pay
or otherwise, instead of quarterly, a corresponding
number of units at the sliding-scale rates would be t
allowance would be made quarterly or monthly as th
be. A 16-c.p. lamp would be reckoned as two 8-
32-c.p. lamp as four 8-c.p. lamps, and so on. The rat
energy for motive power and heating and cooking p
sively when measured by separate meter were as follo
sumer guaranteeing in writing that his motors or oth
would be in use for not less than 45 hours per w
charged 3d. per Board of Trade unit; any consumer u
guarantee of 45 hours' use per week would be charged 4d
Trade unit. These rates were conditional upon the e

st approving the type, size, and number of the motors and cooking appliances, and all apparatus appertaining to the plant being afterwards maintained and run to ion and in accordance with the Company's wiring rules. tated, the general conditions under which the Company ctric energy were not varied. The Board hoped to gements very shortly to supply and fix all wiring, rs, and other apparatus for consumers upon the basis on the outlay. This scale would date from Jan. 1. t was adopted.

RAPH CONSTRUCTION AND MAINTENANCE COMPANY, LIMITED.

Sir Anthony H. Hoskins presided (in the absence of V. Herbert) over the thirty-fourth ordinary general hich was held on March 1 at the offices, Old Broad-

rman stated that while they had had no important carry out during the past year, yet their factories both ad and East Greenwich had been actively employed, d been able to maintain their dividend at the same whole year as that paid for the previous year—15 per nount carried forward was, however, somewhat smaller, nsidered it better that the dividend should be main- ar as possible at a fixed rate, and that the amount ard should vary rather than the dividend. This was year of the insulation of telegraph wires. The gutta- s of the Company were started in May, 1845, to cleanse an almost unknown gum called guttapercha, a small which had been imported into Europe from Singapore in s not until the beginning of 1848 that the great value cha as an insulator of telegraph wires was fully recog- atented machinery was erected at the Wharf-road works opper wire covered with this material. Guttapercha d without a rival as an insulator for submarine cable y had entered into a contract for the building of a new er, which when completed would be the largest tele- in the world. He concluded by moving the adoption t and the payment of the dividend mentioned.

s **Pender, M.P.**, seconded the motion.

discussion followed, and in answer to questions the stated that the subject which had been referred to by lder who had quoted from an article on "The Strategic bles," was one of the highest national importance, and, s an ex-Admiralty official, he knew that it was occupy- atest attention of the Government. He did not think portance of the question had been at all overstated, as the Company was concerned he did not think it e anything to do with them except that when the cable or ion of the kind pointed out in the article was decided y should be prepared to take their share in carrying out It was entirely a governmental and strategical question. every reason to hope that their new cable ship would be l towards the autumn—in September or October. He that the question of wireless telegraphy was quite ant as far as they were concerned, for there was no ty of its superseding cable telegraphy to any extent. l a small instance of it in the interesting experiment at net Rock, but except on a very small scale like that he think there was any development of it which need at all e future of submarine telegraphy.

otion was unanimously adopted.—*The Times*.

EAUX TRAMWAYS AND OMNIBUS COMPANY, LIMITED.

report of the directors of the Bordeaux Tramways and s Company, Limited, for the year 1897, to be submitted rdinary general meeting to be held in London on 9th inst., s the following paragraph: "The question of electrical has received constant attention from your directors during t year, and after lengthy negotiations they succeeded in to terms with a committee of the Bordeaux Municipal l appointed for the purpose. Since the end of the year, r, the Council has rejected the committee's report by s to 15. The directors, whilst regretting this decision, feel y have gone as far as they prudently can in their endeavour t the views of the Municipality without prejudicing the s and interests of the shareholders.'

NG HILL ELECTRIC LIGHTING COMPANY, LIMITED.

eleventh ordinary general meeting of this Company was n Wednesday, Sir W. Crookes, F.R.S., in the chair.

Chairman said that in 1896 the sum of £10,000 was raised issue of 4 per cent. mortgage debentures. These debentures ssued at 106 per cent., and applications were greatly in s of the amount required. In accordance with the trust deed, mount was limited to 50 per cent. of the share capital actually l and paid up. At present, therefore, there were £40,000 bentures available for extra expenditure. The capital nditure during the current year was estimated at £7,000, hich further debentures would be issued. Their greatest nditure during the year was for new mains—viz., £1,169 of £14,079. They had now commenced to lay mains in new areas. There was a difference of 10 per cent. in output, owing to the reduction in the prices per unit. Great inconvenience had been caused the last six months of last year owing to the engineers' strike. The lamp connections in 1891 were 6,056, and had now risen to 33,000. In 1891 there was a loss of £555, and last year there was a gain of £6,854. Their revenue per 8-c.p. lamp was as low as 6s., while with most other companies it was 10s. A contract had been concluded with the Free Wiring Company to wire the houses in their districts, and they hoped to derive some benefit from this. They had every reason to be satisfied with the result of the reduction to 6d. per unit.

Mr. Daws enquired what length of mains they now had.

Sir W. Crookes said the mileage was about four or five at the present time.

The report was seconded by **Mr. A. E. Franklin**, and adopted.

BARCELONA TRAMWAYS COMPANY, LIMITED.

The annual general meeting of the Barcelona Tramways Company, Limited, was held on Wednesday at Winchester House, Old Broad-street, E.C., Mr. E. M. Underdown, Q.C. (the chairman), presiding.

The **Chairman** moved the adoption of the report and the declaration of a final dividend of 4s. per share on the old shares and 1s. 7½d. on the new, making, with the interim dividend, a total dividend of 4 per cent. for the year 1897, payable on and after the 3rd inst., free of income tax.

Mr. J. B. Concanon seconded the resolution.

Mr. Hamilton said that those who had followed the progress of the electric traction were satisfied that it would eventually be very remunerative. He thought the shareholders were greatly indebted to Mr. Concanon, who had rendered great service in bringing about the utilisation of electric traction for tramways generally, and in connection with the Barcelona tramways in particular, with a result which must be encouraging to all who had faith in his ideas with regard to the matter. He was quite certain that when they met in 12 months' time they would be in a position to congratulate themselves on the adoption of electric traction.

The motion was then put and carried unanimously.

Mr. W. G. Woolston (the retiring director) was re-elected, as were also the auditors (Mr. J. G. Griffiths, F.C.A., and Mr. G. Cloutte, F.C.A.).

NORTHAMPTON ELECTRIC LIGHT AND POWER COMPANY, LIMITED.

Directors: Francis Hugh Thornton, Esq., J.P., Daventry, chairman; Richard Cleaver, Esq., J.P., Northampton; Harry Manfield, Esq., C.A., Northampton; Samuel Lipscomb Seckham, Esq., J.P., D.L., Lichfield; William Tomes, Esq. (alderman), Northampton. Secretary: E. M. Browne. Engineer: W. E. Heenan.

Abstract of the ninth annual report and accounts presented by the directors to the shareholders at the annual meeting on the 24th ult.:

The directors are again able to present a favourable report to the shareholders, notwithstanding several circumstances, but for which the Company's progress would have been even more marked. The engineers' strike occasioned much delay and inconvenience, and it is fortunate that no mishap occurred during the busiest season. It became necessary, in view of continued difficulties with the local gas company, to appeal to arbitration on the question of the removal or alteration of gas service pipes, which interfered with the construction of this Company's culverts, on the safest and most approved plan. The Board of Trade arbitrator has granted the facilities asked for, but at the expense of valuable time and a resulting loss of revenue. The new system of charging for current has been much appreciated, and will conduce to the advantage of both the Company and its customers. The special rebate to consumers during the past year has amounted to no less than £488. The immediate result of this is a loss of income, but the use of electricity for lighting and motive purposes has been so popularised that the tendency cannot be otherwise than beneficial. The ordinary charge for current is 8d. per unit (less special rebate if shown by the "indicator"), for places of worship 4½d., and for motive power 3½d. (the demand in both cases being at times when the plant is least employed). Discount is also allowed for cash. Further developments are taking place at the Company's works. In addition to the two new engines and dynamos referred to in the last report, one more engine of 240 h.p. has been erected with dynamo complete, making in all six engine and dynamo sets. There has also been fixed a new boiler of a capacity equal to all the three original boilers combined, with an economiser and other subsidiary machinery. Further land and buildings have been acquired and an additional boiler-house has been erected, with a storage tank capable of holding 33,000 gallons of water. A supplemental accumulator battery has been added. The system of supply will be changed over during the present year from two to "three wire," thereby securing greater efficiency and economy. In view of the increasing demand for current, further plant has been ordered, consisting of boiler, engine, and dynamo, all of large capacity. The mains have been extended in several directions during the year. The machinery is maintained in a high state of efficiency. The balance of the revenue account for the past year was £1,409, less depreciation £500—£909. The lamps in use (at 8 c.p. each) during five years have been 4,600, 5,300, 6,130, 8,014, and 11,084 respectively, motive power being accounted for as lamps. It will be seen by the net revenue account that, after paying interest on debentures and temporary loans to the end of last year, there remains £562. 13s. 11d. to be dealt with. It is now proposed to pay a year's dividend on all the shares for the year ending Dec. 31

last—viz., on 6 per cent. preference shares, £232; on 5 per cent. preference shares, £65. 3s. 8d.; and on ordinary shares, at the rate of 2 per cent., £201. 0s. 3d.—leaving £64. 10s. to be carried forward. Further shares were issued last year—viz., ordinary shares to the number of 710, and 3,000 5 per cent. preference shares—but the total debenture issue was not increased. It is now proposed to issue 4,290 further ordinary shares at par, and also to raise £3,950 in 4 per cent. debentres, which will be issued at a small premium. The existing shareholders, debenture holders, and customers of the Company will have the first option of taking these shares and debentures. Messrs. F. H. Thornton and R. Cleaver retire from the Board in rotation, and will be proposed for re-election.

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal, etc.	£509	2	2			
Oil, waste, etc.	91	9	9			
Proportion of salaries of engineers, etc.	332	2	0			
Wages at generating station	355	14	10			
Repairs and maintenance	123	3	5			
				1,411	12	2
Distribution of Electricity.						
Repairs, maintenance, and renewal of mains				32	4	9
Rent, Rates, and Taxes.						
Rates and taxes				108	11	4
Management Expenses.						
Salaries of managing engineers, secretary, accountants, etc.	110	0	0			
Stationery and printing	63	15	11			
General establishment charges	60	11	6			
Auditor	10	17	6			
				245	4	11
Law expenses				40	0	0
Depreciation				500	0	0
Insurances, etc.				48	4	6
Total expenditure				2,385	17	8
Balance carried to net revenue				909	10	2
				£3,295	7	10

Cr.	£	s.	d.
Sale of current	3,032	2	7
Rental of meters	114	9	11
Rents receivable	27	5	1
Transfer fees	3	10	0
Premiums for pupils	101	2	0
Labour to customers	16	18	3
	£3,295	7	10

GENERAL BALANCE SHEET.

Liabilities.	£	s.	d.
Capital account—amount received	26,890	0	0
Sundry tradesmen and others, due on construction of plant, machinery, etc.	1,106	16	2
Net revenue account	562	13	11
Suspense account	124	5	0
Depreciation fund account	1,350	0	0
Cash at bank, current account	684	6	0
Cash at bank, loan account	2,000	0	0
	£32,718	1	1

Assets.	£	s.	d.
Capital account—amount expended for works	30,879	16	8
Stores on hand: coal, £46. 17s. 6d.; oil, waste, etc., £15. 5s. 2d.; general, £29. 9s. 10d.	91	12	6
Preliminary expenses	431	1	6
Sundry debtors for current	1,315	4	5
Cash in hand	0	6	0
	£32,718	1	1

RICHMOND (SURREY) ELECTRIC LIGHT AND POWER COMPANY, LIMITED.

Directors: Frederick W. Reynolds, chairman; Francis E. Savory; the Chevalier Soares. Engineer and manager: A. J. Lawson, M.I.E.E. Secretary: H. B. Renwick.

Report of the directors (with abstract of accounts) presented to the shareholders at the fourth ordinary general meeting of the Company held at the offices of the Company, Moorgate-court, E.C., on Thursday, the 3rd inst.:

The capital expended during the year amounted to £3,828. 17s. 1d., making the total expenditure at Dec. 31 last £44,793. 11s. 9d. It will be seen that of the amount expended during the period under review the principal items are in respect of mains and accumulators, the latter of which have been increased to more than double their previous capacity. The balance to credit of revenue account, including the amount brought forward, and after payment of interest, depreciation, and reduction of suspense account, is £1,072 18s., as against £33. 14s. 9d. in 1896. Out of this sum the directors recommend the payment of a dividend on the ordinary shares of the Company at the rate of 3 per cent. for the year ended Dec. 31, 1897, which will leave a balance of £133 to be carried forward to next account. The total number of lamps connected on Dec. 31 last was equivalent to 9,512 8 c.p., being an increase for the year of 2,387. In order to meet the growing demand for current additional plant will be installed in time for next winter's lighting, and further extensions of mains have already been decided upon. The retiring director is Mr. F. W. R[illegible] who, being eligible, offers himself for re-election. M[illegible] Marsh, the auditor, also retires, and is eligible for re-elec[illegible]

REVENUE ACCOUNT, YEAR ENDED DEC. 31, 1897.

Dr.				£
Generation of Electricity.				
Coal and other fuel	£609	17	8	
Oil, waste, water, etc.	99	16	1	
Engineers' salaries	77	4	7	
Wages	300	17	10	
Repairs—buildings, £15. 9s. 2d.; engines and boilers, £108. 2s.; other machinery, instruments, and tools, £32. 5s. 2d.; accumulators and accessories, £82. 17s. 10d.	238	14	2	
Cartage of ashes	17	8	6	
				1,3[illegible]
Distribution of Electricity.				
Engineers' salaries	65	12	0	
Wages	48	10	0	
Repairs—Mains	28	14	10	
Apparatus on consumers' premises	6	7	10	
				1[illegible]
Rents payable	59	0	0	
Rates and taxes	307	3	11	
				3[illegible]
Directors' remuneration	15	15	0	
Salaries, head office	100	0	0	
Stationery and printing	38	19	0	
General establishment charges	74	2	9	
Auditors of Company	15	15	0	
Auditor appointed under the provisions of the order	10	10	0	
				2[illegible]
Law expenses				[illegible]
Insurance				[illegible]
Bad debts written off				[illegible]
Balance carried to net revenue account				2,2[illegible]
				£4,4[illegible]

Cr.	£
Sale of current	3,9[illegible]
Rental of meters	1[illegible]
Rents receivable	1[illegible]
Discounts	1[illegible]
	£4,4[illegible]

BALANCE-SHEET, DEC. 31, 1897.

Dr. Liabilities.	£
Capital account—amount received	46,0[illegible]
Sundry creditors on open accounts	79[illegible]
Depreciation fund account	5[illegible]
Net revenue account—balance from last account, £33. 14s. 9d.; add profit for year ending Dec. 31, 1897, £1,039. 3s. 3d.	1,0[illegible]
	£48,4[illegible]

Cr. Assets.	£
Capital account—amount expended	44,7[illegible]
Stores on hand at Dec. 31, 1897: coal, £17. 14s. 1d.; oil, waste, etc., £7. 16s. 1d.; general, £56. 16s. 1d.	8[illegible]
Deposit with Richmond Corporation	10[illegible]
Sundry debtors	1,8[illegible]
Suspense account, £1,500; less amount written off, £250	1,2[illegible]
Cash at bankers and in hand	41[illegible]
	£48,4[illegible]

STATEMENT OF ELECTRICITY GENERATED, SOLD, ET[illegible]

Quantity generated in B O.T. units
Quantity sold to private consumers by meter
Quantity used on works
Total quantity accounted for
Quantity not accounted for
Total maximum supply demanded (kilowatts)

COUNTY OF LONDON AND BRUSH PROVINCIAL EL[illegible] LIGHTING COMPANY, LIMITED.

Directors: The Right Hon. Lord Rathmore, chairman[illegible] Braithwaite, jun., deputy chairman; Emile Garcke; Fred[illegible] Reynolds; Aymor H. Sanderson; Francis E. Savory; [illegible] Sellon; B. A. Van Tromp. Engineer and manager: A. J. [illegible] M.I.E.E. Secretary: H. B. Renwick.

Report of the directors (with abstract of accounts) to [illegible]sented to the shareholders at the fourth ordinary general [illegible] of the Company, to be held at Winchester House, Old [illegible] street, E.C., at 12 noon on Monday, March 14, 1898:

The capital expenditure during the year in respect [illegible] Company's London districts amounted to £141,[illegible]6. 3s. 9d. [illegible] sum £138,078. 5s. 10d. has been expended at St. L[illegible] Clerkenwell and at Wandsworth, making the total expend[illegible] the two London stations up to Dec. 31 last £410,[illegible]1. This expenditure was met by the balance of instalment[illegible] due on the second issue of 10,000 6 per cent. preference sha[illegible] by the sale at a premium of the balance of the second [illegible] ordinary shares. In order to provide funds for additional [illegible]

ments during the current year, a further 10,000 ordinary shares at par were allotted *pro rata* to the ordinary shareholders on Dec. 6 last. The premium received on the balance of the second issue of ordinary shares has been applied as follows: to reduction of general preliminary expenses, £3,253. 19s. 6d.; to writing off costs in connection with applications for provisional orders, £889. 15s. 6d.; amount carried to reserve (raising this item to £5,000), £1,500. The interests of the Company in the Bournemouth and District Electric Supply Company, Limited, have been disposed of to the Bournemouth and Poole Electricity Supply Company, Limited, at a substantial profit. Your directors deeming it to your advantage to retain an interest in the latter company, applied for and received an allotment of ordinary shares at par. The net revenue for the year, including the balance from last account, and after payment of proportion of rents, rates, taxes, interest, and general establishment charges, is £21,400. 14s. 2d. Out of this sum an interim dividend on the preference shares for the half-year ended June 30 last, at the rate of 6 per cent. per annum, has been paid; and the directors now recommend that a further dividend on the preference capital for the half-year just ended be declared at the same rate. This will leave a balance of £10,090. 14s. 2d., which it is proposed to carry forward. The Company's two London generating stations are now fully equipped and in good running order, having a joint plant capacity sufficient for the supply of 120,000 8-c.p. lamps connected. It is intended to supply the Company's districts north of the Thames from the St. Luke's station in the City-road, and those on the south side of the river from the station on the Wandle. The retiring directors are Mr. B. H. Van Tromp and Mr. R. Percy Sellon, who are eligible for re-election. The auditor, Mr. R. H. Marsh, also retires, and is eligible for re-election.

London Stations.

St. Luke and Clerkenwell.—The station buildings and the equipment thereof are practically completed. The plant installed is capable of supplying 80,000 8-c.p. lamps connected. The equivalent of 23,737 8-c.p. lamps were connected to the mains at Dec. 31 last, showing an increase of 9,578 for the year, and applications representing a further 1,073 were then awaiting connection. A considerable demand having arisen for motive power, separate mains have been laid down, and a supply of current for power purposes is now available in most of the important thoroughfares in the district.

Holborn (Eastern Portion).—A provisional order for the eastern portion of this district was granted to the Company by the Board of Trade, and confirmed in the last session of Parliament. The work of laying mains in the compulsory area was at once taken in hand, and current is now being supplied to consumers within this district from the generating station in the City-road. The Company's application to the Board of Trade for a provisional order for the western portion of Holborn, and for the adjoining district of St. Giles-in-the-Fields, has received the consent of the local authorities.

Wandsworth.—The station buildings on the Wandle were completed during the year, and the capacity of the plant there installed is equal to 40,000 8-c.p. lamps connected. The Company's mains have been carried into new neighbourhoods, and further extensions are in progress. The supply of current was commenced in the early part of 1897, and since September last has been available throughout the 24 hours. The equivalent of 13,907 8-c.p. lamps were connected to the mains at Dec. 31 last, showing an increase of 13,690 for the year, and applications representing a further 2,927 were then awaiting connection.

Camberwell.—The work of laying mains in the compulsory streets within this district has been commenced, and it is expected that by next autumn a supply of current will be available.

Mile End Old Town, St. George's-in-the-East, and the District of the Limehouse District Board of Works.—Provisional orders for these districts were granted by the Board of Trade in 1896, and confirmed by Parliament in 1897.

Provincial Stations.

Dover Electricity Supply Company, Limited.—In the past year an important addition was made to the Dover station by the laying down of generating plant for the supply of current to the Corporation tramways. The running of the trams by electricity was commenced in September last. In the second completed year of the working of this station the gross profits amounted to £1,127. 17s. 5d., as against a loss in 1896, and the Company may now be considered as fairly established on a profit-earning basis. The equivalent of 10,137 8-c.p. lamps were connected to the mains at Dec. 31 last, showing an increase of 2,619 for the year (including nine arc lamps for street-lighting), and applications representing a further 239 were then awaiting connection. In the early part of 1897 the Dover Company made an issue of £25,000 4½ per cent. debenture stock, the interest upon which is guaranteed by your Company.

Richmond (Surrey) Electric Light and Power Company, Limited.—A considerable improvement is shown in this company's accounts for the year under review. The gross profits amounted to £2,233. 5s. 4d., which allows of a dividend of 3 per cent. on the share capital, after providing for interest charges and reserve for depreciation of plant, etc. The equivalent of 9,512 8-c.p. lamps were connected to the mains at Dec. 31 last, showing an increase of 2,387 during the year, and applications representing a further 220 were then awaiting connection. In order to meet the increasing demand for current at this station, it is intended to lay down additional plant during the present year, and further extensions of mains have been decided upon.

Dr. Revenue Account.	£	s.	d.
Proportion of directors' remuneration, salaries and wages, rents, rates and taxes, and insurance	2,225	7	8
Printing and stationery, and postage	329	3	6
Sundry charges, including legal and travelling expenses	607	8	2
Auditors' fees	105	0	0
Depreciation of office furniture	135	13	8
Interest paid on temporary loans	1,093	11	3
Balance carried to net revenue account	20,875	1	5
	£25,371	5	8

Cr.	£	s.	d.
Gross profits derived from interest on investments, rents, discounts, and administration of associated companies	6,858	11	0
Transfer fees	110	15	0
Dividends receivable	908	11	5
Profits on investments realised	13,690	13	5
Balance from revenue accounts	3,802	14	10
	£25,371	5	8

County of London (North) Electric Lighting Order, 1892.

Dr. *Revenue Account.*	£	s.	d.	£	s.	d.
Purchase of current				2,757	9	4
Generation of Electricity since Sept. 8, 1897.						
Engineers' salaries	£156	11	11			
Wages	261	2	7			
Coal and other fuel	752	2	2			
Oil, waste, water, etc.	135	12	6			
Repairs — engines and boilers, £50. 1s. 2d.; dynamos, £2. 9s. 2d.	52	10	4			
				1,357	19	6
Distribution of Electricity.						
Engineers' salaries and wages	107	8	4			
Repairs	5	16	0			
				113	4	4
Rents payable	142	6	6			
Rates and taxes	76	5	1			
Insurance	11	1	0			
Stationery and printing	60	7	6			
Audit fee—Board of Trade	41	0	0			
General charges	59	8	8			
				390	8	7
Balance profit carried to revenue account				2,521	14	9
				£7,140	16	6

Cr.	£	s.	d.
Sale of current	6,554	17	5
Rental of meters	254	12	8
Rents receivable	327	14	11
Testing fees	3	11	6
	£7,140	16	6

Wandsworth Electric Lighting Order, 1892.

Dr. *Revenue Account.*	£	s.	d.	£	s.	d.
Generation of Electricity.						
Engineers' salaries	£300	0	0			
Wages	539	18	5			
Coal and other fuel	741	14	8			
Oil, waste, water, etc.	79	11	6			
Repairs—engines and boilers	64	15	0			
				1,725	19	7
Distribution of electricity—salaries and wages				110	3	9
Rates and taxes	15	15	10			
Insurance	10	7	9			
Stationery and printing	76	2	1			
Audit fee—Board of Trade	33	0	0			
General charges	75	16	3			
				211	1	11
Balance profit carried to revenue account				1,281	0	3
				£3,328	5	6

Cr.	£	s.	d.
Sale of current	3,102	12	1
Rental of meters	127	18	11
Rents receivable	92	10	0
Testing fees	5	4	6
	£3,328	5	6

Statement of Electricity Generated, Sold, etc (County of London, North).

Quantity purchased and generated in B.O.T. units	333,140
Quantity sold to consumers by meter	260,572
Quantity used on works	4,865
Total quantity accounted for	265,437
Quantity not accounted for	67,703
Total maximum supply demanded (kilowatts)	322

Statement of Electricity Generated, Sold, etc. (Wandsworth).

Quantity generated in B.O.T. units	162,151
Quantity sold to consumers by meter	116,821
Quantity used on works	5,689
Total quantity accounted for	122,510
Quantity not accounted for	39,641
Total maximum supply demanded (kilowatts)	251

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bo ton.—The School Board invite tenders for the supply of six electrical clocks. Specification may be obtained at the School Board Offices, Nelson-square.

Derby.—The Corporation are prepared to receive tenders for the electric wiring of their lunatic asylum and premises at Rowditch, Derby. Tenders by March 24. Further particulars will be found in our advertisement columns.

St. Chamond (France).—Tenders are invited for lighting the town by electricity or otherwise. Particulars are to be obtained from, and tenders addressed to, Municipal Authorities at above place (Department Loire) by March 31.

Alexandria (Egypt).—Tenders are invited for indiarubber tubes, etc., for the Post and Telegraph Department. Specifications may be obtained from, and samples inspected at, the Gabbary Stores, and tenders are to be addressed to the President of the Council of Administration, Cairo, by March 28.

Madras.—The Secretary of State for India in Council announces that the time allowed for the receipt of tenders by the Chief Engineer for Irrigation, Madras, for the utilisation of water power of the Periyar Lake has been extended from Oct. 31, 1897, to July 1, 1898.

Melbourne (Victoria).—The Telegraph Department of the Victorian Government Railways are inviting tenders for the supply of alternating-current transformers and one main switchboard. Tenders to the Telegraph Superintendent's Office, Spencer-street, Melbourne, by March 21.

Seraing (Belgium).—Tenders are invited for electric installation for public and private lighting and for power transmission for 30 years, to commence from Feb. 1, 1899. Particulars are to be obtained from, and tenders addressed to, Municipal Authorities at Seraing, Belgium, by April 1.

Kolding (Denmark).—For complete establishment of electric lighting works, etc. Specifications are to be obtained from Byraadets Udvalg for Electricitätsvaerket, Sugfòrer Edv. Lau. for 50 kroner (£3. 3s.) to be returned on receipt of bona fide tender, and tenders addressed the same at Kolding by March 24.

London.—Tenders are invited for the supply of the lightest possible form of motor (to be complete with tank, tender, or other fuel supply), capable of developing energy of 9 h.p. on brake test, at a spindle revolution of 500 per minute. Dimensions and total weight of the machine to be sent to Mr. B. Morley Fletcher, A.M.I.C.E., 7, Victoria-street, Westminster.

Ipswich.—The Electric Lighting Committee are prepared to receive from responsible firms full detailed offers for carrying out the provisions of the Ipswich Electric Lighting Order, 1897, including terms upon which the undertaking could be acquired by the Corporation at certain dates if so desired. Offers, endorsed "Tender," to be sent to the Chairman of the Electric Lighting Committee, Town Hall, Ipswich, by March 25.

Plymouth.—The Corporation invite tenders for the supply of electricity meters (alternating-current) for the 12 months ending March 31, 1898. Specification, with form of tender, may be obtained by bona fide meter manufacturers or their authorised agents on application to Mr. John H. Rider, borough electrical engineer, East-street, Plymouth. Sealed tenders, endorsed "Electricity Meters," must be delivered to Mr. J. H. Ellis, town clerk, Plymouth, not later than March 23.

St. Pancras.—The Vestry invite tenders for building a brick chimney, shaft about 240ft. from the foundations. Copies of specification, conditions of contract, and form of tender are to be obtained at the Electricity Department Offices, 57, Pratt-street, Camden Town, N.W., on payment of a deposit of £1, which will be returnable on receipt of the specification accompanied by a bona fide tender. Tenders to be sent to Mr. C. H. F. Barrett, vestry clerk, endorsed "Tender for Chimney," by 12 noon on March 17.

Belfast.—The Corporation invite tenders for the wiring of the new police cells Chichester-street. Specification, with schedule of lights and form of tender, may be obtained on application to Mr. Victor A. H. M'Cowen, electrical engineer, Marquis-street, Belfast, on payment of £1. 1s., which will be returned on receipt of a bona fide tender accompanied by the specification. Sealed tenders, endorsed "Tenders for Wiring of Police Cells," to be delivered at the offices of Sir Samuel Black, town clerk, by 10 a.m. on March 9.

West Ham.—The Council invite tenders for wiring and fitting up the following buildings, situated in the county borough of West Ham: (1) town hall and fire station, Stratford, E.; (2) police court West Ham-lane, E.; (3) Corporation stables, Abbey-road, E.; (4) fire station, mortuary, and weights and measures offices, Barking-road, Canning Town, E; (5) public conveniences, Broadway, Stratford, E.; (6) fire brigade watchbox, Woodgrange-road, Forest Gate, E. Tenders by March 8.

West Derby.—The Guardians invite tenders for the following work in connection with the lighting of the Mill-road Infirmary: (Contract No. 1) two dry-back return-tube boilers, each to evaporate 4,000lb. of water per hour; (No. 2) three 50-b.h.p. coupled engines and dynamos, one booster, two feed pumps one feed-water heater, one switchboard, steam, etc., piping, tanks, etc.; (No. 3) one secondary battery of 900 ampere-hours' capacity; (No. 4) wiring of infirmary, administrative buildings, and nurses home, and cable connections from main switchboards to above buildings. Tenders by March 8.

London, S.W.—The Secretary of State for War is prepared to receive offers, in writing, accompanied by competitive designs and specifications, for the supply of portable electric search-light apparatus. General particulars as to requirements can be obtained on application, either by letter or personally, to A. Major, director of army contracts, War Office, Pall-mall, S.W. The offers and designs must be delivered at the War Office, Pall-mall, London, S.W., by April 27, addressed to the Director of Army Contracts, and marked on the outside "Designs for Search-Light Apparatus."

Coventry.—The Electric Lighting Committee of the Corporation will receive tenders for the supply and erection of the following plant for the extensions of the municipal electricity works: (Section A) engine-house plant—300-kw. steam alternator and exciter; (B) separate exciting plant—25-kw. steam dynamo and accumulators; (C) surface-condensing plant—condenser, air-pump, circulating pump, and footplates, etc.; (D) pipework—steam, exhaust, suction, and discharge pipes, valves, oil separator, etc.; (E) switchboards and instruments—main H.T. switchboard, exciter and accumulator switchboards, step-switches, etc. Tenders by March 8.

Egremont (Cheshire).—The Wallasey Urban District Council invite tenders for the following works—viz., (*a*) engine, alternator, and exciter; (*b*) two Lancashire steam-boilers and one water-tube steam-boiler; (*c*) condensing apparatus. Copies of the specifications may be obtained on application to the engineer, Mr. J. H. Crowther, Gas and Water Works, Great Float, near Birkenhead. A charge of £2. 2s. will be made for copy of each specification, to be returned on receipt of a bona fide tender. Sealed tenders, on the form provided for the purpose, addressed to the Chairman of the Gas, Water, and Electricity Committee, and endorsed "Tender for Engine and Alternator," or any other contract, as the case may be, to be delivered at the office of Mr. H. W. Cook, clerk, Public Offices, Church-street, Egremont, Cheshire, by 4 p.m. on March 17. Contractors will be required to enter into a bond with approved sureties for the performance of contract.

Northwich.—The Weaver Navigation Trustees invite tenders for the construction and erection of the necessary electric power plant for lighting and working the new swingbridges at Northwich. The current will be supplied by the Northwich Electric Supply Company, and while the machinery will have to be constructed on the general lines laid down in the specification, and shown on the drawings, the details will be left largely to the discretion of the contractor, who will be expected to supply sufficient information and drawings to enable a decision to be arrived at as to the suitability of his proposals. The specification and drawings may be seen, and all further information obtained, from Mr. J. A. Saner, Engineer's Office, Weaver Navigation, Northwich, on and after Feb. 14. Tenders and plans will have to be sent in, marked "Tender for Electric Plant," and addressed to the Clerk, Weaver Navigation Offices, Northwich, on or before March 5.

Shoreditch.—The Vestry are prepared to receive tenders for the following works for one year from March 26 next to March 25, 1899, inclusive—viz., electricity works department—(A) electric cables and sundries, (B) engineers' stores, and (C) ironmongery, tools, etc. Samples may be seen at the Electric Lighting Station, Coronet-street, Hoxton, N. Forms of tender for all the above-mentioned articles can be obtained on application to Mr. H. Mansfield Robinson, clerk, Town Hall, Old-street, E.C. Tenders must be sent to the Clerk before 4 p.m. on March 8. Contractors or their agents must attend at the Vestry meeting at the Town Hall, Old-street, on March 8, at 6.30 p.m., and must agree to pay the trades union rate of wages observed at the date of the contract, and to observe the usual hours of labour recognised by the trade. Forms of tender, with any further information, may be obtained from the various departments of the Vestry or from the Clerk.

Watford.—The Urban District Council invite tenders for the supply and erection of the following plant: (Section A) generating plant, water tube boilers and fittings, economiser, feed pumps, injectors, etc., steam alternators and exciters, condenser, oil filter, fittings, etc., steam exhaust, blow-off, and sundry pipes, valves, water tank, etc.; (B) switchboard and all connections; (C) overhead travelling crane; (D) conduits and mains for general supply; (E) public lighting and adaptation of existing public lamps; (F) transformers, sub-stations, and switching gear; (G) arc lamps and posts. Tenders may be sent in for any section or sections or for the whole of the sections, but not for part of a section. The ground plan of works, plan of streets, etc., and specifications with forms of tender, may be obtained at the offices of Mr. W. C. C. Hawtayne, consulting engineer, Mansion House-chambers, 20, Bucklersbury, E.C., on payment of £5. 5s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting," must be addressed to Mr. H. Morten Turner, clerk to the Council, at the Council Offices, Watford, and be delivered on or before 12 noon on March 16.

Sophia (Bulgaria).—Her Majesty's Secretary of State for Foreign Affairs has received a despatch from her Majesty's Agent and Consul-General at Sophia to the effect that the Municipality of Sophia have issued a notice inviting tenders (*a*) for electric lighting of the town, town hall, and fire brigade barracks; (*b*) for an electric tramway for the town and surroundings. Only bona fide electrical firms are allowed to tender. Tenders must be in by March 5-17, at 11 a.m. A deposit certificate of the National Bank of Bulgaria of £6,000 must accompany each tender; also documents showing that the contracting firm has already successfully carried out similar works. If up to the 10th-22nd of March, at 10.30 a.m., a proposal of a reduction of at least 5 per cent. per kilowatt-hour of the lowest

tender is received, a new adjudication will take place on the same day at 11 a.m. Specifications are to be obtained from the Mayor of the above town (8s. prepaid), where tenders are to be addressed. Further particulars may be obtained, and a copy of the specification and other papers may be inspected, on application at the Commercial Department of the Foreign Office, between the hours of 11 and 5.

Pembroke (Ireland).—The Lighting Committee are prepared to receive tenders for the supply and erection of the following plant: (Section A) boiler-house plant—Lancashire boilers and accessories, mechanical stokers, feed pump, injector, economiser, electric motor; (B) engine-house plant—high-speed steam dynamos and accessories, oil-filter, steam, exhaust, feed, blow-off, and sundry pipes, valves, feed-water and storage tanks, etc.; (C) overhead travelling crane; (D) Switchboard and instruments; (E) accumulators; (F) underground work—trenching, cables, etc.; (G) public lamps—arc and incandescent street lamps and lamp-posts; (H) meters. The whole bound up in one specification. Tenderers are at liberty to tender for any one section, but not part of a section. Specification, with terms and conditions and forms of tender, may be obtained at the offices of Mr. Robert Hammond, M.I.E.E., the consulting engineer to the township, Ormond House, Great Trinity-lane, London, E.C., on payment of £5. 5s., which sum will be refunded on the return of the specification filled up with a bona fide tender. Duplicate copies of the specification, £1. 1s. each, not returnable. Tenders, sealed, and marked "Tender for Electricity Works," must be addressed to Mr. J. C. Manley, secretary, Pembroke, and be delivered by March 5.

Blackpool.—Tenders are invited by the Corporation for the supply and erection of the following plant at the Corporation electricity works—viz.: Contract No. 1—(Section A) one tubular boiler with superheater; (B) superheaters for five existing Lancashire boilers; (C) surface condensers, pumps, pipes, and storage tanks; (D) two 55-light rectifiers; (E) 10 15-kw. boosters. Contract No. 2—(Section A) high and low tension lead-covered cables; (B) 10 50-kw. transformers. Contract No. 3—(Section A) 20 arc lamp pillars; (B) 100 arc lamps. Tenderers are at liberty to tender for any section, but not for part of a section. Specifications, general conditions, forms of tender, etc., may be obtained from Mr. Robt. C. Quin, borough electrical and tramway engineer, Blackpool, on prepayment as to Contract No. 1 (Sections A to D, which are bound up together) of the sum of £5. 5s., and as to Contract No. 1 (Section E), Contracts No. 2 and 3 (Sections A and B) of the sum of £2. 2s. for each section, which respective sums will be returned on receipt of a bona fide tender on the prescribed form and within the prescribed time. Duplicate copies of Contract No. 1 (Sections A to D) and Contract No 2 (Section A) will be charged £1. 1s. each, which will not be returned. The Corporation require the erection and completion of above plant within four months from the date of order. Tenders, endorsed "Electricity Works Extension (Contract No. —, Section —)," should be addressed and delivered to Mr. T. Loftos, town clerk, Town Hall, Blackpool, before 10 a m on March 22.

RESULTS OF TENDERS.

Wimbledon.—The following tenders have been received for the erection of an electric light station at Wimbledon. Mr. A. H Preece is the engineer:

Yerbury and Co.	£3,984
Balled and Co.	3,720
Wall and Co.	3,578
J. Burges	3,388
Lorden and Sons	3,333
Thomas and Edge	3,261
Minter and Co.	2,990

Gloucester.—The Corporation have received the following tenders for the supply of plant and machinery for the municipal electricity works of the city of Gloucester. Mr. Robert Hammond is the consulting engineer. The type of boiler, engine, and meter is given in parentheses:

Section A.—Boiler-house plant.—Lancashire boilers and accessories, mechanical stokers, feed pump, injector, economiser, electric motor.

Yates and Thom (own make) (accepted)	£2 409
Tinkers, Limited (own make)	2,478
E. Danks and Co. (Oldbury), Limited (own make)	2,478
India Rubber, Gutta Percha, and Telegraph Works Company, Limited (J. Adamson and Co.)	2,553
E. T. Danks, Limited (own make)	2,590
Holdsworth and Sons (own make)	2,665
H. F. Joel and Co. and T. Potter and Sons United, Limited (Yates and Thom)	2,821
J. Fraser and Son (own make)	2,910

Section B.—Engine-house plant.—Steam dynamos and accessories.

C. A. Parsons and Co. (Parsons turbine)	4,570
India Rubber, Gutta Percha, and Telegraph Works Company, Limited (Belliss) (accepted)	5,917
Siemens Bros. and Co., Limited (Sisson and Co.)	6,495
Easton, Anderson, and Goolden, Limited (Willans)	6,535
Crompton and Co., Limited (Sisson and Co.)	6,614
Siemens Bros. and Co., Limited (Belliss)	6,720
Electric Construction Company, Limited (Belliss)	6,753
Crompton and Co., Limited (Sisson and Co.)	6,820
H. F. Joel and Co. and T. Potter and Sons United, Limited (Willans)	6,882
[illegible], Limited (Belliss)	6,980
[illegible], Scott, and Co., Limited (Willans)	6,994
Electric Construction Company, Limited (Willans)	£7,035
P. R. Jackson and Co., Limited (Belliss)	7,052
Siemens Bros. and Co., Limited (Willans)	7,060
Crompton and Co., Limited (Belliss)	7,402
W. Sisson and Co. (own make)	7,415
Crompton and Co. (Willans)	7,640
Brush Electrical Engineering Company, Limited (Willans)	7,749
J. C. Howell, Limited (Willans)	7,752

Section C.—Overhead travelling crane.

Bedford Engineering Company	240
India Rubber, Gutta Percha, and Telegraph Works Company, Limited	262
J. Spencer and Co. (accepted)	265
Marshall, Fleming, and Jack	267
Humpidge, Holborow, and Co., Limited	285
Carrick and Ritchie	306
H. F. Joel and Co. and T. Potter and Sons United, Limited	310
Summers and Scott	315

Section D.—Switchboard and instruments.

J. White	1,074
Nalder Bros. and Thomson (alternative)	1,083
Edison and Swan United Electric Light Company, Limited	1,083
Crompton and Co., Limited (accepted)	1,111
Nalder Bros. and Thomson	1,120
Williamson and Joseph, Limited	1,211
P. R. Jackson and Co., Limited	1,265
Veritys, Limited	1,275
General Electric Company, Limited	1,300
E F. Moy, Limited	1,318
Electric Construction Company, Limited	1 357
H. F. Joel and Co. and T. Potter and Sons United, Limited	1 393
Siemens Bros. and Co., Limited	1,530
India Rubber, Gutta Percha, and Telegraph Works Company, Limited	1,555
Burbey and Hutton	1,559

Section E.—Accumulators.

Electrical Power Storage Company, Limited (accepted)	1,350
Lithanode Electric Storage Syndicate, Limited	1,384
India Rubber, Gutta Percha, and Telegraph Works Company, Limited	1,537
Pritchetts and Gold	1,576
Chloride Electrical Storage Syndicate, Limited	1,700
Epstein Electric Accumulator Company, Limited	1,808
P. Radford, Limited	1,862
H. F. Joel and Co. and T. Potter and Sons United, Limited	1,868
Allan and Adamson, Limited	1,943
Hill, Gifkins, and Co.	2,036
Tudor Accumulator Company, Limited	2,043
D.P. Battery Company, Limited	2,119
J. C. Howell, Limited	2,247
Elieson Lamina Accumulator Company, Limited	2,508

Section F.—Mains.

Callender's Cable and Construction Company, Limited (accepted) (approximate schedule of prices)	13,500

Also tendered: British Insulated Wire Company, Limited; Western Electric Company (Fowler-Waring Cable Company, Limited); W. T. Glover and Co.; W. T. Henley's Telegraph Works Company, Limited; India Rubber, Gutta Percha, and Telegraph Works Company, Limited; Siemens Bros. and Co., Limited.

Section G.—Public lamps.—The decision upon the tenders for this section has been deferred.

Stewart Electrical Syndicate, Limited (part 1 only)	828
Brockie-Pell Arc Lamp, Limited (part 1 only)	1,058
Phaeton Electrical Company, Limited	1,552
Taylor and Fairbrother	2,138
General Electric Company, Limited	2,205
Crompton and Co., Limited	2 222
Hill, Gifkins, and Co.	2,387
W. Lucy and Co., Limited	2,488
British Insulated Wire Company, Limited	2 550
Brush Electrical Engineering Company, Limited	2,679
Siemens Bros. and Co., Limited	2,702
India Rubber, Gutta Percha, and Telegraph Works Company, Limited	2,717
British Blahnik Arc Light Company, Limited	2,859
Johnson and Phillips	3,144
Electric Construction Company, Limited	3,330
Drake and Gorham	3,681

Section H.—Meters.

Chamberlain and Hookham (Hookham) (accepted)	1,121
S. Z. de Ferranti (Ferranti)	1,207
India Rubber, Gutta Percha, and Telegraph Works Company, Limited (Hookham)	1,207
General Electric Company, Limited (British Aron)	1,210
J. White (Kelvin)	1,210
Downie and Adams (Brillie)	1,439

Willing's British and Irish Press Guide and Advertisers' Directory and Handbook, 1898.—The twenty-fifth annual edition of this concise and comprehensive index to the Press of the United Kingdom has just been issued by James Willing, jun., Limited, at the price of 1s. A list of the principal foreign newspapers is attached. It is handy for reference, and recommendable for its low price.

BUSINESS NOTES.

Harrow.—An extension of the electric light mains down South-hill-avenue is proposed.

Loughborough.—A committee has been appointed to report on the question of establishing electric light in the borough.

Long Eaton.—The Council have lodged a petition against the Bill promoted by the General Power Distributing Company.

Appointment Vacant.—An electrical engineer is required for British West Indies. Particulars are given in our advertisement columns.

Wath.—The Urban District Council have decided to petition against the Bill promoted by the General Power Distributing Company.

Rowley Regis.—The Urban District Council have consented to the application of the Midland Electric Corporation for Power Distribution.

Glossop.—The question of lighting the town by electricity permanently will be brought forward at the next meeting of the Town Council.

Dorking.—A public meeting is to be held to discuss the electric light question. In the meantime the Council will issue a circular giving a brief *résumé* of the question.

Beckenham.—The Electric Lighting Committee of the Urban District Council are preparing a report on the probable applications for electric light throughout the district.

St. Helens. — An Electricity Works Committee has been appointed for the control and management of all matters connected with electric lighting and electric traction on the tramways.

House-to-House Electric Light Supply Company, Limited. — The transfer registers of this Company will be closed from the 2nd inst. to the 12th inst., both days inclusive, for the preparation of dividend warrants.

J. S. Cunnington and Co.—We are informed that, in consequence of increasing business, Mr. J. S. Cunnington, electrical engineer and contractor, has removed from 18, Cecil-court to larger premises—93, St. Martin's-lane.

London United Tramways.—We have received from the London United Tramways, Limited, a map by Mr. J. Clifton Robinson, C.E., showing the existing lines and the proposed extensions in and near the county of London.

City of London.—The Corporation have decided to instal the electric light into the offices of the late Commission of Sewers and the offices of the engineer, and the Offices Committee has been instructed to have the work carried out accordingly at an estimated cost of about £120.

Bradford.—At the last meeting of the Gas and Electricity Supply Committee of the City Council, a sub-committee was appointed for the purpose of considering the desirability of reducing the price of electricity for lighting purposes. The present charge is 5d. per unit.

Weston-super-Mare. The Urban District Council have passed the following resolution: "That the clerk be instructed to apply to the Board of Trade for their approval of the system of electric lighting proposed to be adopted, and that he forward the necessary information to the Board of Trade."

Liverpool.—Mr. Arthur Bromley Holmes has been appointed electrical engineer-in-chief for both the tramway service and for the electric lighting and other electrical purposes, on condition that he gives up private practice. Mr. Holmes's salary has been increased by £600 per annum in lieu of his private practice.

Derby.—An extension of the main on the Duffield-road has been ordered, on an agreement being entered into and the approval of the proper authorities obtained. The engineer is preparing a specification for wiring the Board schools at the request of the School Board. Tenders for carbons have been received, but the contract has not been awarded.

Alloa.—On Tuesday the brewery of Messrs. George Younger and Sons, Limited, situated in Candleriggs, as also their business offices in Bank-street, were lighted by electricity. This is the first installation of the electric light in the town. The local authorities have resolved that the principal streets shall next winter be illuminated by the same process, the installation costing £3,000.

Sunderland.—The report of the Electric Lighting Committee to be presented to the Council at its next meeting contains a recommendation of Mr. J. F. C. Snell, the electrical engineer of the borough, to apply for sanction to a loan of £25,000 for extensions to plant and mains. It is intended to spread this amount over a number of years, using £8,700 during the present year.

River Plate Telegrafico-Telefonica Company.—The receipts during the past year have amounted to 336,165 dol. and expenditure to 266,400 dol., the receipts showing an increase of 78 per cent. and the expenses of 34 per cent. in correspondence with the previous year. A dividend of 10 per cent. will be distributed, which, added to the interim distribution of 8 per cent., makes a total return of 18 per cent. for the year.

Uxbridge.—A petition to the London United Tramways having been signed by 6,000 residents, and approving of the promoting of an electric tram route to connect Uxbridge with the London United Tramways system, was discussed at the Urban District Council meeting, and the seal of the Council was attached to the petition, the same to be sent to the London United Tramways, Limited, as the petition of the town and Council.

Portsmouth.—A discussion took place at the last meeting of the Council upon the report of the Roads and Works Committee, recommending the Electric Lighting Committee to consider the desirability of having a refuse destructor at their works in Gun-wharf-road, and utilising the steam to be generated thereby for electrical purposes, and report to the committee as soon as possible.

Hammersmith.—A report of the Electric Lighting Committee recommending the Vestry to construct two new sub-stations, one in Uxbridge-road (Lime-grove) and the other in Goldhawk road (St. Stephen's-avenue) at an estimated cost of £250 each, to include building, connecting-up, and equipment, and also to sanction the expenditure of £150 upon finishing and furnishing the offices at the electricity works, has been adopted by the Vestry.

Coventry.—At the last meeting of the City Council the Electric Light Committee presented a report showing that the revenue had increased from £1,245. 16s. 6d. to £1,958 19s. 8d. during the past year. A loss of £41 in the previous year had been converted into a profit of £106. The supply of the light was being extended into the residential quarters of the city, and it was hoped ere long that arc lamps would be placed in the streets. The report was adopted.

Southwark.—At the last meeting of the Vestry of St. George-the Martyr, it was agreed to adopt the recommendations of the Electric Lighting and Dust Disposal Committee: "That application be made to the Board of Trade for a provisional order to enable the Vestry to supply electrical energy throughout the parish." The Board of Trade will be informed that the Vestry will lay down the necessary plant directly the provisional order is confirmed by Parliament.

Southborough.—The Urban District Council have received notice from Mr. H. E. McKrell, of Little Mowshurst, Edenbridge, Kent, intimating his intention to apply at an early date for a provisional order for the lighting of Southborough by electricity in accordance with the provisions of the Electric Lighting Acts, 1889 and 1890, and making application for the consent of the authority to his proposal. The committee have recommended the Council to oppose such application.

Waterloo.—Twelve new arc lamps are to be erected at a cost of £216. The electric lighting company are to pay half the cost of the service lines, and also undertake to carbon, maintain, and keep in perfect working order the 12 lamps at a cost of 2s. 6d. per hour. It is estimated that the cost of supplying 12 lamp standards, exclusive of fitting, will be £184. 4s. The suggestion to erect four arc lamps at the junction of Great George's-road and Crosby-road is under the consideration of the Council.

Storage Cells.—We are informed that Mr. J. W. Barnard, late secretary of the Electrical Power Storage Company, Limited, has been appointed by that company sole agent in the United Kingdom for the sale of their Q and V types of storage cells. It will be remembered that these types of E.P.S. cells are intended specially for use in connection with carriage, cycle, miners', domestic hand-lamps, phonographs, electro-medical appliances, etc. Mr. Barnard has secured offices at 4, Great Winchester-street, E.C.

Lancaster.—Two new 2,000 c.p. arc lamps are to be fixed in the streets. At the last Council meeting, in the course of a discussion, it was suggested that in the narrow streets of Lancaster it would be better to use two 1,000-c.p. arc lights instead of one 2,000 c.p. light; also that the arrangement to keep the lamps lighted longer on dark mornings should be a permanent one. It seemed a foolish thing to keep the lamps lit all night and then extinguish them just when people were beginning to stir.

Free Wiring.—The contract for the complete installation for the electric lighting of the headquarters of the Metropolitan Fire Brigade, Southwark, S.E. has been given to the National Electric Free Wiring Company, Limited, by the London County Council. The work comprises steam dynamo, storage batteries, incandescent and arc lighting complete. The same firm have also secured the order for the installation of the electric light at the Bridge Hotel, Arundel. The National patent system of house wiring is to be used throughout in both these cases.

Radcliffe.—The District Council have resolved that the surveyor's report be entered on the minutes; also that Dr. Hopkinson and Mr. J. J. Bennett, Mr. Clirehugh, and Mr. Medhurst, be asked for their terms for advising the Council upon a suggested scheme for electric lighting for the Radcliffe district at an estimated cost of between £15,000 and £20,000; further, that the Municipal Electric Supply Company be asked for information as to what places have adopted their system of electric lighting, and on receipt of the same the towns mentioned be written to.

Gorton. At an ordinary meeting of the Urban District Council it was proposed that the common seal should be affixed to the Council's petition against the Bill now being promoted in Parliament by the Manchester Carriage and Tramways Company. It was said that the object of the opposition was not unfriendly, but merely to safeguard the interests of the district. They were aware that the Manchester Corporation had decided to take over and work the tramways within their own boundary. As a private company, the Manchester Carriage Company stood first in the country. The motion was agreed to.

Personal.—We understand that Mr. J. Stanley Richmond, Liverpool electrician, who has had considerable experience in the New World as well as in England, has been appointed by the Government of Trinidad to examine and report upon the various systems light, power, and telephone—using electric current in the Port of Spain and its vicinity, with a view to determining the risk to life and property now involved. Mr. Richmond starts for Trinidad on March 9, and though the precise engagement is

months, the Government of Trinidad has reserved to ption of extending it to 12 months.

General Omnibus Company.—At the half-yearly eting of the London General Omnibus Company, which ast week at 6, Finsbury-square, E.C., Mr. John Pound The chairman, replying to questions, said they were ery closely the development of motor vehicles, but as cost of a motor 'bus would not be less than between £600, they did not see their way at present to adopt ere was no intention of splitting up the stock, because to see that any advantage would be gained by it. They ir horses at £27 apiece. Many of them had cost between 50.

a.—The Towns Improvement Act of 1854 having en adopted in Macroom, co. Cork, it was decided at a the Town Commissioners held on the 21st ult. that the t with electricity, and to carry out this scheme, Mr. A d, C.E., was directed to make a map of the town. The ners intend getting the town lit as soon as possible, and directed the town clerk to make enquiries as to whether electric lighting companies would take up the lighting n, and as there is sufficient water power to be had to the town, no difficulties present themselves in e scheme through.

n.—The committee to whom was referred the question the Edmonton workhouse by means of electricity, t the last meeting of the Guardians that they had e report of Mr. Knightley, the architect, upon the d were unanimously of the opinion that it was desirable ouse should be supplied with the electric light, by were satisfied that a large saving of expense would be d they recommended that the subject be referred back obtain plans, specifications, and estimates for the work, r. if necessary, to employ a consulting electrical The report was carried.

d—At a special meeting of the Town Council the poses Committee reported that they had resolved to the Council to petition against the Electric Tramways nited Tramways) Bill, and to authorise the General ommittee to take such action in support of the petition y deem expedient, especially with reference to the (1) no further doubling of the line in Kew-road; (2) d trolleys; and (3) if the company be authorised to line, the company to be compelled to acquire the nd at their own expense. After some debate the further f the question was adjourned.

-A special meeting of the Council is called for Monday ider Prof. Kennedy's report and their future action to the electric light. The *Buxton Herald* says that ree courses open to them: first, they may do the work ; secondly, they may let the Council's powers and duties y; and the third course will be to settle, with the help nnedy or some other expert, exactly what works are obtain a specification and form of contract, to invite the work—not for the order—and to let the work on ms. We can only hope that the Council will come to sion, and that having come to it they will promptly arry it out.

.—At the last meeting of the Swansea Corporation c Lighting Committee, Mr. Manville attended. The as exhaustively discussed, and there was practical s to immediately proceeding with the electric lighting d much more accord on the question of the dust The site was discussed, but no absolutely definite e to. A long discussion on the whole question with e took place, and Mr. Manville agreed that for the e low tension was preferable, and undertook to at e a new report in which due regard would be paid to od of customers being found in the owners of works inery for the day load.

tion.—On Feb. 28 a handsome gold watch, with an address on vellum, was presented on his fiftieth Mr. T. W. Vaughan, managing director of Vaughan , Limited, lighting and heating engineers, 15, 16, and treet, Hatton Garden, and 109 and 110, Great Saffron- presentation was made by Mr. P. W. Hastings on e members of the staff and old employés, some of whom rith the firm from 20 to 35 years. Mr. Hastings spoke h respect and esteem in which Mr. Vaughan was held ected with the business, from the lowest to the highest, were glad to think the business had prospered and s present large dimensions.

a.—At the last meeting of the Vestry, upon the ation of the Works Committee, that the sum of e raised by means of a lighting rate, an amendment, sum be reduced to £9 895," as a protest against the e electric current for public street lighting, was moved. the electrical engineer, said that private consumers were n a sliding scale from 7d. per unit downwards, according y of current used. The Vestry undoubtedly had the ble terms, and much better terms than the public. The the Vestry included the cost of the maintenance of and the cost of carbon, which averaged ¼d. per hour. The nt was lost, and the motion agreed to.

phone Service.—A memorial having been forwarded ited Chambers of Commerce to the Postmaster- g attention to the irregularities and delays on the telephone service, and suggesting the adoption of remedial measures, the Duke of Norfolk has replied that the Department is continuing its efforts to provide a wide-spread and efficient system of communication; and during the period from April 1 to Dec 31 last the construction of additional trunk wires, amounting to upwards of 3,000 miles, has been undertaken. Some of these wires have been completed, and others are being constructed as quickly as possible. So far as the Department is concerned, every effort will be made to deal with the traffic as expeditiously as possible, and the Department will from time to time carefully attend to the question of providing such additional trunk circuits as the growth of the traffic may demand.

Bedford.—The report and the third annual statement of accounts of the electricity undertaking to Dec. 31 states that the output has gone up 60 per cent., and the number of extra 8-c.p. lamps in the last year was 2,850 over that of the corresponding period of the previous year. The statement of accounts and the following resolutions have been adopted by the Council: "The committee are of opinion that if during the current year the electric light continues to be taken up in the borough to the same extent as in the past year, that a reduction in the price per unit can reasonably be expected to be made to consumers from the beginning of the next year. (*b*) The committee are assured of the advantages resulting from the use of mechanical stokers, and recommend that two more be purchased at an estimated cost of £385. (*c*) The committee also recommend that two water purifiers in connection with the steam-boilers be purchased at the price of £120."

Aberdeen.—The Gas and Electric Lighting Committee of the Town Council last week approved the annual accounts, which show a balance of £169 carried to the reserve fund. Some discussion took place on the question of fixing the price for next year, but in view of the fact that the new system of charging has been in operation for only six months, the present charges for light—5d. per unit for the first hour on the maximum quantity, and 3d. per hour afterwards—are to be retained at least for the next six months. It was decided that in future the charge for motive power should be 6d. per unit for the first hour, and 1½d. per hour afterwards, instead of 3d. as at present. The committee are inclined to allow a rebatement to the Students' Union, but before that could be done it will be necessary to carry a service main from the street to the union buildings at a cost of £35. It was stated that after having ascertained what the union would do in the matter, a rebatement might be recommended.

Manchester.—A sub-committee of the City Council, after conference with representatives of the Corporations of Salford, Oldham, Ashton-under-Lyne, Stalybridge, and Stockport, and the Urban District Councils of Stretford, Denton, Droylsden, Gorton, Levenshulme, Audenshaw, Moss Side, Failsworth, Withington, and Heaton Norris, have resolved that, subject to the approval of the City Council, measures be taken for the promotion of a Bill in Parliament to enable the Corporation and any neighbouring local authorities to make arrangements for working their tramways in conjunction with those of the city, upon terms to be mutually agreed upon, and also to authorise the supply of electric power by the Corporation or any of the other authorities, and the purchase or lease by the Manchester Corporation of any of the tramways of the other local authorities, such Bill also to contain all necessary provisions as to the working, use, management, and maintenance of such tramways, the supply of rolling-stock, plant, machinery, and electrical energy or other power, and other matters incidental to the objects of this resolution.

Greenock.—The sub-committee of the Police Board, on the question of electric lighting, held a meeting last week, when the report by Mr. Teague, electrical engineer, Paisley, already noted by us, was considered. The report stated that the most suitable place for the installation would be at the Water Trust works at Prospecthill, and that the cost of laying the necessary plant to light the streets from Rue End-street and along west to Campbell-street would be about £25,000. Mr. Teague was asked to submit a report on providing plant for lighting the whole town by electricity. It was roughly estimated that to do so would cost over £95,000.—The Gourock Police Commissioners have proposed that the lease of the tramways through Greenock and Gourock should be altered by the Greenock Police Board, so that both leases should terminate at the same time, and that the charges for wayleave in Greenock should be reduced to enable the tramway company to give a larger sum for wayleave in Gourock than they are at present doing. The Greenock Board have resolved to continue the present arrangement with the tramway company.

Camberwell.—The Vestry held a special meeting on the 23rd ult. in order to receive a report from the General Purposes Committee recommending that notice be given to the County of London and Brush Provincial Electric Lighting Company requiring them to sell their undertaking to the Vestry. The terms, full details of which appeared in our last issue, were stated to be £133 for every sum of £100 properly expended by the company, and 5 per cent. per annum dividend. Mr. Cox said they were starting upon an expenditure of £20 000, and the question arose whether they were embarking on a wise course of procedure. He found that the cost of their own electric lighting requirements, such as public lamps, would amount to £4,500 a year, as against a sum of £1,450 they were paying at present for those same requirements. Doubtless they would make a profit by selling the light to others, but how much were they going to sell? As he thought they ought to have further information on the subject, he moved that the recommendation be referred back to the committee. After an acrimonious discussion the amendment was carried.

Hoarcross.—An installation of the electric light has just been completed at Hoarcross Hall and Church for the Hon. Mrs.

Meynell-Ingram. The electric light station has been erected on the site of the gasworks, and the installation is in every way most complete. The engine and dynamo room is 40ft. by 22ft. The engine is a Hornsby-Arkroyd oil-engine of 40 b.h.p., with two 7ft. flywheels. The dynamo is a Crompton shunt and compound 1898 pattern, and is capable of supplying current to 400 16-c.p. lamps. The accumulator-room is 20ft. square, and the accumulators are of the Faure-King type and the first of that type in use. They consist of 68 cells, and are neatly staged on four stands two tiers deep, with free access from all sides to allow of inspection. A special feature of this battery is that the plates are so protected and arranged as to prevent buckling and short circuiting, while they are so small as to allow one man to handle them with ease. The capacity of each cell is equal to the old type, which is twice as large. Messrs. Walker Bros., of Cherry-street, Birmingham have carried out the work, which includes also a most complete telephone installation.

Wakefield.—On Tuesday of last week the new municipal buildings for the County Council of the West Riding of Yorkshire were opened. These premises, occupying a square, therefore having four frontages, have been erected under the direction of Messrs. Gibson and Russell, of 11 Gray's-inn-square, at a cost of about £130,000. The electric light has been installed by Mr. T. Harding Churton, of Leeds. There are in all about 1,100 lights, all the wiring being carried out in insulated conduit, and the distribution being effected by the switch and fuse board plan. All the electroliers have been specially designed by the architects, and are of a most artistic character. We are informed that the light, which was turned on for the opening, gave great satisfaction. The buildings are fitted throughout with a most complete telephone installation. There are five exchanges in the building, all being connected by up and down trunk lines. All the wires, which have been run in iron conduit, are metallic circuit. This work has been carried out by the Private Wire and Telephone Installation Company, of 110, Cannon-street, London. All the electrical work has been under the direction of Mr. Sidney à Court, A.M.I.C.E., of Victoria-street, S.W.

Lewisham.—At the last meeting of the District Board of Works the Works Committee reported that they had at a special meeting considered the matter of the application made to the Board of Trade by the Great Western Electric Light and Power Company, Limited, for a provisional order empowering them to supply electricity in the district, and letters from Mr. G. Offor, secretary to the company, confirming and consolidating the company's proposals, on the terms they were prepared to grant to the Board in the event of their consenting to the application. Mr. Offor and Mr. Reason, a director of the company, had fully explained the proposals to the committee, which for the occasion included all the members of the Board. Eventually it had been decided by 22 votes to 2 to recommend that the Board do not give their sanction to the application. Mr. Trenchard moved as an amendment that the report be referred back, and proceeded to argue against the proposal that the Board should seek power for electric lighting themselves The Chairman said he was out of order on his amendment. It had been decided that the Board should apply for these powers, and Mr. Trenchard's proper course would be to give notice of a motion to rescind. Mr. Trenchard said that at the proper time he would do so. His amendment was not seconded, and the recommendation was adopted.

Bath.—The first meeting of the Electric Light Committee was held last week. A long report was presented by the Works Committee as to the delay in completing the new work at the station in Dorchester-street. Mr. R. Hammond, the consulting engineer, explained that the boilers and accessories had long since been made and were waiting for delivery; the engine-house plant had been completed for many months, and the bulk of the engines were stored in Bath. Though the alternators were not in the same position, they had been held back by the makers because they knew the committee were not ready to take delivery; when the foundations were ready they would be ready to be fixed. The cable work had gone on readily. The overhead crane had been interfered with by the strike, but it would be ready as soon as required. With regard to the arc lamps and accessories a delay had arisen because they desired to get the best possible article. As to the arrangement with the liquidators of the old company for the use of their lamps, he was willing personally to bear any expense which the authority had been put to in the hire of that plant after Jan. 7 last. He thought, when completed, they would be very proud of the splendid installation the city would possess. The new installation will probably be ready in time for the next winter season. The question of purchasing 10 railway trucks, at a cost of £600 to £700, for the carriage of coal needed at the works, was referred to the sub-committee.

Belfast.—The Electric Committee, in their report to the monthly meeting of the Corporation, stated that Councillor Andrews had been elected chairman for 1898. Previous to preparing a specification for the lighting of the library, some experimental lighting in the art gallery was authorised. The resolution previously passed by the Council, referring the consideration of the question of the electric traction of tramways to the Electric Committee was submitted, and a sub-committee was appointed to examine the minutes and correspondence on the subject, and prepare a *précis* of the same for submission to the committee. It was resolved: "That the tramway company be invited to say on what terms they would instal electric traction for the remainder of their term of the tramways." The Engineer reported that, as instructed, he had directed the several contractors to proceed with delivery and erection of plant, but that he found the building contractors not so far forward as promised. It was resolved: "That the architect's attention be drawn to the fact that the
have not kept faith with the committee, a fact whic
mittee are more than surprised at, considering the
lenient way in which they have dealt with the contr
that the architects be requested to inform Messrs. S
the buildings not being ready to receive the plant a
the committee will hold them responsible for any loss
they may suffer by reason of this delay." The report
after considerable discussion.

Hull.—At the last meeting of the Electric Light
of the Hull Corporation, the electrical engineer (
Barnard) reported, with respect to the price of
motive power, that it appeared that the present pric
unit did not compare favourably with the price char
for gas for gas-engines, and, therefore, the Corporat
reap the benefit of any considerable sale of curre
purpose. Four towns charged 2d. per unit and un
2½d., the majority 3d. or 3½d., and others, includin
per unit. During 1896 the cost per unit of generat
in Hull was 2·31d. It might be safely assumed that
sold for motive power and purposes other than ligh
be chiefly required during the working hours of the
there was a very small demand for current for lightin
A large amount of such current could, therefore, b
without in any way increasing the two items of rate
and management expenses. He was, therefore, of o
the price at present charged—namely, 4d. per unit-
very substantially reduced, and so customers be enc
make a larger use of the supply for the purpose
than had hitherto been the case. During 1897, the
units sold for purposes other than lighting was only
there was every probability of several large motors
down in place of gas-engines, if a sufficiently low
quoted for the current, and in that case the sale for su
would assume more important dimensions, and the m
the works would be more fully utilised throughou
After some discussion, it was decided that the report
upon the minutes, and that from March 31 next t
current for purposes other than lighting be reduced
unit.

Exeter.—The Electric Lighting Committee's report,
total capital expenditure of £13,980. 13s. 6d., and gro
£1,843. 6s. 5d., has been adopted.—At the last mee
City Council the Mayor drew attention to the
Mr. Drummond, the local manager of the National
Company. Most of them were aware, he said, that the
a serious breakdown of the wires through the recent
storms The Council had been thinking of putting the
ground, and if any of them wanted to put any questio
be glad to answer them. Councillor Linscott as
Drummond would give a general outline of any rem
in view. The necessity for some measures to be take
greatly emphasised by the recent breaking of the wire
street. Mr. Drummond made a lengthy statemen
desirability for putting the lines underground. By
the subscribers would each be supplied with a do
The only thing now was what acknowledgment t
would require from them. When the application
some time ago, the Council asked 5s. a subscri
of the inconvenience caused by pulling up the ro
extra benefit to the subscribers. This they could n
Corporations elsewhere came to better terms, and the
rally paid by towns the size of Exeter was 1s. a
This he considered reasonable, and their borough sur
the same opinion. He had approached them on the
order that the city should have the best telephonic co
possible. Councillor Linscott enquired whether Mr.
could state what the size of the tunnel through whic
would go would have to be? This would, he thoug
committee in considering the matter. Mr. Drummo
said that it would be only necessary to lay one line of
and by laying a double line of piping the town would
for for some time to come. Councillor White advised
not to settle the question in the absence of the tow
surveyor. They were agreed as to the advisability of
wires underground, but he did not think they ought t
question as to the rate per subscriber. The matter wa
the Streets Committee.

Poplar.—A special meeting of the Board of Work
last week at the offices, Upper North-street, to c
question of the electric lighting of the district on the r
tion from the special committee that the Board procee
act upon its provisional order, and to supply electr
the compulsory area at the earliest possible moment;
Electric Lighting Committee be instructed to take th
steps to carry this resolution into effect, reporting its
time to time for the approval of the Board. The Bo
wrote enclosing copy of a letter of the County of Londo
Provincial Electric Lighting Company stating the
the Poplar Board of Works to the granting of
supplying the district with electric light. Mr. Bussey
the adoption of the committee's recommendation, tha
proceed at once to supply electricity within the com
at the earliest moment. In doing so, he acknowledged
rendered to the committee by Mr. Potts (the clerk), w
indefatigable. The company were desirous of getting
themselves. They were desirous of getting everythin
selves and stopping the local authority from effecting
improvement, because they thought the authori

edge of the matter, that they desired only to perpetrate an se expenditure and in the end bring the matter to a condition so far as the ratepayers were concerned. Now were the facts with regard to Camberwell, as Camberwell een referred to in the company's letter. Camberwell had o its senses, and had said that in spite of having paid for mpany's order they must take the thing in their own hands. ompany had been continually touting the members of this . He had received several visits from a representative of mpany, who had tried in every possible way to make him with a course favourable to them. He would go further y overtures had been made of a character which at the t moment he could not go into. The company wanted to he very best producing areas in the Tower Hamlets. They l to go from Whitechapel, through St. George's and Stepney ehouse and Poplar, and they wanted to raise a charge which be prohibitive in a district such as that. They would not e iota about outlying districts. Ultimately it was decided ward a copy of the resolution adopted by the Board to the of Trade, and with regard to the letter of the electric g company no action was taken.

cester and the Electric Light.—A meeting of the ster City Council took place on Tuesday, the chief busi-eing the consideration of the minutes of the Electricity Committee, which were as follows: At a meeting of the ttee on Feb. 16, Mr. Hammond, the electrical engineer, ed by the Corporation, attended and reported that on the st. he visited Gloucester, in company with Mr. Charles , of Bradford, and inspected the old gasworks and some adjoining properties, and made a careful examination of the les made by the city surveyor on the site of the old gas- and afterwards consulted with Mr. Waller, architect, and as to the character of the foundations met with in the ourhood of the quay and other parts of the city. He also d that the boring had since been enlarged into a trial hole are, and laid before the meeting a section of the trial hole d by the city surveyor, from which it appeared that the s was reached at a depth of 31ft. 3in. below the surface. ammond said he should not like to take the responsibility tructing the electricity works on the gasworks site unless ndations were carried down to the level of the blue lias, ated that the adoption of the gasworks site would probably an additional minimum expenditure of from £2,000 to on extra foundations and other special work. In answer estions, Mr. Hammond also stated that if a central were adopted instead of the gasworks site (about a r of a mile from the centre of the city), the saving in cables would amount to from £1,500 to £2,000, but if the ar the depôt in Seymour-road (about a mile distant from tre of the city) were adopted, the cost of feeders to those ntemplated for supplying 30,000 lights fixed on consumers' es would be £1,088 more than for the gasworks site. The ability and cost of obtaining water from the canal for sing purposes, if the works were constructed near the was also considered, and Mr. Hammond stated that, under circumstances of the case, he should prefer a site near the to that of the gasworks site. After fully discussing the l question of site, it was moved by Alderman Trevor Powell, conded by Councillor Radford, that instead of adopting the ks site, and the recommendations relating thereto, the l be recommended to erect the proposed electricity and dust ctor works upon land of the Corporation opposite the depôt, ur-road. An amendment was moved by the chairman (Coun-Clutterbuck), and seconded by Councillor Allen, to the effect e Council be recommended to adopt the old gasworks site, prove of the recommendations made with regard to it. endment was lost, and the original motion was carried votes to four. At a meeting on Feb. 25 plans and lars of some other sites were presented, from which it ed that one or two of such sites would be suitable, and special advantages for the proposed scheme, but as some r information was required by the committee, the Mayor quested to obtain fuller particulars with a view to the n of site being finally dealt with at the next meeting Council, held on Tuesday. The various tenders recom-d for acceptance, published in another column, amount 5,930. 19s. The acceptance of these tenders is condi-upon the necessary loans being sanctioned by the Government Board, and subject to the respective ctors entering into formal contracts containing such pro-s as the town clerk may think necessary, and giving escribed or approved security, and that provisional ts be in due course sealed with the common seal. Mr. nd stated that he had arranged for Mr. H. A. Dancey, ter, to act with him and assist him in dealing with chitectural portion of the proposed electricity works. esday's Council meeting, the Mayor stated that the city Supply Committee at their last meeting considered estion of erecting the proposed electricity and dust ctor works upon part of the Beanland Estate, near the of the city, and easy of access, and it was pointed out that for the boilers and for condensing purposes might be obtained ing a pipe from the dock basin, on the other side of Com-d. The Mayor further reported that he had obtained lars of the Beanland Estate, and that the price originally £10,000, but that he had entered into a provisional h the owner to purchase the property, subject to the mancies, at the price of £7,125. It was resolved: "That mended that, instead of adopting either of the other sites commended by the committee, the proposed electricity and dust destructor works be erected upon part of the Beanland Estate, and that the provisional contracts entered into by the Mayor with Mr. Walter de Winton, and Alderman Monsell for the surrender of his leasehold interest in certain parts of the estate, be approved and adopted." Whereupon an amendment, "That the gasworks site be adopted," was proposed and lost. The original motion was carried with two dissentients. It was further resolved to apply to the Local Government Board for sanction to the purchase of the Beanland Estate, or the portion thereof not required for the proposed electricity and dust destructor works as a means of investing the proceeds received from the sale of corporate lands. An amendment, that the question be referred back to the committee, having been withdrawn, all the tenders recommended were passed by the Council, excepting Section G, Part I., as to lamps, which was referred back for further particulars.

PROVISIONAL PATENTS, 1898.

FEBRUARY 21.

4267. **Improvements in or relating to enclosed-globe electric arc lamps.** Charles Oliver, 31, Southampton-buildings, Chancery-lane, London.

4278. **Improvements in or relating to railway electrical signalling apparatus.** John Augustus Busher, 111, Hatton-garden, London.

4282. **Improvements in automatic cut-outs for arc electric lamps.** Gustav Byng and Arthur Ernest Angold, 73, St. Stephen's-road, Upton Park, London.

4287. **Improved electric arc lamp.** Henry Vincent James, Westhill, Higher Broughton, Salford. (Complete specification.)

4306. **Improvements in electrodes for secondary batteries.** Percy Wilbraham Northey, 28, Victoria-street, London.

FEBRUARY 22.

4339. **Improved coin or prepayment attachment for electrical meters.** Harold Shaw May, 8, Stanley-road, Blackpool.

4371. **Improvements in electric meters, applicable also to instruments for testing the magnetic properties of iron.** James Finlayson, 62, St. Vincent-street, Glasgow.

4398. **Improvements in electric railway systems.** John McLeod Murphy, 111, Hatton-garden, London. (Complete specification.)

4409. **Third-rail underground electric railway system.** William Humphrey Wheatley, 40, Chancery-lane, London. (Louis Edward Walkins and George Manypenny Jewett, United States.) (Complete specification.)

4414. **Improvements in lamp globes or apparatus for distributing and modifying the light of oil, gas, and electric lamps or burners.** William Henry Witham, 37, Essex-street, Strand, London.

4416. **Improvements in or relating to electricity meters.** Robert Francis Sidebottom Venner and Chamberlain and Hookham, Limited, 37, Essex-street, Strand, London.

4435. **Improvements in electric signalling apparatus for use on railways.** Christopher Samuel Davy, 45, Southampton-buildings, Chancery-lane, London.

4441. **Improvements in or relating to electric motors.** Herbert Osbaldeston Duncan, 111, Hatton-garden, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Jan. 14, 1898, being date of application in France.)

4455. **Electric railways.** Frederick Carleton Esmond, Norfolk House, Norfolk-street, Strand, London.

FEBRUARY 23.

4468. **Improvements in conduits for wires carrying electric current.** Frank Geere Howard and Arthur William Sclater, 10, Berners-street, Oxford-street, London.

4471. **Wareham's electric clock or time recorder.** Ethelbert Wareham, 1, Ivy-dene, Goldlay-road, Chelmsford.

4508. **Apparatus for metering electrical current.** William Arthur Price, Teign House, Westcombe Park-road, London.

4518. **Improvements in holders for the brushes or collectors of dynamo-electric generators and motors and other revolving electric machines.** Joseph Matthews and George Birrell Cruickshank, 128, Coleman-row, Birmingham.

4549. **Apparatus for electrically controlling the hoisting mechanism of elevators or any other type of machinery.** Henry Harington Leigh, 22, Southampton-buildings, Chancery-lane, London. (Frank Julian Sprague, United States.)

4550. **Improvements in telephone signal systems.** Edmund Edwards, 65, Chancery-lane, London. (Wallace Stillwell and Alexander Barneck, United States.)

FEBRUARY 24.

4588. **An improved method of and means for holding the bases of electrical fittings within boxes or upon other surfaces.** Frederick Bathurst, 73, St. Stephen's-road, Upton Park, London.

4621. **Improvements in electric arc lamps.** Arthur Freemore Spooner, 323, High Holborn, London. (Pierre Vassia, France.)

4624. The electrolytic manufacture of alkaline bichromates. Joseph Heibling, 4, South-street, Finsbury, London.

4635. Improvements in apparatus for travelling through pipes or conduits, more especially intended for use in threading through electric conductors. Henry Edmunds and Albert Harris Howard, 47, Lincoln's-inn-fields, London.

FEBRUARY 25.

4646. Improvements in apparatus for magnetic testing. James Alfred Ewing, Langdale Lodge, Cambridge.

4678. Improvements in insulation of wire for electrical purposes. Charles Edward Hearson, 7, Staple-inn, London.

4683. Improvements in electric accumulator grids. Alexander Schanschieff, Trafalgar-buildings, Northumberland-avenue, Charing Cross, London.

4742. Improvements in devices for lighting lamps by electricity. Charles Melbourne White, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Henry Martyn Brigham and Svend Martin Meyer, United States.) (Complete specification.)

4746. Method of and means for measuring the work performed in a rotary-phase current system. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellchaft, Germany.)

1747. Improved means for counterbalancing the frictional resistance in alternating-current motor meters. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellchaft, Germany.)

FEBRUARY 26.

4761. Improvements in electric controlling and regulating apparatus. Walter Emmott, Penny Bank-chambers, Halifax.

4764. Improved process and apparatus for tanning by the aid of electricity. N. P. Anderson, J. Westengaard, and Hugo Zerener, 46, Lincoln's-inn-fields, London.

4791. Improvements in connection with the mechanism of electrically illuminated devices. William Hastwell Clegg, John Sibley Richardson, and Samuel Jevons, 8, Quality-court, London.

4812. Improvements in or connected with alternating-current electric motors. Alexander Heyland, 47, Lincoln's-inn-field, London.

4819. A method of electrically heating materials in closed chambers and apparatus for that purpose. Electric Reduction Company, Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (William Taylor Gibbs, Canada.)

4820. Improvements in electric arc lamps. Siemens Bros. and Co., Limited, and Frederick Booker, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

4825. Improvements in and relating to electric accumulators. Charles Junge, 75, Chancery-lane, London. (Reinhold Knöschke, Germany.) (Complete specification.)

4828. Improvements in electromagnetic couplings for shafts, pulleys, and the like. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (W. Dierman and Co., Belgium.)

SPECIFICATIONS PUBLISHED.

1897.

2818. Electricity meters. De Ferranti.

3288. Electric furnaces. Contardo.

5237. Suspension of electrical accumulators or batteries on motor carriages. Brougham and Bersey.

6276. Electric arc lamps. Crompton and Pochin.

6825. Supply of current to and governing arc lamps. Lewis.

7235. Switching apparatus, more especially adapted for use with electric motors. Edmunds.

7532. Combined electrolytic and leaching treatment of zinc-bearing ores and zinc-bearing products. Ashcroft.

7955. Electric propulsion of vehicles and apparatus therefor. Siemens Bros. and Co., Limited. (Siemens and Halske.)

10295. Electrically illuminated advertising balloon. Bussby.

22215. Alternating-current energy meters. British Thomson-Houston Company, Limited. (Shand.)

26729. Alternating-current electric motors. Wise. (Churchward.)

27543. Electric cables. Gould.

29377. Propulsion of railway trains and the like by electricity. Kaselowsky.

29586. Electrical transformers. The British Thomson-Houston Company, Limited. (Moody.)

29587. Dynamo-electric machines and electric motors for electric railways. The British Thomson-Houston Company, Limited. (Priest.)

30264. Windings for polyphase machines. The British Thomson-Houston Company, Limited, and Hobart.

30445. Apparatus for simultaneously connecting a number of pairs of electric conductors. Siemens Bros. and Co., Limited, and Holmes.

TRAFFIC RECEIPTS.

Dover Tramways.—The traffic receipts for the we[ek ending] February 19 were £104. 13s. 9d. The total receipts for 1898 are £747. 17s. 11d. The mileage open at present is

Bristol Tramways.—The traffic returns for the wee[k ending] February 11 were £2,296. 3s. 9d., compared with £2,120 for the corresponding period of last year, being an in[crease of] £175. 8s. 4d.

Birmingham Tramways.—The traffic receipts for t[he week] ending February 26 were £3,322. 9s. 4d., as compa[red with] £3,370. 19s. 4d. in the corresponding week in 1897, decrease of £38. 10s. 0d.

Liverpool Overhead Railway.—The traffic receipt[s of the] railway for the week ended February 27 amounted to £ compared with £1,275 in the corresponding week of the year, being an increase of £25.

City and South London Railway.—The returns for ended February 27 were £1,065, compared with £996 for t[he corre]sponding period of last year, being an increase of £69. receipts for the half-year amount to £9,630, compa[red with] £9,713 for the corresponding period last year, being a of £83.

South Staffordshire Tramways.—The traffic return[s for the] week ending February 25 were £551. 0s. 4d., as compa[red with] £601. 11s. 7d. in the corresponding week of the previ[ous year.] The aggregate receipts for the year are £4,696 0s. against £4,534. 8s. 9d. in the corresponding period previous year.

Dublin S.D. Tramways.—The traffic receipts for ending February 25 were £352. 0s. 1d., as compar[ed with] £508. 11s. 3d. in the corresponding week in the previo[us year,] being a decrease of £156. 11s. 2d. The number of p[assengers] carried was 61,674 in 1898 and 77,074 in 1897. The a[ggregate] returns up to date are £3,215. 12s. 9d., as compa[red with] £3,456. 1s. 11d. last year, being a decrease of £240. 9s. mileage open is the same as last year—viz., 8 miles.

COMPANIES' STOCK AND SHARE LIS[T]

Name.	Paid.
Birmingham Electric Supply Company	5
Brush Company, Ordinary	2
—— Non. Cum., 6 per cent. Pref.	2
—— 4½ per cent. Debenture Stock	100
—— 4½ per cent. 2nd Debenture Stock	100
Callender's Cable Company, Debentures	100
—— Ordinary	5
Central London Railway, Ordinary	10
——	6
—— Pref. Half-Shares	1
—— " "	5
Charing Cross and Strand	5
—— 4½ per cent. Cum. Pref.	5
Chelsea Electricity Company	5
—— 4½ per cent. Debentures	100
City of London, Ordinary	10
—— Prov. Cert. 80,001-90,000	10
—— " 90,001-100,000	2
—— 6 per cent. Cumulative Pref.	10
—— 5 per cent. Debenture Stock	100
City and South London Railway, Consolidated Ordinary	100
—— 4 per cent. Debenture Stock	100
—— 5 per cent. Pref. Shares	10
—— " " " '96	10
County of London and Brush Provincial Co., Ordinary	10
—— 6 per cent. Cum. Pref.	10
Crompton and Co., 7 per cent. Cum. Pref. Shares	5
—— 5 per cent. Debentures	—
Edison and Swan United Ordinary	3
—— 5 per cent. Debentures	5
—— 4 per cent. Deb. Stock, Red.	100
Electric Construction, Limited	2
—— 7 per cent. Cumulative Pref.	2
Elmore's Copper Depositing	1
Elmore's Wire Company	1
W. T. Henley's Telegraph Works, Ordinary	10
—— 7 per cent. Preference	10
—— 4½ per cent. Debentures	100
House-to-House Company, Ordinary	5
—— 7 per cent. Preference	5
India Rubber and Gutta Percha Works	10
—— 4½ per cent. Debentures	100
Kensington and Knightsbridge Ordinary	5
—— 6 per cent. Pref.	5
London Electric Supply, Ordinary	5
Metropolitan Electric Supply, Limited, Ord. No. 101-50,000	10
—— " " " 50,001-82,000	10
—— 4½ per cent. First Mortgage Debenture Stock	100
National Telephone, Ordinary	5
—— 6 per cent. Cum. First Pref.	10
—— 6 per cent. Cum. Second Pref.	10
—— 5 per cent. Non. Cum. Third Pref., No. 1-119,234	5
—— " " " 119,235-250,000	5
—— 3½ per cent. Deb. Stock, Red.	100
Notting Hill Company	10
Oriental, Limited, £1 shares	1
—— £5 Shares	5
—— £4½ shares	4½
Oriental Telephone and Electric Company	1
Royal Electrical Company of Montreal	—
—— 4½ per cent. First Shares Mortgage Debentures	100
South London Electric Supply, Ordinary	2
St. James's and Pall Mall, Limited, Ordinary	5
—— 7 per cent. Pref.	5
—— 4 per cent. Deb. Stock, Red.	100
Telegraph Construction and Maintenance	12
—— 5 per cent. Bonds	100
Waterloo and City Railway, Ordinary	5
Westminster Electric Supply, Ordinary	5
Yorkshire House-to-House	5

NOTES.

...l.—We learn that Mr. Willoughby Mears has ...ointed, under the Government of Bengal, as ... of electric lighting under the special sanction ...cretary of State.

...ational and Colonial Exhibition at ...rt-sur-Mer.—This exhibition will be held from ...o Oct. 1, 1898, and will comprise exhibits of ...y, electricity, machinery, and marine appliances.

Exhibition.—An international exhibition will ... at Dijon from June to October, 1898. A special ... to be provided for electricity, and a new tariff has ... for the supply of power. The commissioner is ...niot, engineer, Dijon.

...ical Engineers (Royal Engineers) Volun-...By kind permission of Colonel Josselyn, the corps ...ble to commence squad drills at the headquarters ... Middlesex Royal Engineers Volunteers in College- ...elsea. Technical drills, which count towards ... will be commenced at the end of the present

...aris 1900 Exhibition.—The estimates of the ...mpire for 1898-99 embody a sum of £15,000 to ... to the expenses of the German exhibit at Paris ... Towards this object £7,500 has already been ...d it is stated that a further grant will be required ... It is time our Foreign Office took more active ...cure the success of the British section.

...stitution "Journal."—We have received the ...f the 1898 volume of the *Journal* of the Insti- ...Electrical Engineers, and note that the value of ...ential address has been increased in reproduction ...ition of illustrations. Major-General Webber's "The Electro-Chemical Treatment of Ores Con- ...Precious Metals," and Mr. Cowper Coles's paper ...Manufacture of Parabolic Reflectors," are also ...n this part.

...ic Headlights on Locomotives.—A few of ...ican railways are attempting to introduce search- ...the fronts of their locomotives. The light, or ...m of light, so obtained is advocated as a signal ...ions ahead that the train is coming. If it is to ...ccessful in this direction on lines where, as is ...e block system is not used, it can only be on ...ight railways. The equipment used on the ...ate consists of a small steam-turbine direct ...o a dynamo. The speed of the set is 1,800 ...s per minute.

...ic Welding.—A lecture was given at Finsbury College on Monday, March 7, by Mr. Reginald Jones, A.M.I.C.E., M.I.E.E., on "Electric Weld-...e various systems in use, such as the Benardos, ...offin, "Voltex," Hoho Lagrange (hydro-electro- ...and the Thomson (incandescence system), were ...and illustrated by experiments and lantern slides. ...que and interesting samples of "Snap" or rapid ...elding (Thomson process) as applied to the ...ure of cycle parts, etc., were shown. Apparatus ...s of work done were lent by the Electrical Metal- ...Syndicate and the Electric Welding Company,

...t Law.—The main object of granting patents is ...nventors by giving them for a limited number ... sole benefit from the supply of the article ...the laws connected with patents, however, ... in different countries. Thus, according to ...American, Turkey's industrial development is seriously hampered by various ordinances, one of which prohibits the use of electricity in the empire, yet there is a party in favour of modern improvements, and even the Government is now making strenuous efforts to stimulate trade. It is to be noted, however, that no patent will be granted in Turkey for improvements in arms or ammunition, or for any machine in which electricity is to be used as the motive power.

Belt Driving.—The Brush Electric Company, of Baltimore, commenced supplying light as far back as 1881, and have since then gone steadily forward. We are surprised to see from the illustrations in the *Electrical World* of their present stations that the Brush arc lighters are still largely used. Some 1,600 arc lamps are now supplied, and we notice that these arc lighting dynamos are driven by belts from each steam-engine. The three belts on the engine flywheel ride over each other, as the pulleys on the dynamos are all placed along the same centre line. Incandescent lighting is supplied by alternate current at 2,750 volts, but parallel running is not resorted to. Hence, in case of the failure of one alternator switching over to another, this has to be carried out as quickly as possible.

Northampton Institute.—This technical institute, for the equipment of which Prof. R. Mullineux Walmsley has been mainly responsible, is to be opened on the 18th inst. The Lord Mayor and Sheriffs of the City of London will pay a state visit to the institute on that day. After inspection a formal opening ceremony will take place. As an indication of the importance of the occasion, we may add that the buildings and equipment have up to the present cost over £80,000, and that the expenditure upon the latter is not yet complete. In addition, the land, over $1\frac{1}{4}$ acres, generously given by the late Marquis of Northampton, is estimated to be worth not less than £25,000. The institute is a branch of the City Polytechnic, and is situated in one of the busiest parts of the Metropolis immediately north of the City boundary.

Telegraph Tournament.—A feature at the electrical exhibition in New York this year will be a telegraph tournament. The exact dates of the contests have not yet been determined. Handsome medals or badges will be awarded to the winners, to which will be added liberal cash prizes. The prevailing opinion is that the same matter should be used in every telegraphic contest for the purpose of comparison. It is just as necessary and important in this work as it is that the mile race track should measure exactly 5,280ft. At the tournament in 1893 the top record was 248 words in five minutes without mistakes. One competitor sends 249 words, but some 14 errors were found in his message. The organisers of the tournament expect the above record to be surpassed, but clearness of signals will be insisted on. Mr. Fred Catlin, who will organise the test, considers it is possible for a first-class operator to read easily perfect transmission up to a speed of about 60 words per minute, a speed not likely to ever be reached by hand transmission. The value of transmission is lost when it is not rendered clear and accurate, and judges will so render their decisions.

Technical Education in London.—The County Council organ, the *London Technical Education Gazette*, is a most useful medium for keeping the educational departments of the Council to the front. From the current issue we gather that the presentation of certificates to county scholars on the 15th ult. was a great success. The Bishop of London, who presented the certificates, advised the students as follows: "Whatever you have to learn, learn

it hard, learn it well, learn it in the spirit in which it ought to be learned. The reasons are simple. When you begin life you all of you know what you want to do, what you mean to do, and this will bear some relation to life itself." The fact of knowing exactly what you want to become certainly is half the battle in educating one's self for any position. We also note that on the evening of Thursday, March 24, the art and science scholars and exhibitioners who were elected in 1897 will be invited to the Northampton Institute, Clerkenwell, for the purpose of receiving their certificates. Visitors will have an opportunity of inspecting a selection of the works submitted for the art and science competitions which are now being conducted by the Board.

Lighting of Trains.—The new train built by the London and North-Western Railway for the service between Euston and Watford is most handsomely equipped both as regards heating and lighting. The latter is effected by electricity on the Stone system, in which a small dynamo and a set of accumulators are fitted to each carriage. Two lamps are provided in each compartment. With reference to our note last week on the electric lighting of the railway carriages on the East and West Junction Railway, we now learn that the trains are equipped with one 10-c.p. lamp in each compartment. The necessary power plant is placed at Stratford-on-Avon, and used to charge 16 cells of the ordinary traction type, made by Messrs. Headland and Co., Pall Mall, which are placed in the guard's van, and controlled by him by means of an ordinary main switch. So far the lighting has proved very satisfactory. All the lamps are on one circuit, and the light is only switched on by the guard when it is required. The above line extends from Broome, near Redditch, on the Midland line, to Blisworth, on the London and North-Western Railway—a distance of about 50 miles. Messrs. Eccles Bros., of Stratford-on-Avon, equipped the trains in question, and devised special electric couplings and fittings for the purpose.

Municipalisation.—The electrical Press in the United States are, as a rule, very hard on municipal management. Without a doubt, so far as the electric lighting is concerned, the success or otherwise of the undertaking depends largely on the municipality. With an energetic and capable engineer, and the cheap capital at the command of the town authorities, the undertaking must succeed, but reading between the lines we find that in the States the electric lighting committees take larger fees than a company's board of directors. Our New York contemporary, *Electricity*, deplores the fact that the town of Albany proposes to municipalise its lighting and also the tramways. The paper in question has a leading article on the subject which is not, to our mind, very conclusive, as the difference in cost of running between municipal and companies' stations does not vary appreciably. In fact, the variations in cost per lamp quoted (by which we fancy arc lamp is meant) do not vary more than 6 per cent. A humorous paragraph to show how little the ratepayers and voters understand the subject of municipalising tramways is the following: "Ye see 'tis this way. The city is going to own the street railroads and the gas-houses and the electric lighting plant and all. The city will own them and run them for the benefit of the people, and a man instead of paying a nickel for riding in the street-car to a lad he has never seen before will transfer the coin from one pocket to another and ring up one fare for himself."

"Radiostereoscopy."—Dr. W. S. Hedley communicates an interesting article to the current number of the *Lancet* on the above subject, and gives the following formula for the lateral displacement which should be given to the X-ray tube when taking two negatives for use with the stereoscope when the distance of the object and it
are known. Where Δ is the relative displacem
tube and object, D the distance of the tube from
and T the thickness of the object, $\Delta = D\,\frac{(D+T)}{50\,T}$
if the object be, say, 3cm. thick, and its distance
tube be 20cm., then the displacement of the tube
3cm. When the displacement of the tube is eq
distance apart of the eyes, say, 6·6cm., the virt
appears at the distance that the object has be
graphed from and is the proper size. Theref
practicable, the displacement ought to be 6·6
being a known quantity, and the thickness of the o
being known, the following formula is given to
under such conditions the proper distance of the ol
the tube: $6{\cdot}6 = D\,\frac{(D+T)}{50\,T}$. Dr. Hedley has latel
on these lines, and has been able fully to v
accuracy of the method. Immediately the neg
taken, the images may be fused in the stereoscop
reduction even with plates $8\frac{1}{2}$in. × $6\frac{1}{2}$in. in size.
case of metallic foreign bodies there is some
apparent want of truth in the result, owing, p
the fact that those objects which are most distir
field of vision have a tendency to appear neare
cases are best dealt with by the lengthier m
localisation.

Electric Lighting and Traction in East
The East London referred to is in South Africa,
strange that most of East London in England
behind its African namesake. We learn from th
and South African Export Gazette that progress ha
far been made with the electric lighting and
scheme for East London that specifications and
about being prepared, and everything set in trim
forward the work as expeditiously as possible. Th
as outlined in the borough engineer's report, cont
supplying the present public and private require
the town, with a large margin for future increas
lation, and furnishing the harbour and railway dep
with such supplies as they may require, in which,
is included motive energy. The supply of electri
for the tramways is also included in the schem
locality of the generating station has been fixed
venient contiguity for coal supplies to the new w
also to the railway line. For the incandescent st
private lighting service, two direct-coupled altern
recommended. For the arc lighting service, two co
current machines are proposed, one being for the
Board's requirement, and the other for the railwa
ment and the streets jointly. For the tramway
one continuous-current machine is apportioned.
continuous-current machine is to be provided, to
able for arc lighting or tramway, the switchboard
arranged that the current can be used for either li
traction purposes. The equipment provides fo
lamps and 5,600 8-c.p. incandescents connected, a
for some three miles of trams, exclusive of the 18
300 32-c.p. incandescents to be used for street-
The Town Council have appointed Messrs. Co
Johannesburg, to confer with the borough engine
drafting of the specifications and plans. Engl
tractors should move in this matter promptly to se
right to tender.

Electric Boat in a Sewer.—The *Scientific*
gives most interesting details of the use made of el
as a motive power in making alterations in a lar
at Worcester, U.S.A. The sewer in question is 1
and 13ft. high, and as the sewage is chemically tr

ble to separate the storm water from the sewage to e expense of the treatment. In order to accomplish a smaller sewer, 6ft. wide and 4,000ft. long, is ilt inside the larger one, utilising the bottom and he sides of the sewer. A cofferdam is constructed e the other wall of the sewer to be built, and in deliver materials to the workmen an electric scow ged up, which has been found very satisfactory. ty is also used to light the sewer, to operate ng fans, and to work electric pumps. All of the and power are generated on the premises in a ilding outside the sewer. About midway between s of the sewer a small dock has been constructed, materials are delivered to it by an incline through nade in the top of one wall. The towboat is a n 22ft. long and 5ft. wide. In the middle of the in is a small paddle-wheel box, which is to prevent g. This is driven by means of sprocket wheels and which are connected with an electric motor of $2\frac{1}{2}$ h.p. tern end is a rudder and controller, so that one man ate both. Only one electric boat is used. It tows s, which have proved capable of handling 12,000 i0 barrels of cement, and 100 barrels of sand daily. ible trolley system is used, the wires being hung ulated brackets secured to the top of the arch in ay that a trolley can be run on it. A scow is also th a centrifugal pump which is used for pumping cofferdam, and it is driven by another motor of The application of the electric towage to sewer tion is novel, and the results obtained are mos ory. The electric arrangements were designed by rison P. Eddy.

inium Conductors.—Mr. Alfred E. Hunt, the t of the Pittsburgh Reduction Company, has issued page pamphlet on "Aluminium as a Rival of and Brass for Electrical Conductors." Comparative re given, and the author does not forget or shelve ng instincts. Thus we are told that the Pittsburgh n Company will sell rods, bars, plates, and wire drawn $\frac{8}{16}$in. diameter in large special orders for electrical es at the rate of 1s. $2\frac{1}{2}$d. per pound at their works nited States. These prices are special rates, below lar prices for aluminium, which these concerns have to make for electrical conductors alone, in order to he introduction of aluminium for this purpose and me the handicap which aluminium has, occasioned wer electrical conductivity than copper, in the special low relative prices. The difficulty of soldering aluminium is the chief drawback to its use as ial conductor. Aluminium can be soldered, but it is ifficult and slow operation at best as compared with and there is much more rapid weakening of the l joint due to galvanic action between aluminium metals of the solder than with the less electro-metal copper. Several forms of joints have been lly used to avoid the necessity of soldering, the ion being to use thin aluminium sheets to wrap the d to twist, or otherwise bind with the aluminium wires to be joined. One way of making joints of m wire is to roll the thin aluminium sheet of about h into two cylinders from opposite edges of the These double cylinders are very cheaply made on h in a lathe. The ends of the wires to be joined ed in these cylinders from opposite ends, and both d sheet twisted with pliers until a firm joint is ach stronger than the body of the wire. The readily be made impervious to the air and An ample field for the employment of aluminium me to come, however, seems open at the present time for bare transmission lines, especially for high-potential long-distance work, and for long-distance telephone lines and for rapid-transmission telegraph lines.

Recent Researches in Magnetism and Diamagnetism.—Prof. J. A. Fleming is now delivering each Thursday a course of Tyndall lectures on the above subject. The first of the course was delivered on the 3rd inst., when the lecturer said he had selected his subject before he became aware that this course constituted the annual series of lectures delivered to commemorate the late Prof. Tyndall. There seemed, however, a special appropriateness in the selection he had made on account of the attention bestowed on the subject of diamagnetism by the late distinguished occupant of the chair of Natural Philosophy in the Royal Institution. Prof. Fleming introduced his subject with a few remarks on the terminology of magnetic science, which he stated to be now based on the view that magnetic effects were due to actions taking place in the space-filling ether. He proceeded to illustrate by simple experiments the production and measurement of magnetic force, magnetic flux, and magnetisation. Devoting the rest of his lecture to the study of the so-called ferromagnetic metals, iron, nickel, and cobalt, he pointed out that their unique qualities showed them to possess in the solid condition a special molecular structure not found in other materials to anything like the same extent. Numerous interesting experiments were then performed to illustrate the changes produced in an iron bar when subjected to magnetisation. The discovery made by Joule in 1842, that an iron bar lengthened on being magnetised, was demonstrated with the aid of an ingenious piece of apparatus, as also was the fact more recently noticed by Bidwell, that under very strong magnetisation it actually became shorter. The slow establishment of the magnetic state in large masses of iron and the sluggishness with which magnetic changes in iron followed the magnetising force were illustrated by instructive experiments. The molecular changes or magnetic noises occurring in iron on rapid magnetisation and demagnetisation were next discussed, the lecturer observing that they really formed the starting point for the invention of the telephone. A concluding series of experiments illustrated the remarkable effects produced on the magnetic qualities of nickel by twisting or pulling it. We are indebted to the *Times* for the above report.

The Primary Battery's Second Youth.—The Stock Exchange editor of the *Daily Chronicle* writes: "At the present moment the drawbacks to electricity as an illuminating power are chiefly of a two-fold character. Firstly, there is the somewhat high cost; and secondly, the necessity of supplying it from a generating station. Like other classes of machinery, the electric supply station ever and anon fails, and a perfect reliance on the supply is impossible. Next, there is the constant pulling up of roads for the conveyance of electricity. But what would be said if it could be shown that all these difficulties of generating stations, cables, and attendant paraphernalia can be done away with? Such a fact may be proclaimed to the public in the course of the year. The statement which reaches us is that the house of Rothschilds are the proprietors of this new means of producing electric light. The cost is claimed to be infinitesimal when compared with that of oil; while its inventor believes that the applicability of the scheme is so great that every house, be it in possession of millionaire or mechanic, in town or country, can be fitted up with the apparatus! No underground cables are needed, and the intervention of a generating station is done away with. The invention partakes of the character of a storage battery, not at all

like any battery such as is used for the propulsion of the motor-cab or otherwise. The battery is in the shape of the instrument which gives power to electric bells. Its most notable quality is said to be its longevity, for its power will last a month or two. Experiments are not yet complete in this particular, and it is hoped that a battery can be built so that a recharging with chemicals will give a life of six months. These are the details furnished us to an invention which, should the completing experiments be successful, will, in the belief of its inventor, revolutionise the electric lighting industry." We have heard all this before—not once, but many times. The fact that "experiments are not yet complete," as regards the life of the battery, is also an old well-established saying. We have only to hear that the by-products of the battery are a gold mine in themselves to be assured that the public's money is wanted. The Stock Exchange editor of the *Daily Chronicle* is not very logical in classifying the drawbacks to the present systems of electric lighting. If the new system of primary battery is to be as reliable as the central station, the experiments in question will not be completed this century.

An Electric Percussion Drill.—We notice in the *Electrical World* illustrations and details of an electric percussion drill worked by a very low-period alternate current. The body of the drill is composed of two similar coils of wire, wound upon a tube, that form a double solenoid. The tube upon which the wire is wound is of steel, and brazed to steel heads at the ends. The coil is encased in a boiler tube, and the jacket hermetically sealed by caulked joints at both ends. These coils alternately receive the half waves of an alternating current, thus imparting a reciprocating motion to the plunger which slides in the tube. The plunger is a soft-steel forging with a chuck formed on one end to receive the bit. A helical spring checks the back stroke of the plunger, returning the energy stored in the spring to the forward stroke. At the top of the plunger is a rifled bar, running in a rifled nut, which is provided with a ratchet wheel, used to keep the drill up to its work. The construction of the two solenoids is of particular interest. They are made of square copper wire and insulated by mica placed between adjacent turns and layers. This makes the construction of these coils fireproof, and the square wire tightly wound and pressed into place prevents any disturbance of the insulation by the vibration of the machine. One of the most noteworthy features of the drill is the entire absence of anything in the nature of a valve or switch, this being unnecessary, as the current is directed alternately into the two coils by the generator itself. The generator is a two-pole machine, with a drum armature containing a loop winding, embedded in slots, which are disposed over a portion of the periphery of the drum, filling opposite arcs. In this a single-phase alternating current is generated. One end of the loop winding terminates in a solid collector ring; the other terminates in a half ring, which alternately shifts the current into the two sides of the drill circuit by means of brushes resting upon the commutator at diametrically opposite points. No appreciable sparking results, as the half ring leaves each brush at the instant when the alternating current is zero. As the flow of current in either of the outside wires is never reversed, the machine is easily compounded by interpolating a series coil in each outside wire, without the use of any further rectifying device. The middle wire, which is the common return for both phases of the current, receives an alternating current. The compound coils maintain a uniform pressure of 135 volts at the drills, whether one or more are at work. The speed of the generator is usually 380 revolutions per minute, and every revolution of the armature prod one complete stroke of the drill. The construction of generator is unique, owing to the necessity for its tr portation to locations difficult of access. The field mag is of rectangular shape, built up entirely of laminæ, into side channels in these laminæ are laid the field c the ends of which are arched to avoid the armature.

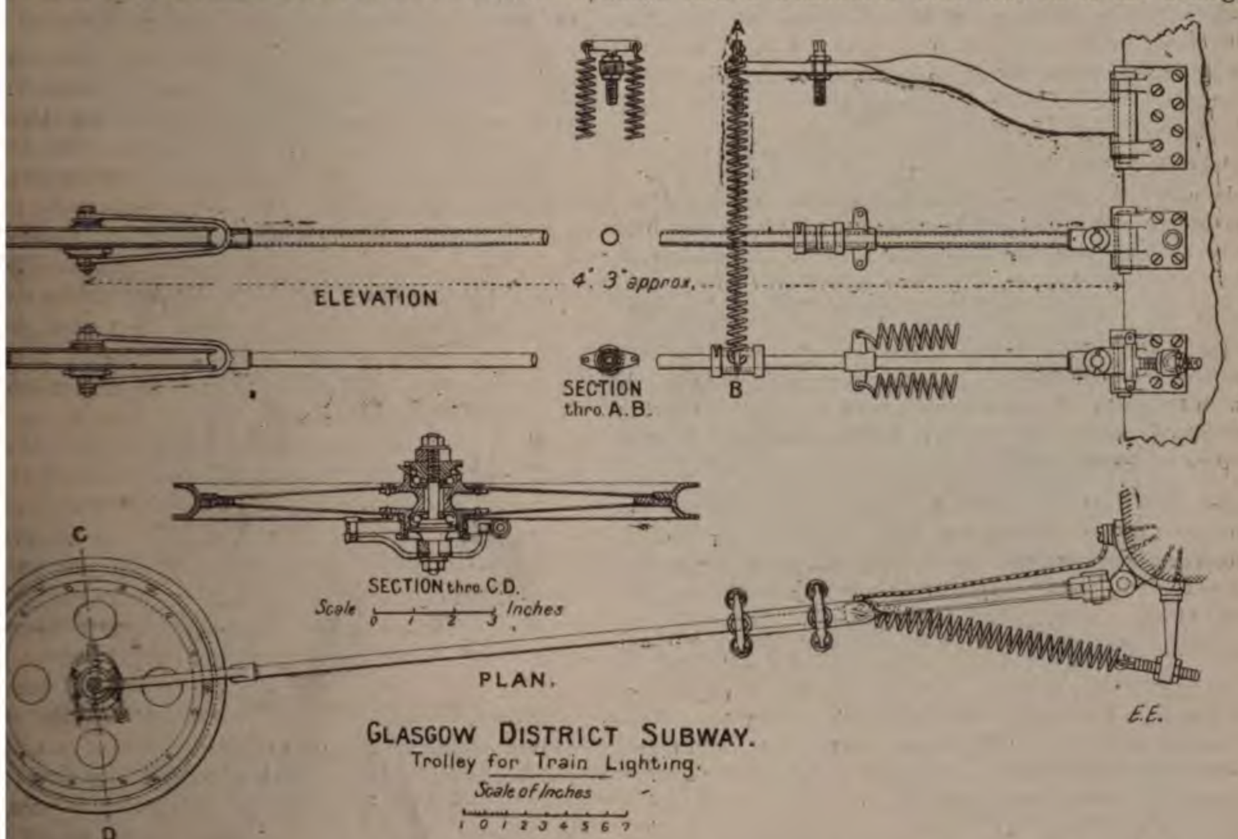
Electric Motors in Papermaking.—Dr. Louis B read a paper on the above subject recently before the N York meeting of the American Paper and Pulp Associatio The following extracts are of interest: The first a greatest use of electrical apparatus in papermaking is supplying cheap motive power from waterfalls, enabli the mills to be located at points favourably situated wi respect to cheap raw material and easy shipment of produ These advantages once gained, the power can be deliver from the nearest available waterfall at a cost general lower than the local cost of steam power. It must distinctly remembered that power thus transmitted el trically is not at all necessarily cheaper than steam pow but in a very large number of cases it is. From t investigation of probably several hundred propositions of th kind, the author felt he was well within the bounds of tru in saying that with coal at about 12s. per ton the electric transmission of 500 h.p. or more from an average wat power anywhere within a radius of 15 miles will pay n times out of ten. This is the case with power transmitt for ordinary purposes, and when, as in papermaking, pow is often used continuously throughout the 24 hours, t conditions become even more favourable for elect working. As a rough estimate of the cost of a 1,000-k equipment the author gave the following figures: thr 500-kw. polyphase generators, working at 5,000 volts, co nected direct to turbine, including fixing, £2,500 eac or £7,500 in all; reducing transformer, 1,000 h.p., £1,2 to £1,500; motor, 1,000 h.p., £3,750 to £5,000; t line, with 10 to 12 per cent. loss, erected complete, n more than £5,000. The total electrical equipment, inclu ing building, about £20,000. The cost of the wat privilege and the necessary hydraulic work is the mo uncertain factor in working out any assumed case of pow transmission. It may fall even to £6 or £8 per horse-powe and it may rise to £35 or £50. Taking the general avera of powers in regions where they have not yet acquired artificial value by proximity to towns, one may say wit out being widely astray that £19 per horse-power will cov the necessary expense. With a considerable head this figu will be somewhat reduced. For a rough estimate of th hydraulic cost in the case in hand, we shall be fairly ne the mark in doubling the cost of the electrical part of th equipment, making £40,000 as the total investment in th power plant for furnishing 1,000 h.p. day and night. Th author then estimates the working costs, including 6 per cen interest and 4 per cent. depreciation, at £8,275, or abo £8. 5s. per horse-power per annum. It is certainly n exaggerating, as one knows of electric power being sol even in Great Britain at less than half the above rate, an with profit. The author then takes up the question electric heat for the drying rolls, and generally for freein the pulp from water. He considers it is only fair to sa right now to those interested that the amount of pow required to furnish heat for drying the daily product of modern paper mill is enough to stagger the wildest-ey and longest-haired electrical crank who ever claimed th electricity was in its infancy. That drying by steam expensive is painfully evident to anyone in the busines but if you are minded to seek for improvements, do n take up electrical heating until you have exhausted th possibilities of producer gas.

THE GLASGOW DISTRICT SUBWAY.

(Continued from page 199.)

The Train Lighting.

question of effectively illuminating the cars was one of the most difficult that had to be faced, and



sulting engineer went into the matter very carefully giving his consent to the present scheme. There are ly two methods by which the cars could have been —viz., by means of accumulators carried under the or else by means of some kind of pick-up arrangement.

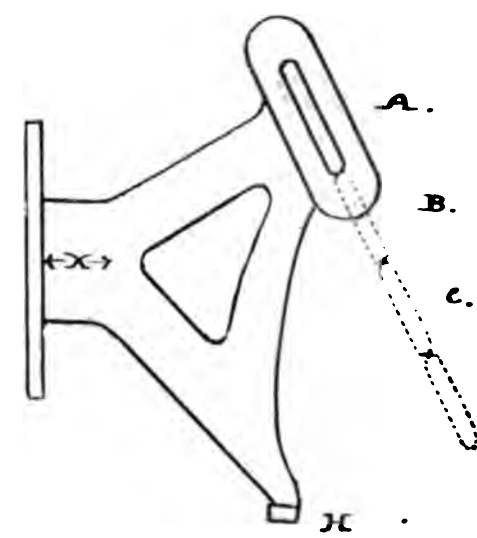
Method of Fixing and Trussing up Trolley Rails.

houghts it seemed that accumulators would save a uble and make the most simple and satisfactory but when the working conditions came to be examined was found otherwise. In the first place, it was quite that the cells would have to be capable of storage capacity for the whole of the day—viz., from 5 a.m. to midnight; then as to the number of lamps required, it was estimated that the minimum quantity of power required for each car would be 480 watts. With these figures as a basis, when the accumulator makers were approached the weight of cells that they estimated would be required added such a tremendous dead load on to the haulage engines, that accumulators were seen to be quite out of the question. Some system of picking-up gear had then to be considered, and the difficulty was where to put the conducting rails. It was settled that there should be two of these, and no attempt made to bond the permanent-way rails with a view to using an earth return. The most convenient place would doubtless have been between the two rails, but it must be remembered that the cable is here; and the engineers would not consent to any further gear being fitted here, as the cable sheaves often

have to be altered and attended to during working hours between the passage of two cars, and it would have been very unwise to have had live conductors in such a position that shocks would have been of frequent occurrence. The next place to consider was the roof of the tunnel, but here in some places there are only some 3in. or so of clearance, so that had it been possible to arrange the trolley pole or other picking-up gear out behind, there would still not have been room for the rails and suitable insulators. There was nothing left for it, therefore, but to put them on the sides of the tunnel, where, owing to the shape of the car, there was more room.

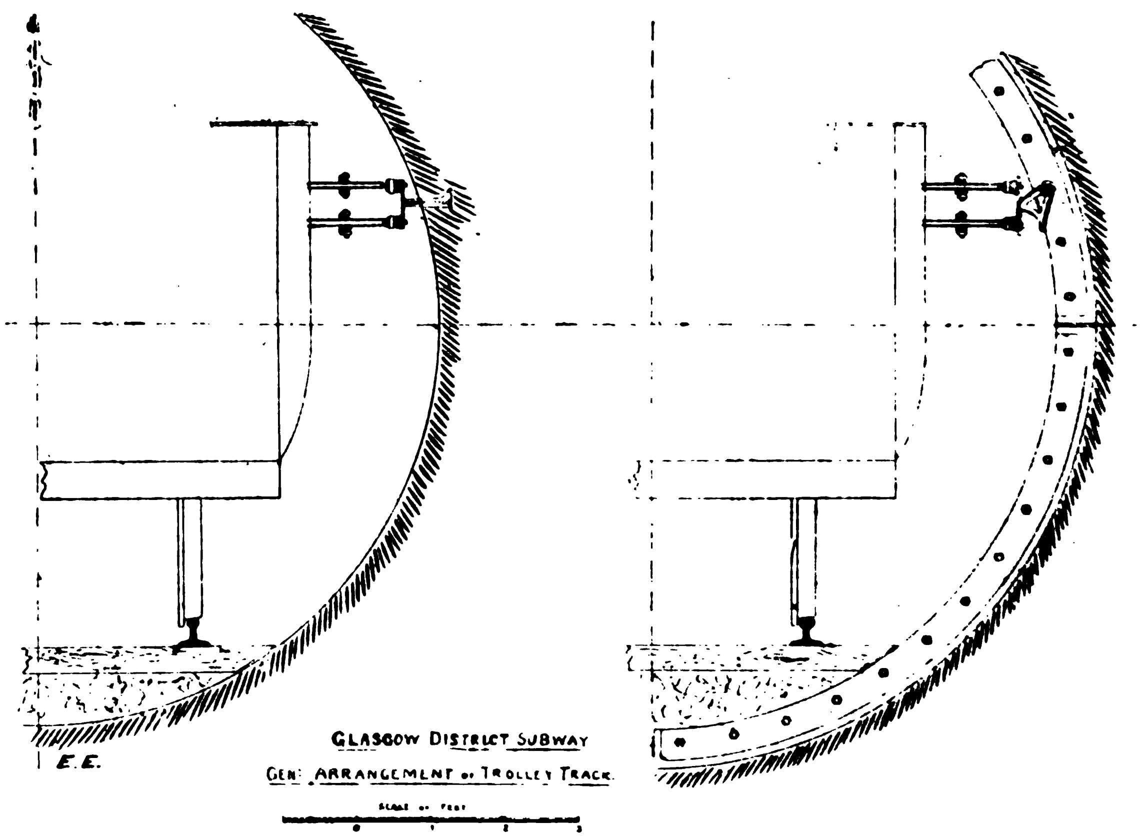
The general arrangement of the rails is shown in the illustration, which also shows the method of fixing on to the cast-iron sections of the tunnel, and also on to the brick or concrete sections; the brackets in the former case being arranged to bolt on to the flanges through one of the existing boltholes, and in the latter case the brackets being made with a longer stem that is cemented on to the brickwork, etc. The photograph shows the method of fixing these rails, and it will be clear that this must be most carefully done, so as to get them in as true a line as possible with the rails. Slight inequalities of the tunnel, which, of course, as far as the rails were concerned, would be made up by ballasting, would, if the trolley rails were kept to the contour of the tunnel, cause sudden jerks that would throw the contact off the rails. As regards the sections of the tunnel passing through brick or concrete work, this was comparatively easily done by scribing a line along the side of the tunnel from a bogie truck running along the lines, and then cutting the necessary holes and cementing in the brackets with the required projection. In the case of the tunnel where lined with cast-iron sections, it was a very much more difficult matter, and it was found necessary to make no less than 23 different patterns of brackets; 20 of these patterns were in regular use throughout the work, the other three being of special design for certain circumstances. A sketch of one of these

From this series of brackets it will be seen tha certain fixed boltholes on the side of the tun bracket-face could be arranged, so as to come to any point. The insulators are of ebonite, and are reed to give greater surface. They are fastened to the by means of sunk bolts. The rails consist o section, the flat side being clamped against the in by means of small malleable castings fastened with bolts and nuts, these castings overlapping on reeded indentions in the insulator. When it is ad there are 23,000 insulators and 250,000 bolts fitting up this system of trolley rails, some idea



Sketch of Bracket, showing different types in use.

formed of the amount of work necessary in getti erected perfectly true. The trolley rails are broke station, and each section is fed independently fro

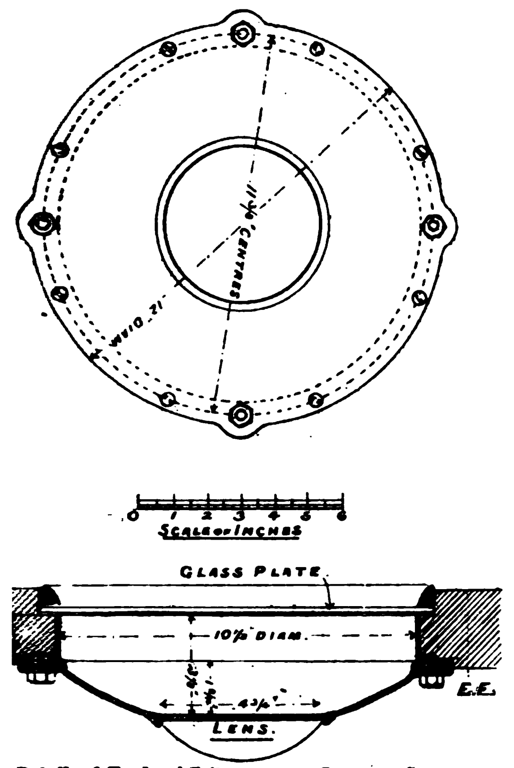


brackets is given showing the slot, A, through which the bolt passed, the heel-piece, H, that rested on the flange of the iron section, and the neck, X, supporting the plate to which the insulators carrying the rails are fastened. Of this type there are five different patterns, each one having the neck, X, an inch longer. There are also five similar patterns of each of the brackets with the slots in the positions as shown by B, C, and D in regard to the neck, X.

end, directly off the mains. The pressure is 220 v one circle is on either side of the three-wire system that there are always the same number of trains on each circle, there is a perfect balance kept as fa portion of the work is concerned.

We now come to the elaborate gear in the f trolley arrangement that is attached to the cars fo up the current from the rails. It is evident that,

rolley rails themselves may have been fixed, their ı relation to the body of the car cannot be kept ıwing to a variation of load or other causes that ert influences on the springs. To overcome this



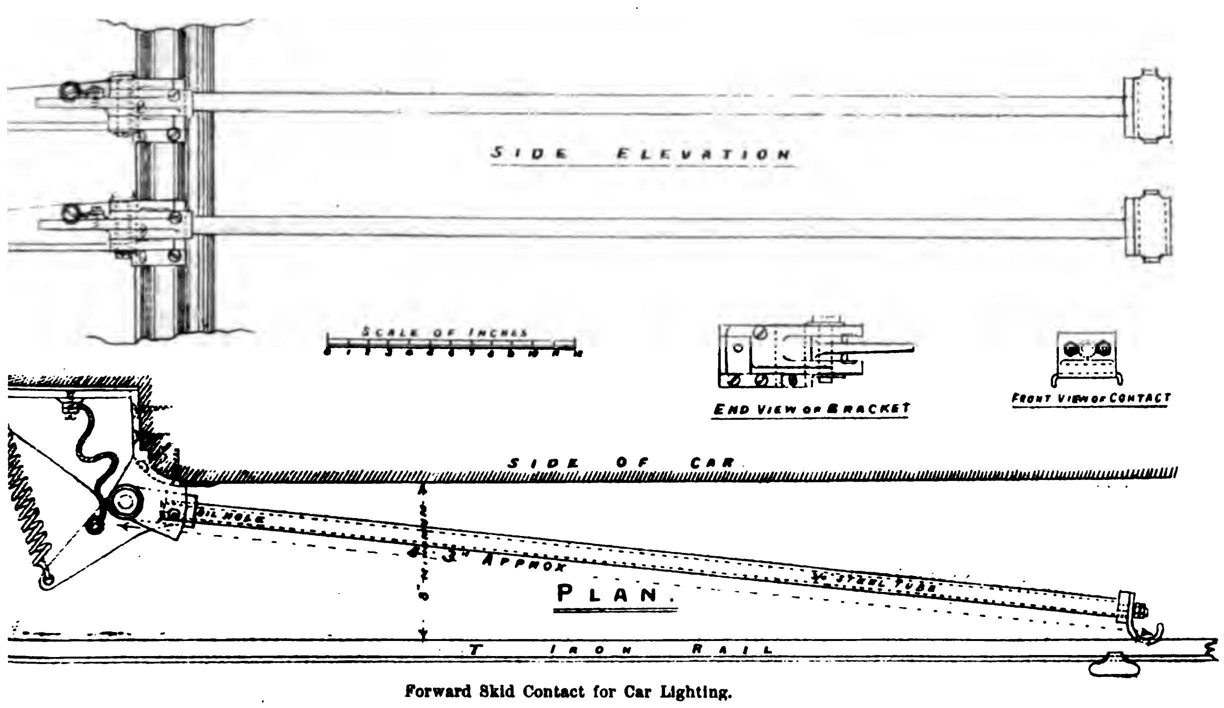
Details of Head and Tail Lantern on Passenger Cars.

trolley poles were designed for the rear of each hown in the engraving), consisting of a pole, ong, of weldless steel bicycle tube, hinged at one ı the car, and finishing at the other end in a fork a trolley wheel mounted in ball bearings. It re be added that since the line has been at work els and forks have been slightly altered from the shown in the figure, the forks being replaced with headed fork, similar to the front fork on a bicycle, springs are suitably arranged for being tightened up if required. The supporting springs are electrically insulated from the trolley pole itself, and there is a flexible conductor connected across the hinge of the pole to assist the contact.

It should be explained that the original idea was to couple two cars together to form a train, and the trolley wheels of the forward car were so arranged as to come at the junction of two cars, where there was more room, the rear trollies, of course, being quite clear of everything; and, of course, the electrician proposed to couple up the two pairs of trolley poles, so that there would be duplicate contacts and a better chance of a steady light. However, the directors decided to run each car by itself, and run them oftener instead of making them up into trains of two each, at all events in the meantime, and under these conditions the light was found to be so unsteady as to be practically useless. The Silvertown Company's engineer therefore had to devise another arrangement for applying another pair of trolley poles to each car, as similar ones to the others could not be fixed owing to there not being sufficient space between the sides of the car and the sides of the tunnel. An arrangement as shown was therefore adopted, with the exception that the contact, instead of consisting of a slipper of brass as shown, has been altered to a piece of hexagon steel some 4in. long, held between a forked end of the trolley pole. The trolley pole itself is similar to the others, but less elaborately made, the hinges being stronger and arranged to be rigid, and no supporting bracket being required, there just being a single spring in each case to hold the contact on to the rails.

This arrangement, when started, was found to answer very much better, and it gave a comparatively steady light, although at times the jolting of the car seemed to be transmitted to both contacts at the same time, and so causes a little unsteadiness in the light. However, just recently some sample trailing cars have been tried on the line, and although there are no contacts on these cars at all, the extra weight seems to steady the tail end of the forward car, where the contacts are, and an almost perfectly steady light is the result.

The interior lighting of the cars consists of four 16-c.p. lamps on the roof, with white enamelled reflectors at the back, and clear-glass domes in front. There is a single white headlight with lense in front and reflector at back,



Forward Skid Contact for Car Lighting.

ın plates, and the 12in. wheel, with semi-circular shown in the figure) being replaced by 6in. ith 1¼in. between the flanges. On reference to ı, it will be noticed that the weight of the trolley arried by a double pair of springs attached to an ın, so as to take the strain off the hinges of the elves; there are also a pair of springs arranged pole to hold it on to the rail. All the various

with a 16-c.p. lamp, and at the rear there are two red tail lights with clear glass on the inside, which also serve to light the lobby of the cars. A drawing of the fitting used for the head and tail lights is shown. The wiring of the cars was carried out during their construction, so all the wires are run well out of sight.

(To be continued.)

THE CENTRAL LONDON RAILWAY.

(Continued from page 266.)

The locomotives for this line are being supplied by the General Electric Company of Schenectady, U.S.A. English

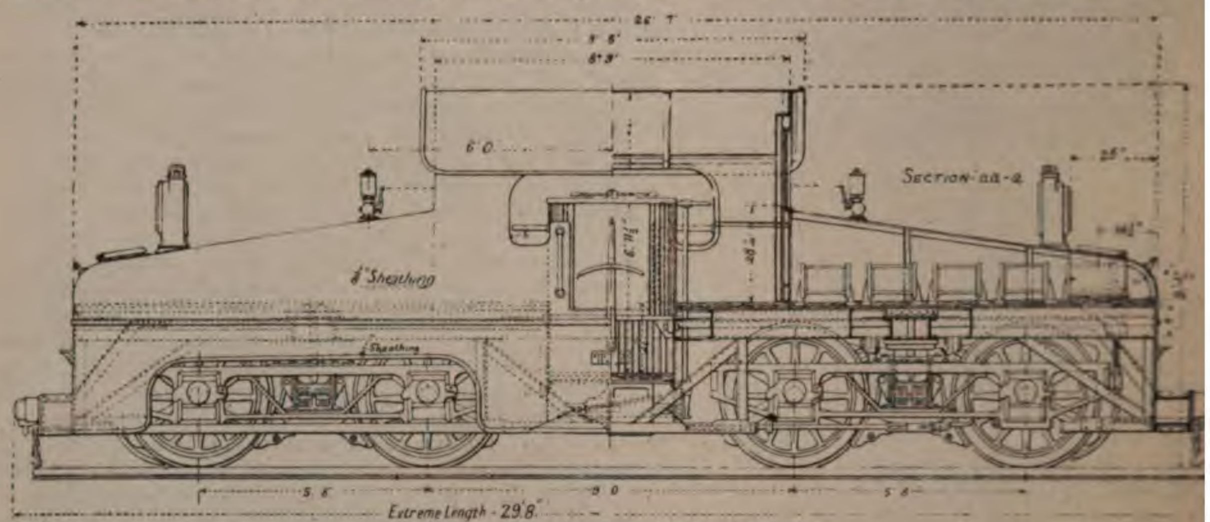


FIG. 6.—Locomotive for Central London Railway.

contractors were to have made them, but they could not guarantee delivery in the time required owing to the work being delayed by the recent strike. The general view of one of these locomotives is shown in Fig. 6, while Fig. 7

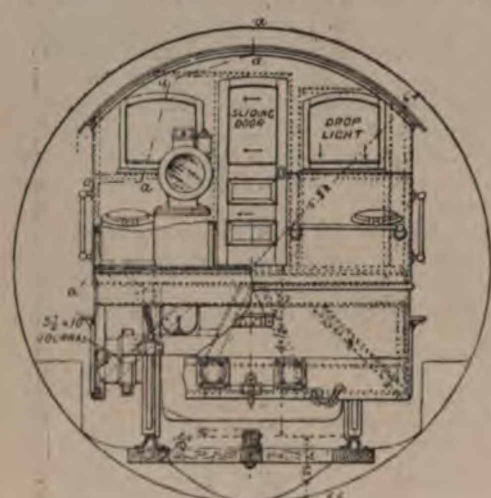


FIG. 7.—End Elevation of Locomotive.

is an end view. The main body of the locomotive is constructed with a bar frame, after the usual American practice, and is supported on two four-wheeled bogies. An electric motor is placed on each of the four axles, two on each bogie. The design of these motors can be gathered from Figs. 8 and 9. The armatures have toothed cores, and the conductors are placed in the recesses formed in the cores. The coils are wound on the cylindrical method, with two layers per slot, and are so designed that they can be built up on formers and then placed in position. The field is a four-pole one, and the armature is placed eccentrically in it. Thus the air-space between armature and core is ⅝in. at the top and only ¼in. at the bottom. This causes a greater attraction between armature and field on the underside, which will support a large part of the weight of the field. This weight thus comes directly on the axle, and not through the bearings, which are in this way relieved.

The most striking departure from usual English practice in the construction is the omission of springs between the axles and the bogie frame. The bearings, frame, and field magnets are thus all rigidly connected, and the second bearing inside the wheels, usually employed to keep armature and field concentric, is done away with. It also removes the possibility of a spring suspension of the field magnet, as is usually adopted for tramway work. The advisability of this construction is open to

criticism, but without doubt it allows much mo
between the wheels for the motors. The shock d
rail joints will be much more severe, and may caus
to the mechanical parts of the locomotives. The
on the lines will be equal to the above, and will

strain the fishplates and joints. The dimension
motors and locomotives will be found in the illus
The weights are as follows: total weight of loco
about 42 tons, so that the weight borne by each

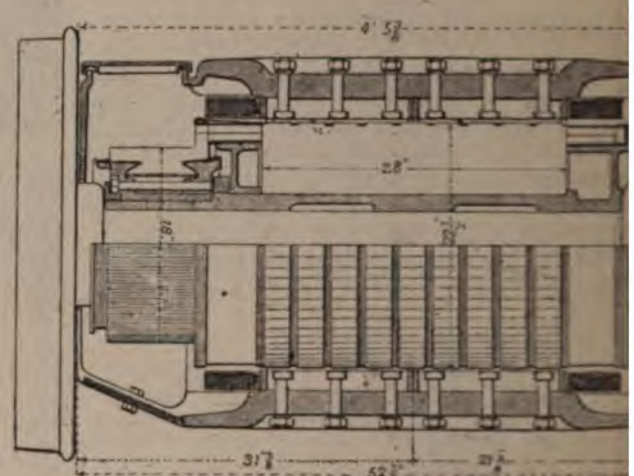


FIG. 8.—Section of Motor.

5¼ tons; the weight of the motor armature is about
and that of the field magnets 8,500lb.

The locomotives will be controlled by a series
controller giving 22 different combinations. Th

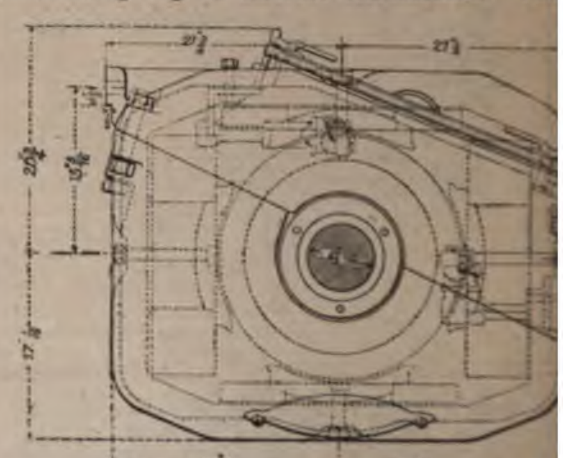


FIG. 9.—End Elevation of Motor.

the motors are started, all the armatures and all t
magnet coils are connected in series. The successi
vary the connection till the motors are connected

rcuits of two armatures and fields in series, r all the motors are in parallel. Resistances it certain stages to prevent too large currents it the arrangements are made so that the resist- d as little as possible. These resistances are seen

nt part of the locomotive under the sloped The locomotive is fitted with 42in. wheels, ive a starting pull of about 14,000lb., and when t 12 miles per hour, a draw-bar pull of about

Fig. 10 shows the arrangement of the plant in the generating station at Shepherd's Bush. The boiler plant will consist of 16 Babcock and Wilcox boilers in eight batteries of two each. The evaporative power of each boiler is to be 12,000lb. per hour, the heating surface

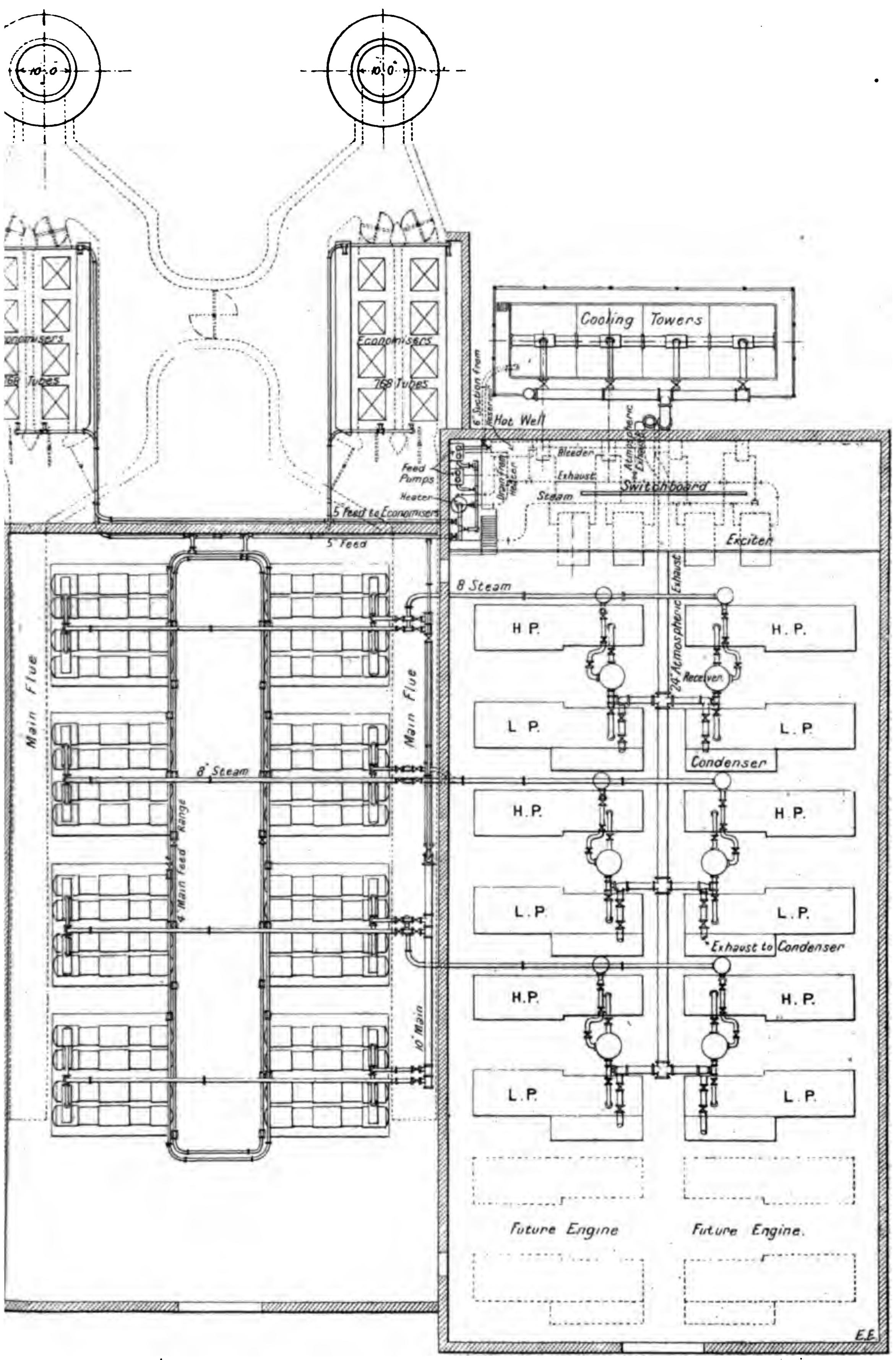


FIG. 10.—Plan of Generating Station at Shepherd's Bush.

3,550 square feet, and the pressure 150lb. per square inch. The boilers will be fitted with Vicars' mechanical stokers, which will be supplied with coal by a conveyor from a coal-store over the boiler-house. The steam-pipe arrangement is such that the engine is supplied by its own steam-

pipe, and that no really large steam-mains are required. The multiphase alternators and engines were described in our last week's issue.

MARDY ELECTRICITY WORKS.

We must confess that when we heard of the formal pening of the Mardy electricity works, we had to look up the position of the village in question and to glean details as to this pioneer in village lighting. The village is at the extreme end of the Ferndale or Rhondda Vach Valley, in the South Wales coalfield. It appears that the district had previously been lighted by gas supplied from the Ferndale gasworks, situate some four miles distant. A few years ago a great dispute arose regarding the price, which was then 5s. per 1,000ft. This was, however, subsequently reduced to 4s. 6d. A meeting was held at Mardy to protest against the price, and eventually a limited liability company was formed to provide electric light. Mr. Davies (a local baker) was appointed chairman of the company, and Mr. S. Edwards (a butcher) secretary. The capital was fixed at 2,000 £1 shares. The whole of this amount was subscribed, and the contract for the laying down of the machinery was entrusted to Messrs. Crompton and Co., of London and Chelmsford, who, under the supervision of their South Wales engineer (Mr. W. W. Hughes, Cardiff) have carried out the work. Hence it will be seen that it is essentially

a local company, and local support is thus secu have, through the courtesy of Mr. Hughes, bee give the details of the plant and mains laid d we are much pleased with the way first cost economised without prejudicing economy in run the first place, overhead wires have been adopte adverse criticism was made on this score at the For such small places, where, as a rule, the h scattered, the first cost of underground main seriously handicaps the undertaking. Again, the not requiring to break up streets, have not to expenses of a provisional order, but by obtai necessary wayleaves have taken their overhea wherever required.

The station is illustrated in plan and elevation i and 2, and the machinery in it comprises the fo A steel locomotive multitubular boiler, by Robey with sheet-iron stack, capable of supplying steam to a 50-b.h.p. engine. This boiler has a total surface of about 340 square feet. Arra are made by a feed heater in the exhaust give a hot feed to the boiler. The small feed pump is also shown in the plan of the The steam-engine is one of Robey's vertic pound engines, with the following dimensions. of cylinders, high pressure 8½in., low pressure stroke, 15in.: speed, 150 revolutions per minu dynamo is driven from this by link leather belting dynamo is one of Crompton and Co.'s shunt

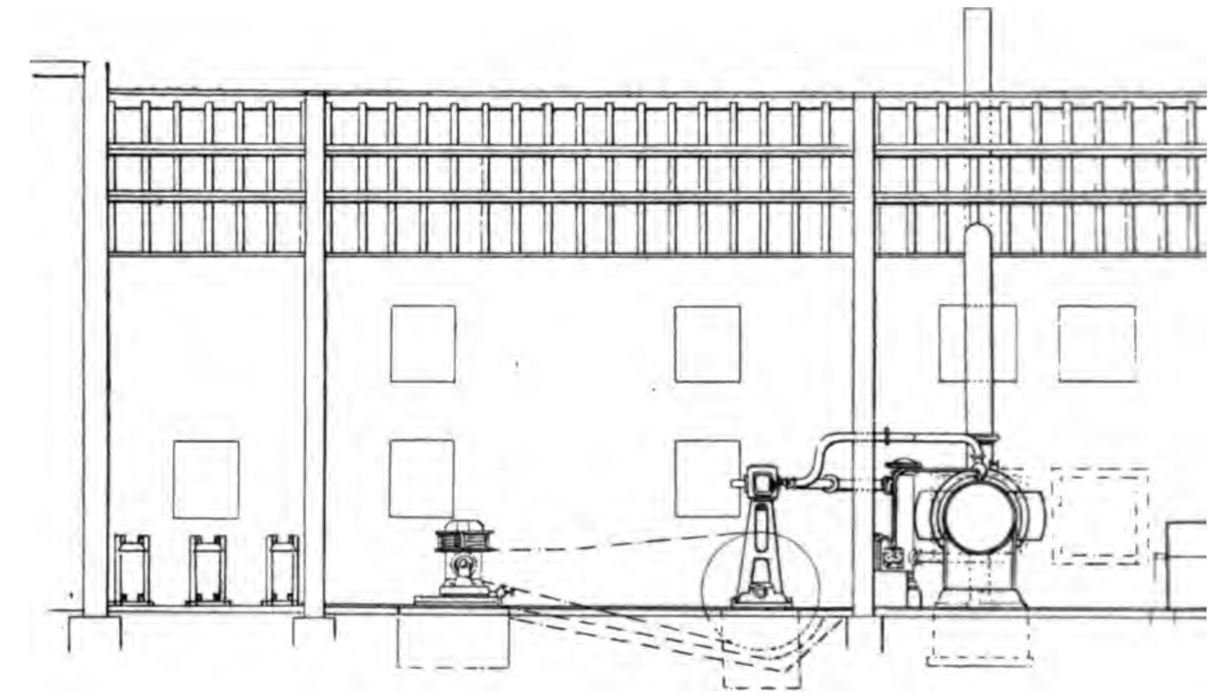


Fig. 1.—Elevation of the Mardy Electricity Works.

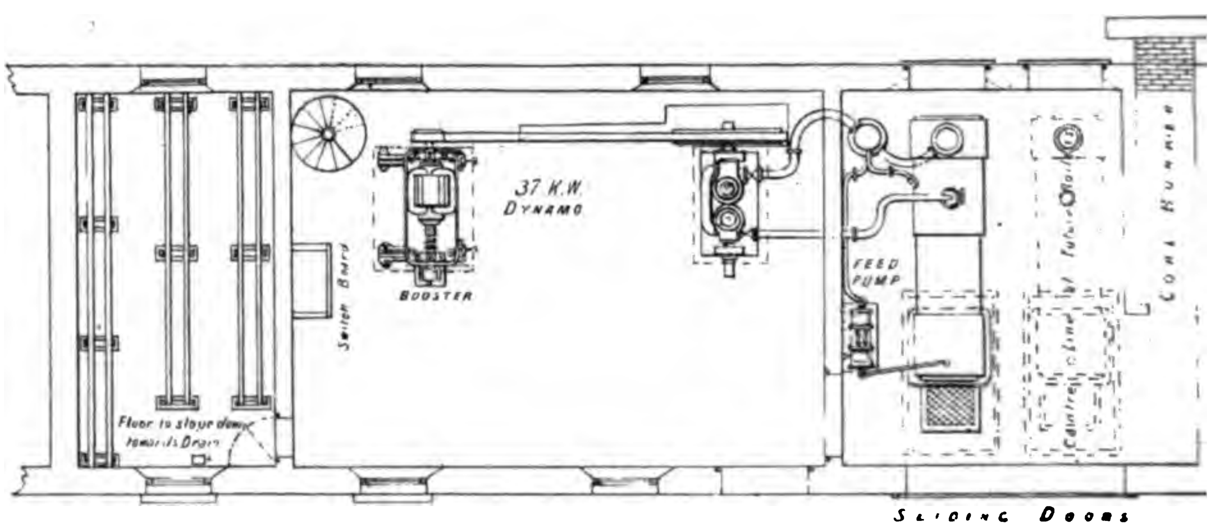


Fig. 2.—Plan of the Mardy Electricity Works.

of giving 168 amperes at 220 volts at a speed of olutions per minute. The mains are supplied direct machine at heavy load and by accumulators at light o enable the accumulators to be charged while the is running the lights, a small booster has been laid hitch up the voltage. The booster armature is n a continuation of the main dynamo shaft, and magnets are bolted to an extension of the bed- the machine. The output of the booster is 45 at about 80 volts, so that a total charging voltage n be obtained.

ccumulators are of the Chloride Company's R type, apacity of 220 ampere-hours. Some 120 of these n fixed, so that ample voltage is obtained. The ard provides switch, etc., for the regulation of these l for three feeders running at different parts of the These terminate at three points—one near the Hotel, one near the Royal Hotel, and the other at ion of Thomas-street and Cross-street. The lengths feeders are respectively 1,320 yards, 1,804 yards, yards. The first is of the heaviest section, being l of five No. 7 S.W.G. wires. The second consists No. 7 S.W.G. wires, while for the other and for ibutors one or two No. 8 S.W.G. sizes are used. l length of feeders and mains is about 8,000 yards. orting these, some 72 wooden piles are used and lators. The drop in voltage to the feeding point ad is limited to five volts, and the distributing e volts. The height of the wires above the ground over 25ft., and at road crossings 30ft. The whole ove plant has been laid down for about £1,600, so capital of the company has not yet been fully spent. s out at £43 per kilowatt installed—a most reason- re.

sent there are some 600 lamps supplied, but the Company hope to have in a short time no less than hich will be the maximum that the present plant ly. Installations at houses have been made by the Company themselves, under the supervision of Mr. The fittings for this installation were supplied by on and Swan United Electric Light Company, . Mr. Harris has been appointed electrician to the pany, and it is anticipated that the District Council a short time concede the company the right of the public streets of Mardy.

e formal opening last Thursday week a short was delivered by Mr. J. W. Leyshon, lecturer in hy, University College, Cardiff. A dinner was ently held at the Mardy Hotel, presided over by shon.

TES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

[*Copyright.*]

LXXXIX.

e year 1886 it occurred to me to experiment on the ion and utilisation of peroxide of lead in a granular he object in view was the admixture of the material form with the various compounds containing litharge the production of peroxide active material. *Primâ* would seem to be very expedient to mix the s in powder with the other ingredients of such ds in order to obtain a certain degree of con- y which facilitates the "forming" and allows it to se from without inwards, and in order, also, to the period of formation. But such admixture about 5 per cent. is usually very detrimental to the properties of the resulting peroxide, rendering it ost or "rotten." When, however, the peroxide buted through the compound in the form of s, surrounded by the compact and firm material d by the peroxidation of litharge alone, the admix- y become much less objectionable, whilst still con- conductivity to some extent and giving an initial to the material. But the most valuable property granulated peroxide used in admixture with com- used for "pasting" grids or perforated plates is that it practically obviates or greatly reduces the *foisonnement* or expansion by which the grids or plates become deformed, warped, or buckled during the peroxidation of the litharge paste.

Another object in view was to surround a conductor with depolarising peroxide of lead in such a form that it can be readily retained within a perforated envelope of some more or less indestructible substance. The process for obtaining the granulated peroxide of lead is described in the complete specification of patent No. 7,636, 1886: "I obtain the granular peroxide of lead by mixing preferably the monoxide of lead (litharge) with the solution of a salt or acid which will react more or less gradually upon the lead compound so as to cause it to slowly 'set' or harden, and by passing the plastic mass before the reaction is complete through a sieve or its equivalent, or through an apparatus similar to that used in the manufacture of vermicelli. The vermicular mass produced by this granulating apparatus breaks up into granules, and is allowed to remain undisturbed until the chemical reaction is complete, or nearly so, when the granules acquire a considerable degree of hardness, and do not disintegrate or become reconverted into a plastic mass when they are immersed in a liquid. The granules are next more or less superficially converted into peroxide of lead by treatment with chlorine or with a hypochlorite, and the conversion may afterwards be carried to any required extent by means of electrolysis. In making lithanode elements by the present invention, the granules, more or less completely converted into peroxide by one or both of the above-mentioned processes, are mixed in any suitable proportions with the plastic mass preferably of oxide of lead in admixture with a solution, such as one of those above mentioned, or with glycerine, or with a mixture of glycerine and water, which will produce the same effect—*i.e.*, cause the mass to 'set.' The elements thus constructed are allowed to harden by exposure to the atmosphere, and are afterwards, before use, preferably subjected to further processes of peroxidation. A porous vessel, or preferably a perforated or reticulated vessel or partition made of celluloid or other suitable material, may be used to contain the granulated peroxide, when this is employed as a depolarising agent in contact with a negative—*i.e.*, electro-negative—element made of lithanode (LXX.), or other suitable negative element, such as carbon or platinum."

The third claim of this patent is for "The use, in combination with and surrounding an element of carbon, platinum, or lithanode, of the granular peroxide of lead, or partly peroxidised granules of lead compound, as a depolarising agent, the same being contained within a porous, perforated, or reticulated vessel or partition."

XC.

The storage batteries which have been used for traction on common roads have been almost exclusively of the type in which the elements are enclosed in an envelope of perforated celluloid. They have, in fact, been imitations or colorable modifications of the Tommasi accumulator, manufactured by the Compagnie industrielle d'Accumulateurs, of Liège, and used on the tramways of that city. According to M. E. Gerard, the engineer-in-chief for traction and railways to the Belgian Administration, the above company, although their battery failed to withstand the test of long-continued action, did very good work in the direction of reducing the weight of storage batteries for traction purposes.

"An element according to this system," says M. Gerard, "is not composed of a simple metallic support and oxide of lead; it is constructed with a central core of antimonial lead, in the form of a grid, immersed in a pasty mixture of active material contained in a sheath, originally of lead and subsequently of celluloid, perforated with a great number of small holes."

In making up a battery with these elements, the Compagnie Industrielle separates them by rods of celluloid glued to the envelope by means of a solution of the same substance. The containing vessels are also of celluloid, 2mm. or 3mm. in thickness. The proportion of active material to metallic lead was 70 per cent.; whereas, accord-

ing to Mr. J. S. Sellon, "in a complete E.P.S. peroxide plate (1887) weighing 5lb. the peroxide in the form of paste weighed only 25oz."—*i.e.*, constituted only 31·25 per cent. of the element.* "If the whole of this active material," observes M. Gerard, "cannot take part in the electrochemical reactions, it plays a mechanical part, by reason of its mass and of the elasticity of the envelope, in permanently covering the internal conductive support. It was this idea that suggested the arrangement." The peroxide support is not, in fact, corroded and ultimately destroyed as in other arrangements.

Referring to the trials with this battery on the tramways at Liège, M. Gerard reported as follows: "The car employed in the experiments at Liège was a vehicle belonging to the tramways company which had been altered with a view to these experiments. It was provided with one of the simple-reduction motors of the Oerlikon Company, and carried the accumulators under the seats. When empty, the car weighed 4,500 kilos, and with 30 passengers 6,500 kilos. Included in these figures, the battery, in eight boxes of 12 elements (180 volts), amounted to the total weight, with the wooden boxes, of 1,000 kilos. The plates weighed 672 kilos. This is about *half* the weight of the battery plates employed at Brussels and at Hamburg for cars of the same capacity but somewhat shorter. Taking into account the weight of the cars in the two cases, that of the Tommasi battery is *reduced by 40 per cent., and its volume is reduced to a similar extent.*"†

Criticising the results obtained, the engineer to the Belgian Government enquires: "Is this reduction in weight obtained at the cost of the maximum safe rate of discharge or of the storage capacity?" The Compagnie Industrielle answers this question in the negative by referring to facts demonstrated during the trials. They particularly draw attention to the fact that the car ascended inclines of 45mm. to the metre with outputs of 40 to 70 amperes, augmented to from 125 to 150 amperes when the car was started on such inclines: these currents corresponding to rates of discharge of from 10 to 20 amperes per kilogramme.‡ The capacity of the 672 kilos (1,480lb.) of plates was sufficient for a run of 70 km. (43½ miles).

The concluding remarks of M. Gerard are not so favourable to the Tommasi battery: but it should be borne in mind that these trials were made some five years ago, and that with accumulators, as with other appliances, success is to be obtained only through comparative failures. M. Gerard says: "It should at the same time be stated that, after being in use for a certain period, plates of this description lose their initial activity by reason of phenomena of sulphatation: in consequence of defective contact with the support (or, rather, the conducting core) the sulphate of lead formed does not become completely reduced. The envelopes of organic matter will not withstand the electrical overcharges needed to convert the sulphate thus formed. The internal resistance due to these envelopes is appreciable."

It may no doubt be assumed that the pasty mixture surrounding the conductor in this type of battery as ordinarily constructed does not "set," and does not therefore become compact and conductive, as in the case of the lithanode compounds which have been described (LXX., LXXII., LXXIV.). This is a defect which might without much difficulty be remedied. And, although the resistance of the perforated envelope may be appreciable, it would be a mistake to suppose that it can be considerable. As I have pointed out elsewhere,§ it is quite true that, if there were no perforations in the envelope, the resistance would be practically infinite; but the assumption that if one-half of the insulating material were removed by perforation, the resistance would still be twice as great as that opposed to the passage of the current when the envelope is removed

is altogether fallacious. It is the resistance layer of electrolyte, out of many, that would b the removal of the envelope of insulating mat half its substance removed by perforation. And, it is the resistance of one layer only, out of m doubled by the introduction of the perforated question.

Taking the case of a prismatic mass of el sectional area S, and of length (distance between $n\ l$, the resistance of this electrolyte may be e:

$$r = \frac{n\ l}{S}.$$

Now if we place vertically, anywhere b electrodes (excepting in contact with the core), a septum of insulating material of thicl originally of sectional area S, reduced by per $S - \frac{S}{m}$, so as to allow a sectional area of fluid, $\frac{S}{n}$ passage of the current, the resistance will be i

$$R = \frac{(n-1)\ l}{S} + \frac{l}{s}.$$

Thus, if $n = 100$ and $m = 2$, the increase of resi to the insertion of the septum will be from 100 t

XCI.

A description of the mode of manufacturing recent form of the Tommasi cell was given in *Electro-Chimique* for July last, from which the f translated: The peculiarity of this accumula consists in a tubular envelope or sheath of chem celluloid perforated with a multitude of small the middle of this sheath is placed a grid of anti which acts solely as a conductor of the current, way supports the active material as in the case o forms of accumulator. The whole surface of this is in contact with a layer of oxide of lead, which i from all shedding or disintegration by the perfor lope by which it is imprisoned. This arrangemen moreover, the advantage that the lead grid can attacked by the sulphuric acid electrolyte, a fact been certified by the engineers of the Lyon rail case of a battery which has been in use for 18 m

A result immediately due to the arrangement i is that in a given weight the proportion of activ and consequently the capacity of the accumulat doubled. This accounts for the superiority of t lator from the triple point of view of large lightness, and small volume, desiderata whi difficult to realise in traction, lighting, and mar pulsion. To obtain these envelopes a sheet of celluloid is immersed in hot water, and when s softened is moulded upon an iron mandril b dimensions and form required for the envelope. of the latter are then cemented together with cell made by soaking celluloid scrap for about 48 acetone, or in glacial acetic acid mixed with 40deg. (*i.e.*, of specific gravity ·826). In this rectangular sheath is obtained, to which is fitted of unperforated celluloid, of which the edges coated with the celluloid glue. Within this e placed the grid, which is then surrounded wi fluid paste formed of oxide of lead mixed wi sulphuric acid. The excess of active material h removed, the electrode is subjected to a cert of pressure so as to obtain a very porous, homogeneous mass of the same thickness througl

The electrodes thus prepared are exposed t heat, and when quite dry are washed with wetted sponge, and then wiped, after which rods o intended to maintain the proper distance be elements, and to obviate any contact between elements, are attached to each side of the en means of the above mentioned celluloid glue. Th to contain the electrodes is of a hard kind of wood perfectly waterproof by means of a celluloid li traction cells, however, it is preferable to con recipient entirely of celluloid. The recipient is means of a frame, to which is attached a plate o

* For pasted grid plates, the proportion is generally given as from 25 to 30 per cent.

† Compare the recent announcements relative to the so-called Faure-King accumulator: "Weight reduced by 40 per cent.; space reduced by 45 per cent.; plates enclosed in refractory envelope; free from risk of short-circuit; discharge rate for up-grade work almost unlimited."

‡ 4·55 to 9·1 amperes per pound of plates, or from 3 to 6 amperes per pound of battery.

§ The *Electrical Review*, Aug. 9, 1895, p. 157.

; of transparent celluloid, through which the level fluid and the working of the cell may be examined. cumulator being mounted, the recipient is filled with ted water, and the charging operation is commenced. te of charge may be as high as three or four amperes o of electrodes. In case of necessity, this may be ed without any disadvantage other than a less utilisation of the charging current.

discharge may vary from one to four amperes per kilo es, but is not limited to this rate. In fact, these ilators will support without damage rates of discharge n or eight amperes, or even of 12 to 15 amperes (per plates) when a great expenditure of energy is d. These intense discharges may be continued for in period of time.

Electric Constants.

E.M.F.	2·4 volts.
"	2 "
ty per kilo of electrodes......	22 to 25 amp.-hours.
icy for amp.-hours	95 per cent.
, watt-hours	80 "

a capacity of 22 utilisable ampere-hours a mean rate charge of from one to three amperes per kilo of les has been adopted. A higher capacity may be d at a lower rate of discharge.

LORD KELVIN'S PATENTS.*

(*Continued from page 233.*)

THE ELECTROSTATIC VOLTMETERS.

e voltmeters have the great advantage of being le as accurate measures of potential on direct and ting systems, and, being electrostatic, they use no , and consequently require no temperature correc- They are therefore free from the causes of error so nt in instruments of the electromagnetic type, accuracy is impaired by variations of temperature, ich when used on alternating systems are affected rs due to self-induction varying with the period of tion. The chain of electrostatic voltmeters measures 0 to 100,000 volts, and is composed of three distinct -viz., the multicellular electrostatic voltmeters, the l electrostatic voltmeters, and the electrostatic . Two types of the multicellular instrument are -one with a horizontal scale for laboratory use, the rith a vertical scale and dead-beat action for engine- se. The ranges of the separate instruments, as made, are:

llular electrostatic voltmeter	range	40	to	160
	best of range	50	,,	100
" " "	range	60	,,	240
	best of range	70	,,	130
" " "	range	80	,,	400
	best of range	100	,,	240
" " "	range	200	,,	800
	best of range	300	,,	600
" " "	range	500	,,	1,600
	best of range	700	,,	1,300
l ,, ,,	range	200	,,	4,000
,, ,,	,,	400	,,	8,000
,, ,,	,,	800	,,	12,000
,, ,,	,,	1,000	,,	20,000
static balance	,,	5 000	,,	50,000
,, ...	,,	10,000	,,	100,000

vertical scale multicellulars, as shown at Fig. 2, have ranges than those given above. Their ranges correspond ly to "best of range."

instruments are made on the principle of an air ser, having one of its parts movable about an axis, increase or diminish the capacity. The condenser losed in a metal case, for the double purpose of pro- the movable part from air currents, and from the ing influence of any electrified body, other than the portion, differing from it in potential. In all the ments, except the electrostatic balance, the fixed ns consist of two sets of quadrant-shaped cells in lic connection with each other, and formed by a ir of parallel brass plates. These cells are fixed by an insulating support to the case of the instrument, and a terminal passes from them to an insulated binding screw on the outside of the case.

The movable portion in all the instruments is in metallic connection with the surrounding case. In the multicellular voltmeters this connection is made through the suspending

FIG 1.—Multicellular Electrostatic Voltmeter.

wire, and in the vertical scale voltmeter and electrostatic balance through the knife-edges which support the movable part. The movable portion carries the pointer which indicates by direct readings the difference of potential between the two parts of the condenser.

The action of the instrument, shortly stated, is as follows: when the fixed and movable plates are connected respectively to two points of an electric circuit, between which there exists a difference of potential, the movable plate tends to move so as to augment the electrostatic capacity of the instrument, and the magnitude of

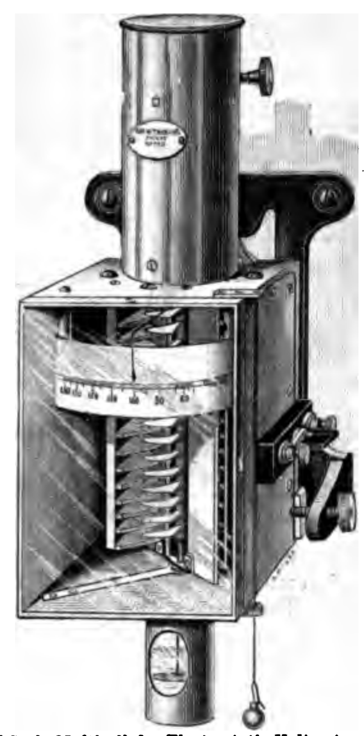


FIG. 2.—Vertical Scale Multicellular Electrostatic Voltmeter for Low-Tension Circuits (Engine-Room Pattern).

the force concerned in any case is proportional to the square of the difference of potential by which it is produced. In the use of the vertical and electrostatic balance instruments this force of attraction is balanced by the horizontal component of a weight of any convenient amount hung on the knife-edge in connection with the movable part, while in the case of the multicellular it is balanced by the torsion of the suspending wire.

THE MULTICELLULAR ELECTROSTATIC VOLTMETER.

The arrangement of the parts of this instrument is shown in Fig. 3. This figure applies to an early form of the instrument, and differs in two matters of detail

* bstract of paper read by Dr. Magnus Maclean to the ophical Society of Glasgow, Feb. 23.

from the voltmeter as now made. For simplicity in manufacture the cells are now made with straight backs, and the plates looked at in plan are, therefore, triangular instead of square. A coach spring has now been interposed between the suspending wire and the spindle carrying the vanes, as explained below.

The insulated cells are formed of triangular brass plates fixed into saw cuts in a brass back-piece so as to be equal distances apart and accurately parallel to each other. Two sets of these cells are fixed by a vulcanite support to the sole-plate, so that their plates are horizontal, and are completely enclosed within the brass cylindrical case of the instrument. On the top of this cylinder is a shallow horizontal circular scale box containing the scale of the instrument, and having a glass cover, which serves to protect from currents of air the movable indicator, I, and the scale and interior parts from dust. For the movable part a number of vanes, V, similar in form to those of the quadrant electrometer are used. These vanes are placed parallel to each other on a spindle with distance pieces between them. The top end of this spindle passes through a small hole in the sole-plate of the instrument, which forms the bottom of the scale box, and is attached to a small coach spring, which in turn is secured to one end of a fine iridio-platinum wire suspended from a torsion head at the top of a vertical brass tube. The torsion head may be turned by means of a forked key

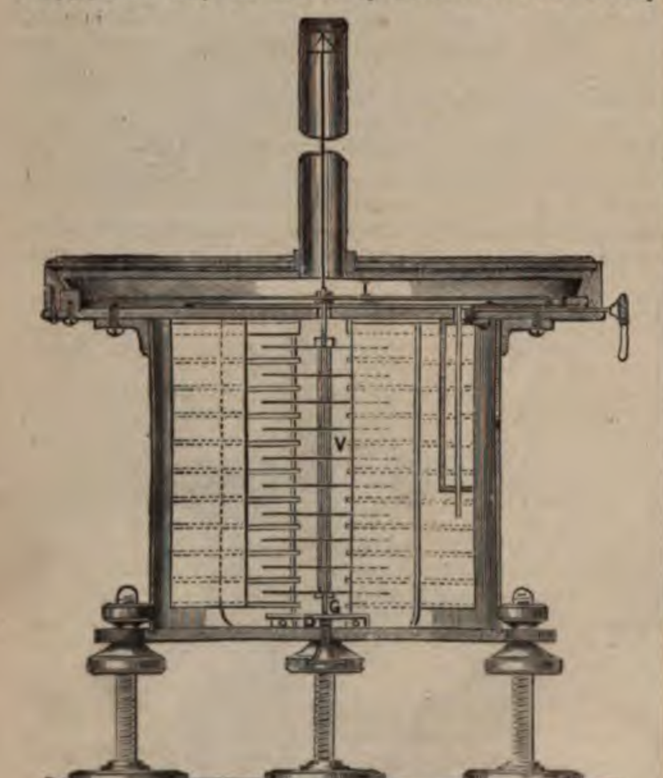


Fig. 3.

provided for the purpose, and is clamped, to protect it from accidental displacement, by a cap which screws on to the end of the tube. The coach spring has sufficient resilience to allow the spindle to touch a guard stop, and so saves the suspension from injury in event of the instrument being roughly set down.

Two vertical brass repelling plates, which also act as guard plates to prevent the movable part from turning beyond its prescribed limits, are fixed to the bottom of the sole-plate. These two plates carry a guide plate, G, with a circular opening in it, through which the lower end of the spindle passes. A little brass disc, or head, D, is attached to the end of the spindle, sufficiently large to prevent its passing back through the hole in the guide plate. Thus the movable part is effectually secured from swinging about so as to be injured, and by no possibility can it come into contact with the insulated quadrants. When the instrument is level, the spindle hangs free by the suspending wire, so that the vanes are horizontal, and each is in a plane exactly midway between those of two contiguous condenser plates.

An aluminium needle attached to the top of the spindle indicates, on the horizontal circular scale fixed to the side of the sole-plate, the difference of potential be the movable and fixed portions of the condenser by readings in volts.

Engine-Room Pattern Multicellular.—The descript the instrument given above refers to the horizontal or laboratory pattern. In the new engine-room p the parts are in every way similar, but the instr has a vertical scale. A vane attached to the spindle in an oil dash-pot, and gives the instrument a dea action.

Portability.—A small thumb-screw is placed in the of the base plate below the instrument, which c screwed in so as to lift the weight of the spindle and from the suspending wire and clamp the disc on th of the spindle against the guide plate. A lifter or cl is also provided similar to that used in the magnet instruments.

A switch is attached to the insulated terminal instrument by which the voltmeter can be taken circuit when desired. The switch, after breaking c puts the case and the insulated cells in metallic conne

Vertical Electrostatic Voltmeter.

The instrument is shown in Fig. 4, and, as will be the insulated quadrants are supported with their

Fig. 4.

vertical, and only one large vane is used. This mo plate is supported in a vertical position on knife-edg that the plane of its motion is parallel to the two plates which form the insulated quadrants. Its uppe has a fine prolongation which serves as a pointer fo cating the deflections on the scale of the instrument at its lower end is fixed the knife-edge for the we having its length perpendicular to the plane in whic plate moves.

In order to save time in taking readings, an arr ment is provided for checking the oscillations of movable plate, and stops are placed to limit its range prevent damage to the pointer. One of these stop left-hand one, is made to act as a support for the va the arrangement for portability.

The scale is graduated from 0 to 60, and the div represent equal differences of potential—the actual m tude of the difference per division being dependent up weight in use at the time. A set of three weights is with each instrument, providing for three grad measurement in the proportion of 1 : 2 : 4. Thu instrument shows one division per 50 volts with the

itest weight) alone, one division per 100 volts medium weight hanging on the link, and one per 200 volts with all three weights on.

THE ELECTROSTATIC BALANCE.

rrangement of the parts of this instrument is n Fig. 5. The fixed portion of the condenser in rument is a brass disc, B, which is supported from ase, S, on three glass pillars, P. The disc is pro- ith the well-known Thomson "hole, slot, and rrangement, so that it always rests in exactly the ition on its supports.

e thickly covered with indiarubber passes from a , T, through a glass tube, C C C, and makes on with the disc by a spring contact, the glass ing filled with paraffin to prevent the lodgment ure and give great resistance to disruptive dis- A sheath formed by a short piece of glass tube over the terminal, T, and protects it from being by accident. The base plate is provided with ew levelling feet. A brass case fits upon the base d fixed to its top is a metal scale box with a glass ich contains the indicator and scale. The movable is a round aluminium plate, supported by two long ich pass through a slit in the top plate of the case nife-edge stirrups on one end of the counterpoised

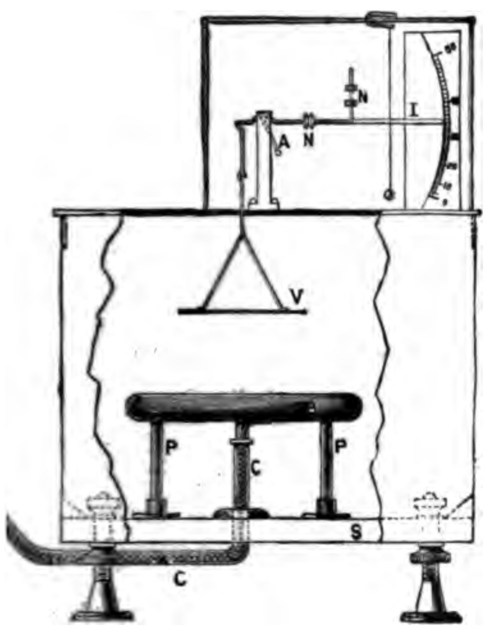


FIG. 5.

The whole movable portion is supported by on two brass pillars and has a short arm, A, nife-edge stirrup at its extremity attached to its The weights which fix the constant of the instrument this stirrup.

nstrument has a scale with divisions corresponding differences of potential. The scale is graduated to 50, and three weights are provided such that, first hung on, the constant is 250 volts per division; second weight on, it is 500 volts per division; and third weight on, 1,000 volts per division.

(To be continued.)

REVIEWS.

rchitects' and Builders' Price-Book. By W. YOUNG. nty-fifth edition, 1898. London: E. and F. N. Spon. York: Spon and Chamberlain.

author in his preface to the twenty-fifth edition aluable handbook states that it has been further d, but still in keeping with the original plan of the The arrangement of the matter in alphabetical , which has proved so useful heretofore, has been Concrete, fireproof floors, and granite have been ecial divisions, and a chapter on electricity has been added, giving specifications and estimates of electric lighting, installations carried out by the author—lightning conductors, electric bells, etc.

INSTITUTION OF ELECTRICAL ENGINEERS, Mar. 10.

At last night's meeting of the Institution the following were the candidates balloted for:

Associates.—G. Balfour, Temple Electric Works, Dundee; E. H. Burgess, Doris Villa, 14, Heathwood-gardens, Charlton, Kent; T. P. E. Butt, 1, Thornhill-villas, Mannamead, Plymouth; W. R. Edwards, Rosedale, Weybridge, Surrey; J. E. Elliott, Church-green, Witney, Oxon; H. P. Girling, Boxmoor, Queen-street, Chelmsford; R. Lund, 43, Parkhurst-road, Holloway, N.; R. Marshall, 30, Woodland-terrace, Charlton; Lieut. C. M. Playfair, R.A., I.P.F. Office, St. George's, Bermuda; M. Railing, 139, Finchley-road, Hampstead, N.W.; T. E. Ritchie, 5, Duke-street, Moss Side, Manchester; B. S. Singh, the Royal Indian Engineering College, Cooper's Hill; H. W. Watts, the Corporation Electricity Works, Ayr, N.B.; J. M. G. Wilson, 25A, Cockspur-street, S.W.

Students.—J. J. Chapman, 90, St. Paul's-road, Burdett-road, E.; J. F. Henderson, 4, Belhaven-crescent, Glasgow; F. H. Hutton, B.A., Trinity College, Cambridge; W. G. Laird, 5, Garden-terrace, Inderwick-road, Hornsey, N.; W. A. Turquand, 10, St. Andrew's-road, West Kensington, W.; E. B. Ward, care of Messrs. Beanland, Perkin, and Co., electrical engineers, Leeds.

FORTHCOMING EVENTS.

FRIDAY, MARCH 11.

Physical Society.—At Burlington House, at 5 p.m.: (1) "On Dynamical Illustrations of Certain Optical Phenomena," by Prof. J. D. Everett, F.R.S.; (2) "On Properties of Liquid Mixtures," by R. A. Lehfeldt.

Institution of Civil Engineers.—Students' meeting, at 8 p.m., "The Drainage of Cottage Property," by H. C. Adams, Stud.Inst.C.E.

SATURDAY, MARCH 12.

Institution of Electrical Engineers.—Students' visit, at 10.30 a.m., to the stations of the Metropolitan Electric Supply Company.

Institution of Junior Engineers.—At the Westminster Palace Hotel, at 7.30 p.m., conversazione.

MONDAY, MARCH 14.

Society of Arts.—At 8 p.m., Cantor lecture, "The Thermo-Chemistry of the Bessemer Process," by Prof. W. N. Hartley, F.R.S.

TUESDAY, MARCH 15.

Institution of Civil Engineers.—At 8 p.m., "Calcium Carbide and Acetylene," by Henry Fowler, Assoc.M.Inst.C.E.

Royal Institution, Albemarle-street.—At 3 p.m., Prof. E. Ray Lankester, M.A., LL.D., F.R.S., on "The Simplest Living Things."

WEDNESDAY, MARCH 16.

Institution of Electrical Engineers.—At 7.30 p.m., students' meeting, "Polyphase Motors," by E. E. Tasker.

Royal Meteorological Society.—At 7.30 p.m., at the Institution of Civil Engineers, lecture on "Photographing Meteorological Phenomena," by Arthur W. Clayden, M.A., F.R.Met.Soc.

THURSDAY, MARCH 17.

Institution of Civil Engineers.—At 8 p.m., the sixth "James Forrest" Lecture on "Geology in Relation to Engineering," by Prof. W. Boyd Dawkins, M.A., F.R.S., Assoc.M.Inst.C.E. At 11 a.m., students' visit to see the ventilating, heating, lighting, and drainage arrangements of the Houses of Parliament.

Royal Institution, Albemarle-street.—At 3 p.m., Tyndall Lecture, "Recent Researches in Magnetism and Diamagnetism" (Lecture III.), by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., M.R.I.

Finsbury Technical College.—At 8 p.m., L. J. Steele on "Electricity Meters"; third lecture of course of five.

FRIDAY, MARCH 18.

Royal Institution.—At 9 p.m., "The Bringing of Water to Birmingham from the Welsh Mountains," by James Mansergh, V.-P. Inst.C.E., F.G.S., M.R.I.

SATURDAY, MARCH 19.

Institution of Electrical Engineers.—Students' visit to the works of Messrs. Easton, Anderson, and Goolden, Erith. Train from Charing Cross, 10.2 a.m.

Institution of Junior Engineers.—Visit to Messrs. J. and E. Hall's refrigerating machinery works, Dartford. Train leaves Charing Cross at 2.30 p.m.

THE

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TO CORRESPONDENTS.

 Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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NEXT, PLEASE!

In the stellar universe some comets are p
visitants to regions within the ken of man,
the sensational literature of the day "Seeing b
tricity" is becoming a periodic headline. The
tigations of Hertz are forming a grand
exploration for the speculative patentee, for.
from that source or from the unknown
opened out by Röntgen - ray experimen
explains the otherwise inexplicable. Prof.
must have felt a glow of expectant pride
the *Chronicle* commenced to exploit the
discovery, and was followed by almost
paper of importance in the kingdom. P
however, the *Telegraph* of Tuesday has th
delightful article upon the subject. It is ape
American cousins in startling headlines, an
readers must have wondered what it had to s
about "Seeing at a Distance," or "The
Picture-Transmitter" Adams, Ayrton, C
and all that galaxy of talent that labou
long and so ardently over the seleniun
must perforce take a back seat to the un
Polish schoolmaster who has, according
Telegraph, perfected its use in an appara
which we are to see by electricity. V
dogmatism—we are dogmatic ourselves at ti
but often that is when discretion is absent, a
valour is present. The *Telegraph's* corresp
has as little discretion, though his or her va
abundant. There may be a schoolboy—we can
realise that there exists a student, much
schoolmaster or a professor, who could do
as follows: "There is no real difficulty
converting rays of light into electrical
impulses. That can be done in a variety o
and one only has to choose." We are a
reminded of a somewhat cynical poet name
who suggested that "Where ignorance is bl
folly to be wise," as having provided a se
applicable to these utterances of the *Tel*
Most electricians—we cannot say all because
Polish schoolmaster and the writer to the *Teleg*
would be delighted to know a few of these way
methods have been kept wonderfully secret, a
few who know them are to be congratulated.
is well known to electrical students is that
experiments have been carried out with sel
that Adams found out that this substance c
its resistance under the action of light. Th
edition of Sloane's "Electrical Dictionary"
selenium: "In one set of experiments it was
that diffused light caused the resistance to
the ratio of 11 to 9. Full sunlight reduce
one-half. Of the spectrum colours, red wa
powerful, and the ultra-red region still more st
affected its resistance." These words are pr
with meaning when we come to consider th
posed apparatus; but what follows is still
important—viz., "The effect produced by ex
to light is instantaneous, but on removal to th
only slowly disappears." If this be true, how
the rapidity of transmission that this new app
requires? Here is the *Telegraph's* account
apparatus:

ncerning the apparatus there is much to be id a good deal of it is exceedingly technical. ›paratus at the transmitting and receiving s are to be connected by one or two con- ; wires. Each apparatus or 'device,' as termed, contains two oscillating mirrors, are moved at exactly the same time— onously is the word—by means of electro- ts. If the devices are joined by a single only one point of the picture can be seen ime (but this does not in any way interfere he result), so that the mirrors have to be d in such a way that in any position and moment *they will bring but one ray into that the apparatus which converts the differences into differences of electric current.* The rays I pointed out, changed into currents, which strength according to the colour of the light l by the several points of the picture. These us converted produce at the receiving station sponding effect in the electromagnet (' ener-), and the prism moves in such a way that only f a similar kind of light, falling on the prism, decomposed and transmitted to the receiving . The light employed for the prism may be ncandescent light or sunlight. The mirrors the apparatus are made by coating the reflect- face of a mirror with a mass which is not rent, and by making a scratch so as to pro- reflecting surface in the form of a narrow strip. naining details dealing with the method and ces for breaking up lines into points, con- differences of light into differences of current, a nature to delight a scientist and take bwebs off an optician's heart, but they leave the general reader where they found not a trifle worse. It is emphatically a f going farther and faring worse. The tion bristles with 'selenium cells,' 'ener- of electromagnets,' 'abscissæ,' and 'mirrors nously oscillating about horizontal axes,' her analogous phenomena. The essential that now, at last, we have an invention by of which not only photographs, but pictures, ransmitted to a distance with every gradation and shadow, colour and hue."

have italicised a few words in the above because the statement does not harmonise ommon knowledge, as stated by Sloane. erse action is not so instantaneous as the and many of the variations in the light must e reverse order. As to the apparatus at the g end, we confess to an inability to under- . That the impingement of light upon selenium se a variation in its resistance is granted, know of no previous apparatus that con- variation of current at the receiving or er end into light. There are dozens of ns which naturally rise; one only need be ned—the proportion of the total resistance of euit that is variable. The selenium cannot whole resistance to the current, and may, , have a comparatively small resistance to f the other parts of the circuit, yet there only variation possible. All things considered, may we not venture to look upon this exploitation of a patent with these astounding pretensions—which the *Daily News*, following the lead of the other morning papers, emphasises in its issue of yesterday—through the columns of non-technical papers as an attempt to impose upon the credulity of the non-technical public, and expect to shortly hear of the formation of a company which will attack their pockets as well as their credulity. If there is anything in the patent, surely the first persons to have the matter before them would be the scientific men who have studied the subject, who have some knowledge of the laws of light and of electricity. We venture to say the Royal Society, or the Physical Society, or the Electrical Engineers, would welcome a paper upon the subject which contained information about a really new discovery. So far, the articles all seem to be based upon interviews with the patent agent, and so far the information given, when carefully examined, does not point to a workable apparatus. We strongly condemn this method of exploitation by sensational headlines and articles, and warn our readers to keep a very open mind till the much-talked-about apparatus has been under the examination of men who understand the matter.

ELECTRICAL ENGINEERING PLANT SPECIFICATIONS.

For some time past the question of the conditions appearing in specifications as commonly issued by consulting engineers and local authorities for electrical plant, has been receiving the attention of electrical engineers in this country.

A very general feeling has been found to prevail that the regulations which commonly govern the execution of building and similar works do not satisfactorily apply to electrical contracts, where the conditions of supply, execution, test, and subsequent use differ widely from the comparatively stereotyped procedure in the former case. Electrical manufacturers and contractors, on their side, complain that the conditions of electrical specifications in the past have placed them too unreservedly at the mercy of the purchaser's engineer; while consulting and municipal electrical engineers in many cases disapprove of the excessive responsibilities which they are called upon to bear under such specifications, and of being forced into occupying a judicial position which properly pertains to the law or independent arbitration.

The result of general ventilation of the subject in the Press and electrical engineering circles, has led to its being taken in hand by the two organised bodies representative of the respective interests of the contractor and the purchaser—viz., the Electrical Engineering Plant Manufacturers' Association and the Municipal Electrical Association.

These associations recently appointed representative committees to meet in conference and thoroughly discuss the subject, with a view, if possible, of agreeing upon a model specification to serve as a basis for future guidance. Their labours have already resulted in the settlement of certain standard clauses upon a number of points in respect of which there has been much divergence of opinion and friction in the past, and it will no doubt prove possible, as it is clearly desirable, to add to these in future, and as occasion offers, until an agreed standard specification is available which will cover all the essential contingencies of electrical contracts.

These clauses are now published in the hope that they may be generally accepted by consulting engineers and local authorities as an equitable adjustment, at the hands

of thoroughly qualified experts representative of the interests of buyer and seller, of past differences and sources of dispute, and that they may be embodied in future specifications for electrical plant.

The committees have so far confined themselves to dealing only with what may be described as the commercial conditions usually appearing in electrical specifications, and have left the purchaser's engineer free to specify the character of plant he considers desirable, and the technical conditions which it is to fulfil. A feeling has, however, been steadily growing that some efforts should be made in the direction of standardisation, as far as possible, of the technical features of electrical specifications, thereby enabling the purchaser to buy cheaper, to obtain early delivery, and to secure freedom from the inevitable risk attendant upon new designs and patterns; while the manufacturer would reap the advantages consequent upon specialisation and repetition in manufacture.

It is accordingly greatly to be hoped that it may prove possible, as time goes on, to extend the scope of the present foundation of a standard specification until all the essential features of a contract based on experience and equitable compromise are included, and so ensure a satisfactory outcome both for the intelligent buyer and the honest contractor.

PROPOSED STANDARD CLAUSES FOR ADOPTION AMONG THE GENERAL CONDITIONS OF SPECIFICATIONS FOR ELECTRICAL ENGINEERING PLANT.

Drawings.—The contractor shall, at his own expense, supply to the purchaser copies of the drawings necessary for the erection of the works under the contract, but shall not be called upon to furnish constructional details further than in the opinion of the engineer are required for the purposes of the contract. If the contractor shall be called upon to supply additional copies of the drawings, they shall be paid for at a fair price to be arranged. The engineer shall, in addition, have the right at all reasonable times to inspect any drawings of any portion of the plant contracted for at the works of the manufacturer.

Powers of Engineer to Reject Materials or Vary Works.—The engineer may from time to time during the execution of the contract vary, increase, or reduce the contract works, and may order any work or portion of work executed, or partially executed, to be removed or altered, and the difference of cost occasioned by any variation, addition, omission, removal, or alteration as aforesaid shall be added to or deducted from the contract price as the case may require, and the amount of such difference shall be ascertained and determined in accordance with the rates specified in the schedule of prices set out in the schedule to the contract so far as the same may be applicable, and where the same are not applicable then according to such rates or prices as shall be fair and reasonable; such prices in case of dispute shall be referred to arbitration as herein provided. No addition shall, however, be made to the contract price in respect of any such variation of, or addition to, the said works unless the instructions for the same shall have been given by the engineer in writing, nor unless such instructions shall state that the matter thereof is to be the subject of an extra charge. A decision of the engineer to reject materials, or require workmanship which is in his opinion defective to be amended, shall be obeyed by the contractor. If the contractor shall so desire, and of such desire shall give notice in writing to the purchaser within 72 hours after receiving notice from the engineer, the question involved in any such decision of the engineer may be submitted to arbitration as herein provided. The contractor shall not under these circumstances cease to proceed with the execution of the contract, to the prejudice of the purchaser.

Date of Completion of Works and Penalties.—The contractor shall within a period of —— from the date of the order of the engineer to commence the contract works (and time shall in this respect be of the essence of the contract) complete the whole of the contract works, and make good all damage done to the roads, buildings, or other property of the purchaser, and fill up all holes and trenches which may have been dug, and level any mounds or heaps of earth that may have been made, and reinstate all works, property, matters, and things disturbed or damaged, and deliver up to the purchaser the said works complete to the satisfaction of the engineer; and in case the contractor shall make default in performing and observing the provisions of this clause within the period hereinbefore limited, or within any extension of the same period which may be granted under the powers herein contained, the contractors shall and will pay to the purchaser on demand as ascertained and liquidated damages, and not as a penalty, the sum of £ —*

* N.B.—Under no circumstances to exceed 1 per centum per week of the contract value.

for each and every week which shall elapse between the
tion of the period limited by this clause, or any ex
thereof which may be granted as aforesaid, and the
performance and observance by the contractor of the pro
of this clause, unless the execution of the contract work
have been delayed by an unreasonable strike of workm
excessive inclement weather affecting the work of th
tractor, or by any circumstances over which the con
shall have had no control, provided that no such damage
accrue as payable by the contractor to the purchaser af
time when the plant is complete and ready to be set to w

Power of Purchaser to Use Works during Execution.
purchaser shall have power to use any portion of the
reasonably capable of use at any time during execution
contract, and also pending any arbitration. In such case
ever, the contractor shall be entitled to receive, by
rental, a sum equal to 5 per centum per annum up
amount withheld in respect of any machinery put into
ficial use, and not paid for.

Payments.—During the progress of the works, and a
as possible after the expiration of each month, the con
shall be entitled to payment, on the engineer's certific
75 per cent. of the value of the work executed on the si
plant delivered on the site during the month, until the b
of 25 per cent. of the value of the executed work retai
the purchaser is equal to 10 per cent. of the total value
contract. Thereafter the contractor shall be entitled to m
payments as before equal to 90 per cent. of the value
remainder of the executed work, until the contract wor
completed for continuous effective usage by the pur
whereupon he shall become entitled to one-half of the ret
moneys. The remaining half of the retention moneys
be payable ——* months later. The purchaser shall, ho
be entitled to retain such sum of money as, in the opin
the engineer, fairly represents the prejudice to the pur
arising out of incomplete or defective details, until the
ment of such details to the satisfaction of the enginee
cases where the contractor, although willing so to do, is
to repair defects in certain parts of the contract works i
sequence of the purchaser not being able to place such
into his hands for the requisite time, owing to their b
use, the contractor shall be paid in full for such portion
contract works on giving an undertaking, with security
satisfaction of the purchaser if required, to remedy the
as soon as the same can be placed in his hands for the pu

Certificates of Engineer.—The engineer shall from ti
time issue his certificates in accordance with the clause r
to payments, and payment shall be made to the contra
the earliest possible date. Certificates of the engineer
than the final certificate shall not be considered con
evidence as to the sufficiency of any work or materials to
they relate, nor shall they relieve the contractor fr
liability to make good all defects as provided by the co
The contractor when applying for a certificate shall, if re
furnish to the engineer an approximate statement of the
of the work executed and materials delivered, based
original estimate. When the contract works shall b
pleted, as referred to in the clause relating to paymen
contractor shall be entitled to call upon the engineer
certificate to that effect. In case of the refusal of the en
to grant such certificate when called upon by the contra
do so, this refusal shall be subject to appeal under the a
tion clause herein contained.

Maintenance and Limitation of Responsibility of Contra
The contractor shall be responsible for, and shall effe
maintain and uphold in good and substantial conditi
accordance with the specification, fair wear and tear
excepted, all and every part of the contract works for a
of —— months* from the date of completion of the c
as certified by the engineer.

Arbitration.—In case any dispute or difference shal
between the purchaser, or his engineer on his behalf, a
contractor, either during the progress of the works, or af
determination, abandonment, or breach of the contract,
the construction of the contract, or as to the reasonable
any extra charge, or as to the withholding by the engi
any certificate to which the contractor may claim to be e
then either party may within 72 hours, but not later,
the other notice in writing of the existence of such dis
difference, and such dispute or difference may be refer
arbitration, which arbitration shall be deemed to be a s
sion to arbitration within the meaning of the Arbitratio
1889.

The above clauses have been approved on behalf
Electrical Engineering Plant Manufacturers' Asso
by R. Percy Sellon, Brush Electrical Engineering Co
Limited; R. E. B. Crompton, Crompton and Co., Li
A. B. Blackburn, Electric Construction Company, Li
S. Z. de Ferranti, S. Z. de Ferranti, Limited; A. F

* N.B.—Under no circumstances to exceed 12 months.

wler and Co., Limited; W. B. Esson, Johnson and ; and on behalf of the Municipal Electrical Associa- A. H. Gibbings, president; C. H Wordingham Wright, past-presidents; A. Gay, G. Pearson, T. P. urst, and A. B. Mountain, members of council.

QUESTIONS AND ANSWERS.

r this heading we insert questions and answers actical character relating to central-station work, y work, or construction work; and for each suit- estion offer *one shilling*, and for the best solu- any question we offer *ten shillings*. We also *shillings* for every other answer we print. The to any question should be sent within 10 days e question has appeared, and should be written on of the paper only. We would call the attention sending in answers to the fact that the neatness sketches sent in is considered when marking the values of these answers. Questions may be sent ime.

Questions.

ss the relative advantages of (*a*) forced lubrication, (*b*) lubrication by splashing for engine bearings.— . B.

ming that no two different types of alternate-current sformers "bank" or parallel correctly together at all s, at what point of the load is it most advisable to have parallel correctly—*i.e.*, to give the same voltage.— C.

Answers.

38.—How is the efficiency of a gas-engine determined?

Answer to No. 38 *(awarded* 10*s.).*—In this question sumed that both the total and mechanical efficiencies uired. To obtain these quantities the following sary: (1) A suitable indicator and gear. The high- rm of Crosby's or Schaffer and Budenberg's gas- ndicator would be about the best to use. A very gear is that invented by Mr. Grover, in which it is to couple and uncouple the cord without slowing he engine; the motion, of course, being taken in nary way from the piston by a rod bolted rigidly d projecting out of the end of the cylinder. (2) rm of friction brake, generally consisting of two or pes placed over the flywheel and kept in position rim by wood shoes at intervals. Weights are l to one end of the strap, while the other end is d to a spring balance fastened to the floor. (3) A unter, preferably one of the tachometer or direct- type. (4) A gasmeter for determining the total con- n of gas. (5) A water-meter for determining the of water used in the jacket. (6) The calorific value as must be determined at frequent intervals. Then, adjusted all the indicator gear and seen everything ler, diagrams should be taken at frequent intervals, 10 minutes; springs varying from $\frac{1}{70}$ to $\frac{1}{80}$ will d most suitable for this purpose. From these s the average of pressure can be obtained by means lanimeter or other form of diagram averager. gines working with the "Otto" cycle, deductions e made for the power lost in the pumping strokes. s must be taken to find the value of this quantity; ly light springs of about $\frac{1}{10}$ to $\frac{1}{20}$ will be found able, care being taken not to damage the indicator the explosion stroke. Next, the explosions per must be accurately recorded while these cards are ken. In most engines these can be counted by f an ordinary watch. A still better way is to have echanism actuated by the gas-valve, and unless the misses fire this method is bound to be correct. dicated horse-power can be found from the formula, N –, where P is the average pressure, L length of l area of cylinder, and N the number of explosions te. Frequent brake readings must be taken in the between the indicator diagram records. To do brake strap is well lubricated with graphite or her good lubricant; often it is necessary to run water on the inside of the rim to keep it from dangerously overheating. Known weights are then hung on one end of the strap. To get the net brake load, the reading of the spring balance must be deducted from these weights. Then brake horse-power is given by the formula, $\frac{2\pi R W N}{33{,}000}$, where R is the radius of the flywheel in feet (this should be accurately found by means of a trammel), W is the net load on the brake in pounds, and N is the number of revolutions per minute taken from the speed counter.

$$\text{Then} \quad \frac{\text{Brake horse-power}}{\text{Indicated horse-power}} = \text{mechanical efficiency.}$$

In good gas-engines of, say, 25 h.p., this will generally be about 80 per cent. To get the total efficiencies, mechanical and brake, the quantity of gas used during the test must be registered by a reliable meter. A correction must then be made for temperature and pressure. From this the average consumption per minute can be found. An analysis of its calorific value will give the British thermal units per cubic foot. By multiplying by 772 (the mechanical equivalent of heat), then energy of the gas in foot-pounds per minute can be determined. Then

$$\frac{\text{Foot-pounds of work per minute (from indicator cards)}}{\text{Foot-pounds of work per minute (stored in gas)}} = \text{total efficiency.}$$

and

$$\frac{\text{Foot-pounds of work per minute (from brake test)}}{\text{Foot-pounds of work per minute (stored in gas)}} = \text{total brake efficiency.}$$

This varies from 18 to 21 per cent. in good engines. The chief losses are those which occur by reason of the high temperature of the exhaust, probably about 1,000 C. in most engines, and the heat carried away by the jacket. To accurately determine these losses is a somewhat difficult matter, but an approximation can be got by measuring the quantity of water used in cubic feet per minute in the jacket, and the difference in temperature of the water at entering and leaving. From this the Board of Trade units and foot-pounds per minute can be determined. Deducting this loss from the difference between the gas consumption and indicator tests, we get the energy lost in the exhaust. Roughly, in most engines the distribution of energy is as follows: utilised as work in cylinder, 24 per cent.; lost in jacket, 33 per cent.; lost in exhaust, 43 per cent. No account has been taken of the gas used in heating the ignition tube or flame, as the case may be. This is generally best registered by a separate meter, but it must be added to the total quantity consumed to get the total mechanical and brake efficiencies.— H. Bell.

Answer to No. 38 *(awarded* 5*s.).*—There are several ways of expressing the efficiency of a gas-engine. The ordinary commercial way is to state the cubic feet of gas used per hour per indicated horse-power. This, however, is not accurate, as the quality of the gas varies in different localities and at different times. A better way is to find the calorific value of the gas and work out the energy of the gas used per minute, and express the efficiency as the ratio of the indicated or brake horse-power to this energy. There is also the mechanical efficiency of the gas-engine—that is, the ratio of the brake to the indicated horse-power. To find the calorific value of the gas some form of calorimeter is necessary; a very good one is "Junker's." In this the gas is burned in a Bunsen burner placed at the bottom of the calorimeter, so that the products of combustion pass up the centre and down the sides through tubes surrounded by water, which is kept flowing uniformly under a constant head, entering at the bottom and leaving at the top. The water condensed from the gas is collected from a drain tap and weighed. The gas passing in a certain time is found by means of a delicate gasmeter, and the average difference of temperature between the inlet and outlet water is noted, also the amount passing in the given time. The calorific value of the gas in British thermal units per cubic foot will be the average rise in temperature of the water in Fahrenheit degrees multiplied by the pounds of water passing and divided by the cubic feet of gas used.

From this, to get the useful value, must be subtracted the weight of water condensed multiplied by the latent heat of steam plus its temperature below boiling point. The average calorific value of a fairly good coal gas is about 600 British thermal units per cubic feet. To obtain the energy per minute, multiply the cubic feet of gas used per minute in the gas-engine by the calorific value, and by 778 and divide by 33,000. This will give the total horse-power contained in the gas. The indicated horse-power is obtained by means of an indicator in the usual way. The simplest accurate way to obtain the brake horse-power is to use an absorption dynamometer. A useful form consists of a double rope passed completely round the flywheel. One end passing between the other two pieces is fastened through a spring balance to the ceiling or a convenient beam, and to the other end are hung weights. The separate turns are kept in place a little distance apart by means of blocks of wood fitting loosely on to the rim of the wheel, with notches in for the ropes. The brake horse-power is obtained by the formula, $\text{H.P.} = \frac{(W - w)\, r \times 2\pi n}{33{,}000}$, where W and w are the weights and spring balance pull in pounds, r is the radius of the pulley in feet, $2\pi r$ being the circumference of the pulley, and n is the revolutions per minute. In a fairly large gas-engine the gas consumption should be about 16 to 20 cubic feet per indicated horse power hour, whilst the mechanical efficiency may vary from 60 to 90 per cent. The brake horse-power may be about 16 to 20 per cent. of the energy contained in the gas.—P. G. M.

Question No. 39.—**Tramway motors are usually specified to have a certain tractive effort at the periphery of the car wheels when the car is travelling at a certain speed. How is this figure arrived at, and what connection does it bear to the size of the motor?**

Best Answer to No. 39 *(awarded* 10*s.).*—The size of the motors required for the electric cars on a particular line depend on (1) the weight of the cars; (2) the average speed on the line; (3) the number of stoppages; and (4) the incline and curves on the line. To simplify the problem, we shall at first neglect the number of stoppages and the curves, and indicate briefly how the required tractive effort is arrived at. Let W be the weight of the car in tons, and let f be the frictional resistance of the rails per ton weight. This quantity, f, is a variable, but the limits between which it must be depending on whether the lines are clean or muddy and dirty can be got from Mr. Conradi's tables.* In England it is usual to take the mean value of f as 30lb. Now if v be the speed of the car in feet per minute, the horse-power on axle required to overcome this frictional resistance is got from the formula,

$$33{,}000\ (\text{h.p.}) = W f v.$$

If there is an incline of 1 in n, then the additional horse-power required is got from the formula:

$$33{,}000\ (\text{h.p.}) = 2{,}240\ W \frac{v}{n}.$$

Adding these answers together, we get the total horse-power required on axle to mount the incline and overcome frictional resistance. Suppose, now, that the diameter of the wheels of the car is d inches. The number of revolutions made in a minute will be $\frac{12\,v}{\pi d}$, and knowing the speed reduction of the gearing, this will give us the number of revolutions made by the armatures of the motors. A little consideration will show that at this speed the tractive effort of the periphery of the wheels must be at least

$$W f + \frac{2{,}240\ W}{n}.$$

If we take into account the extra pull, P, required for getting up a speed of v feet in t seconds, it can be shown that

$$P = \frac{2{,}240 \,.\, W \,.\, v}{32 \,.\, 60 \,.\, t} = \frac{7\,W\,v}{6\,t}.$$

It is necessary to take this further pull into account

* See "Electric Railways and Tramways," by Philip Dawson,

when the number of stoppages are frequent, other motors specified will be too small, and so it will b sible to keep up the required speed on the line. are many curves on the line, then we shall have to the value given to f in the above formula. The value of f can be estimated from Mr. Conradi's tab there are, in general, two motors on the car, t tractive pull required is divided by 2 in specify one motor.

Suppose, then, that in a particular case we wish a tangential force of 1,600lb. on wheels 33in. in d when the car is moving at 12 miles an hour. At th the wheels are making 124 revolutions per minute the gearing reduce the speed in the ratio of 4·78 in the General Electric motors, then the armature is 593 times per minute. Now, at this speed the G motor exerts a horizontal pull on the periphery of wheel of 800lb., and hence two G.E. 800 motors w required for our car.

Tramway motors are generally tested in the w putting a belt round a car wheel connected by the re gearing to the motor, and noticing the difference tensions in the dynamometers when the car wheel at the required speed. The horizontal pull on the p of the wheels is nearly always proportional to the taken by the motor, and hence the curve of tor amperes is generally a straight line.* In the mentioned G.E. 800 motor the current taken at 5 when the speed of the armature is 593 revoluti minute was 50 amperes, hence it was taking from $\frac{50 \,.\, 500}{746}$, *i.e.*, 33·5 h.p. The power actually given car was $\frac{800 \,.\, 12 \,.\, 88}{33{,}000}$, *i.e.*, 25·6 h.p. Hence its effic this speed was 77 per cent. At higher speeds its e was less and the horse-power taken from the trolley w At lower speeds the horse-power taken from the trol would be greater and the efficiency less. I agree w Dawson in thinking that the present method of motors by horse-power is thoroughly illogical, and proper method is to state the tractive effort in po the circumference of a wheel of given diameter gearing, the speed reduction of which is stated, wh motor will exert when making a certain number of tions per minute.—J. C. R.

Answer to No. 39 *(awarded* 5*s.).*—If a pe suitably attached to a spring inserted in the draw- trailing car, and be so placed that it may trace a l paper moving below it, we can obtain from the ordinat curve so traced a mean value for the draw-bar pull to move the car along a road under conditions whic at the time of the experiment. The car may be prop animal power or mechanically, the latter giving th results. It is found, in this manner, that the pull to move a car along a well-laid level line, is about ton weight of car. The value of the draw-bar pull, nature, includes all resistances to motion up to and ing the rolling friction between the wheels and the

Now, a self-propelled vehicle has no draw-bar, another mode of expression becomes necessary. best proposed so far is the tractive force at the wh which includes all resistances to motion exactly case of the draw-bar pull. Thus, if it be requ propel a 10-ton car along such a line as is specified we should require a tractive force of some 300lb. the speed is to be 10 miles per hour, we require

$$\frac{5{,}280 \times 10 \times 300}{60 \times 33{,}000} = 8\ \text{h.p.}$$

at the wheel rims. The average efficiency of a mo single-reduction gear may be taken at 70 per cent. fore the motor required to propel the car would develop at least 11 h.p. in the armature at th corresponding to the number of revolutions of the to travel at the rate required. The size and weigh motor will vary, *cæteris paribus*, inversely as the g and directly as the size of the car wheel.

* "Electric Railways and Tramways," by P. Dawson,

this is not the only effort required of the motor. It produce an extra pull at starting in order to accelerate ass of the car. Thus, if we require to get the car to a certain value, s, in feet per second at a uniform in, say, t seconds, we require an extra pull $\frac{W \times 2{,}240}{t \times g}$lb., where W is the weight in tons, and ralue of gravity, which may be taken as 32ft. per second cond. Further, if we have to run the car up a gradient per cent. we require a force $W \times 22{\cdot}40 \times n$, there no appreciable difference in the sine and tangent of igles of slope of gradients met with in practice. We therefore, a total tractive force

$$T = W \times 2{,}240 \left\{ \frac{s}{t \times g} + \frac{f}{2{,}240} \pm \frac{n}{100} \right\} \text{lbs.,}$$

g the tractive force per ton on the level and the nt term to be taken with its proper sign.

take a case. Let it be required to start a 10-ton car rest up a gradient of 1 per cent., and to obtain the ng speed of 10 miles per hour in 30 seconds. Then ve

$$T = 10 \times 2{,}240 \left\{ \frac{14{\cdot}56}{30 \times 32} + \frac{30}{2{,}240} + \frac{1}{100} \right\}$$

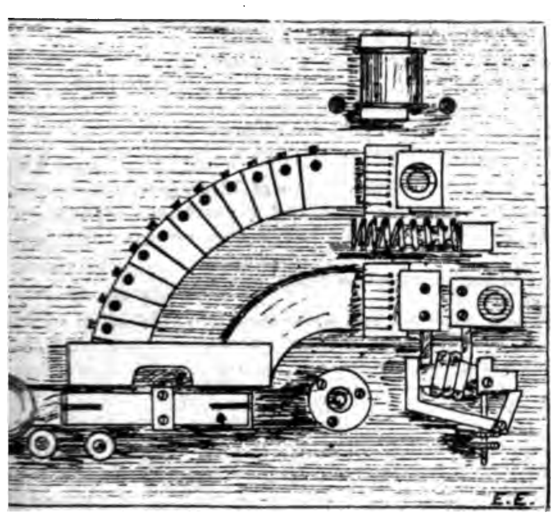
$$= 10 \times 2{,}240 \times {\cdot}039,$$

$$= 874\text{lb. nearly.}$$

motor and gear have a combined efficiency of 70 per then the motor must give a pull equivalent to b. on its spindle. Such a motor would be that con- ed by the General Electric Company, and denoted by rmula G.E. 800, which signifies a tractive force of at the wheel rims. It is usual to place two such s on a car in order to overcome the resistance on bad nd going round curves. They are controlled by a which arranges the two armatures and field coils, with hunts in various orders, with the object of reducing cessive current at starting, and admitting of various s to be utilised as may be required.—E. W. R.

n *No.* 40.—Describe with sketches a good direct-current tor-starting switch for use on a supply company's ins. What is specially required of such switches?

Answer to No. 40 (*awarded* 10*s.*).—There are many starting switches in the market at the present time,



her requirements are needed besides being able to motor without injuring it. If a motor is running t a constant load, and the supply fails, the motor If the switch is left on, the supply, when put on will find the motor with no added resistance to the rush of current. To prevent damage, some atic releasing arrangement is required. A motor- g switch with automatic release for excess currents discontinued supply is illustrated above. In the of the switch there is a coiled spring, which to keep the contact bar always in the off position. the handle is put hard on, thus cutting all the nce out, the iron keeper on the end of the handle bar comes against the poles of the upper electromagnet, and is held there. The magnet is wound with a fine-wire circuit connected in series with the shunt of the motor. Now, if the supply is discontinued, this magnet loses its attraction and the switch flies back, giving the safety referred to above. Another fault will also release the switch, for if due to some accident the shunt circuit of the motor is interrupted, the release will also be effected and the armature saved. The lower magnet is for excess current, and its armature acts by short-circuiting the upper magnet coil, if the current in the armature of the motor exceeds a certain definite limit. This limit is adjusted by altering the nuts on the screwed spindle, as shown, on which the armature of the magnet rests. The other features of the switch are the use of contact jaws for the "on" position, which give a large surface, and the throw-off spring, which helps the contact bar out of these jaws when the electromagnet releases. In the cheaper and simpler type, one electromagnet in the shunt circuit only is used.—F. BRUTON.

Answer to No. 40 (*awarded* 5*s.*).—The switch sketched below fulfils most of the conditions required of a starting switch for motors. The principle on which it works is as follows: On swivelling the switch-arm on to the first stop, the shunt winding is short-circuited by means of a non-inductive resistance. Previous to the arm leaving the first stop, it makes contact with the bottom segment, A, which puts the shunt and non-inductive resistance in parallel across the mains. Moving a little further round on to

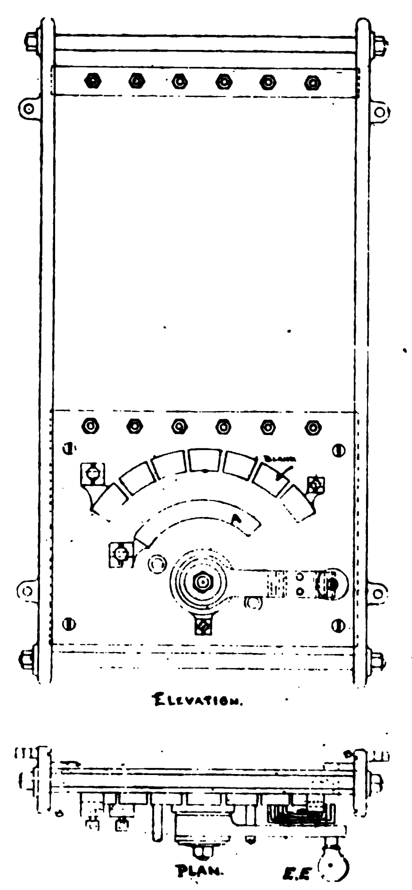


FIG. 1.

No. 2 stop, which is a blank, cuts out the non-inductive resistance; going on to No. 3 stop then completes the armature circuit and starts the motor. The starting resistance will then be cut out in five successive steps. The whole switch is mounted on a slate base; along the top of this there are a number of studs for connection to the resistances, the other ends of which are fastened to corresponding studs in a slate at the top of the frame. This frame consists of two cast-iron sides with projecting beadings to receive the above-mentioned slates, the two sides being secured together at top and bottom by means of screwed wrought-iron rods. The resistances are covered up to prevent any external damage by means of sheet-iron

covers sliding in the grooves, B B. The whole is capable of being fastened to the wall by the lugs shown. The main features that a starting switch should combine are: it should complete the shunt circuit before that of the armature, and should cut out the starting resistance in fairly small steps so as not to have any big rushes of current through the armature. In breaking the shunt there should be some means of reducing the E.M.F. in the shunt coils so as to prevent any danger of rupturing them, and also to minimise the spark at total break, and thus keep the contacts in good condition. It should be strong and capable of standing a fair amount of rough usage,

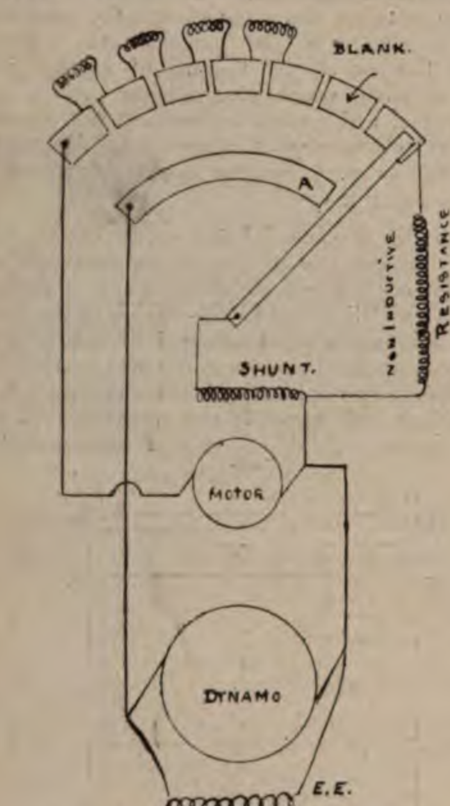


FIG 2.—Diagram of Connections.

should be free from any complications, and, finally, moderately cheap.—H. BELL.

[NOTE.—We have received several other answers to the above, amongst which one by "F. M. M." was specially worthy of notice but for the sketches, which were very roughly drawn. No one has, however, taken up the question of slowly switching out the resistance, which is insisted on by some supply companies.—ED. *E. E.*]

KINGSTON-UPON-HULL.

The following is the fourth annual report of the borough electrical engineer (Mr. J. E. Edgcome, A.M.I.M.E., etc.) to the Lighting Committee:

I beg to present herewith my report for the year ending Dec. 31, 1897, being the fourth annual report on the working of the electricity undertaking of the borough, and I wish to take this opportunity of thanking the members of this committee and the Council generally for appointing me consulting electrical engineer to the Corporation.

Progress.—I would call your attention to the very satisfactory progress which has been made during the last 12 months. A reference to the revenue table will show that after the payment of all the works costs for generation of electricity, maintenance and repair of machinery and mains, taxes, insurance, and all management expenses, there remains a balance of £867. 19s. 9d., as compared to £301. 3s. 1d. for 1896. This sum is sufficient to pay the interest for the year on the capital expended on the undertaking, leaving a balance of £43. 12s. 1d. towards the repayment of principal. In other words, if the undertaking were the property of a company, sufficient profit on the works has been made during 1897 to pay interest at the rate of 3¼ per cent., and to leave a sum of £43. 12s. 1d. in hand to be carried to the reserve fund. As, however, the Corporation are obliged to repay the capital borrowed within 25 years, any surplus after payment of interest is used for paying off a portion of this capital annually, the balance being drawn from the rates until such time as the profit shall b cient to pay off each year both the interest and the instal principal due annually. Any further increase of the profit these payments will be employed in reducing the rates borough generally, but the fact must not be lost sight of the end of the period for which each loan is borrowed th payers will be in possession of a property to the value loans, which will have been entirely acquired by them, and will be in a high state of efficiency, as all expenditure for necessary to keep the machinery in that state of efficien have been met year by year out of the revenue.

Public Street-Lighting.—Three further experimental incand electric lamps have been fixed in St. James's-road.

Extension of Buildings.—The work of extending the engine and boiler houses is being carried out, and the found have been put down for the new steam alternator, and for t new large boilers and the small loco. boiler.

Extension of Machinery.—The work of putting in the new is proceeding rapidly, and I anticipate that this machinery in working order in a few months' time. In the boiler-ho additions to plant comprise: two water-tube boilers, each 2,437 square feet heating surface, arranged in one batter fitted with superheaters and mechanical stokers; an extr pump capable of pumping 4,000 gallons per hour; and co extensions to the steam, exhaust, feed, and blow-off pipes. engine-house the additions to plant consist of one 300-b.h.p speed three-crank engine coupled to a 200-kw. alternator, of supplying current to 6,000 lamps, there being sufficien in the new portion of the engine-house for installing two sets for future work. The new high-tension switchboard ha designed to carry panels sufficient for seven alternating-c machines, distributing panels for the exciter fields, main am voltmeters, and wattmeter, and seven high-tension feeders switchboard platform will be carried upon a glazed brick f tion raised 5ft. from the ground, a covered way being built back of the brickwork to allow of the inspection of the cable the main platform being extended behind the switchbo enable all cable connections to be safely examined and hand

Mains.—High and low tension mains have been laid throu Richmond-road and Albany-park, and are supplying curr 13 new consumers. A high-tension main has been laid Church-street to the Royal County Theatre in Fife-road, to a supply of current has been given since October last. Th tension mains have been extended in Portsmouth-road Anglesea-road to Uxbridge-road, in St. James's-road from street towards Kingston Hall-road, in London-road Cambridge-road towards Queen Elizabeth-road, on Kingst from Park-road to Queen's-road. Mains have also been ex in Lingfield-avenue and Geneva-road as fresh houses hav built, and a further supply of current applied for on this An extension of low-tension mains will shortly be laid in Glou road to supply consumers near Coombe-lane. Five transf with high and low tension switch and fuse gear have been in at various points on the circuit, supplying current from the tension feeders to the low-tension distributors.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1897.

Dr. Generation of Electricity.		£
Coal and other fuel, including carting	£1,313 13 4	
Oil, waste, water, disincrustant, packing, gauge glasses, sweep, and petty stores	155 1 9	
Wages for generation of current	625 4 3	
Maintenance of plant, including wages, small repairs, incandescent lamps, etc.	110 16 8	
		2,29
Distribution of Electricity.		
Maintenance of mains, including wages of arc lamp trimmer, carbons, small repairs, etc.		253
Management.		
Salary of engineer and assistant, salary of clerk	377 19 6	
Stationery, printing, and advertising	36 12 11	
General establishment charges—petty cash, office fuel, stamps, etc.	39 4 9	
		45
Rent, rates, taxes, and insurance		99
Special Charges.		
Interest on loans	824 7 8	
Repayment of principal	835 10 11	
		1,65
Lamps, stores, etc.		4
		£4,72
Cr.		£
Sale of current, per meter, including launch charging, less discounts and after providing for bad debts		2,04
Rental of meters and apparatus		10
Amount for lighting 36 public arc lamps at £20 per annum, from Jan 1, 1897, to Dec. 31, 1897 (inclusive)		72
Sundry sales		6
Deficit balance		
		£4,72

HANLEY ELECTRICITY WORKS.

following is the report of Mr. Joseph Lobley, ı engineer, and Messrs. C. A. Cowell and C. J. and, electrical engineers and joint managers, upon king of the above station for the past year. The account and balance-sheet is also given :

mitting to you the accounts of the electric lighting under- r the year ended Dec. 31, 1897, made out in accordance requirements of the Board of Trade, a few words in ion of the different items will, no doubt, be desirable. ous loans sanctioned amount to £60,990 ; and the present of the sinking fund is £2,585. 18s. 7d., or including on investments, £2,642. 4s. 1d. During the past year nditure has been £7,491. 5s. 8d., principally for mains, ers, and meters, and the new set of 34 arc lamps and inging the total capital expenditure to £51,634. 8s. 2d. ysis of the revenue account brings out the following omparing with the previous year: coal, ·68d. per unit ainst ·73d. in 1896 ; oil, water, etc., ·15d. against ·19d. ; 8d. against ·55d. ; maintenance of buildings and plant, inst ·43d —total for works costs, 1·86d. against 1·90d. It will be noticed that every item is less than the year excepting the maintenance account. There have y charges on this account paid for out of revenue, and d be particularly noticed when considering the question iation of plant. By keeping the plant up to a high fficiency it is claimed that it is unnecessary to provide er reserve for depreciation than is required by the annual ts on capital account. The management charges are unit, which is the same amount as in 1896, but the item and taxes has advanced from ·15d. to ·24d., which alone accounts for the increase in total costs from 2·42d. to he total expenditure was £4,000. 7s. 8d., and the total vere £6,520. 1s. 7d., according to the Board of Trade eaving £2,519. 13s. 11d. as the gross profits of the ng to be carried to the net revenue account. This epresents a profit of 4·88 per cent. on the capital

The receipts do not show such an increased con- as was hoped for by the reduction in price from 6d. to act, the customers who formerly paid 6d., taken y, and of course including Corporation buildings, sumed less current in 1897 than in 1896. This clusively to point out that a much greater inducement ary to bring in long-hour consumers, and this has now ı; but owing to hesitation on the part of intending , the good results may not come immediately. The f the price, particularly to private houses and to shops g hours, should, however, during the ensuing few years e a wise and a sound course, unless Hanley is to be om all other places. In comparing the foregoing totals alysis it should be noted that to arrive at the revenue ricity, the cost of carbons and attendance on public l of lamps, etc., subsequently sold, is deducted from of the account. This is in order to make fair com- h other towns who may not have public arc lighting or ıps. The net revenue account shows the item of £2,519. ceived from the revenue account, out of which £1,392. e been paid in interest (less credits), and £1,315. 11s. 8d. ansferred to the sinking fund account, leaving the item . 1d. as a temporary charge on the district rate account. oted that, notwithstanding the reduction in price, the addition to the sum required to be paid to the sinking the large sums expended in maintenance, rates, and the deficiency is so small an amount as £188. 11s. 1d. income of £6,520. A very few additional customers e converted that amount into a net profit ; in fact, the ctions made already more than warrant the belief that ı will be cleared off in the first half-year. The effect of tional charges is, of course, a distinct matter. If the emained at 6d., and the same quantity sold, the income e been £1,000 more. On the other hand, the lowering of as undoubtedly brought new customers in, and it is only to estimate that the loss caused by the new charges first half of this year will be balanced by the gain in l half. The sinking fund, now amounting to £2,642. presents the value of the works (free from all liabilities) d by the ratepayers, and which has been provided at no m since the commencement of supply. In connection inking fund it has further to be noticed that the periods the loans have been sanctioned are very short compared pstead, Islington, Shoreditch, etc., under the London uncil, and also compared with many of the towns in y. This makes the annual amount required to be repaid our loans are only authorised for 10, 25, and 17 years. s of companies no such short period has to be calculated indeed regarding the terms on which they have been at Liverpool, Sheffield, and other places by the cor- it is a question whether any need for redemption exists ase. The Corporation of Sheffield has just agreed to the company's works (plant almost identical with terms being £220 Corporation 2½ per cent. stock £100 expended by the company, and other pro- ry favourable for the company. In January, 1897, cil sanctioned application being made to the Local nt Board for sanction to a further loan of £15,000 tion to plant and mains, but it was not until the end of July that the approval to a loan of £14,880 for 17 years was received. This, combined with the recent difficulties in the engineering trade, has prevented the supply of the new Ferranti steam alternator. There is reason now to hope that it will be ready to supply the next autumn and winter load, and thus remove the anxiety your engineers have felt during the present season. In September last the Council adopted the principle of charging—at the option of the consumer—for electricity by a sliding scale, known as the maximum demand rebate system. This came into operation on Jan. 1 last, and enables all who desire it to pay 5d. per unit for an average of two hours per day in the winter half-year, or one hour per day in the summer half-year, and 2½d. per unit afterwards; these charges being net, and payable within 21 days. In other words, after he has consumed the amount indicated, or in summer half that amount, he pays 2½d. per unit for the remainder of the quarter.

REVENUE ACCOUNT, YEAR ENDED DEC. 31, 1897.

Dr.				£	s.	d.
Generation of Electricity.						
Coal, including carriage, etc.	£1,002	18	3			
Oil, waste, water, and stores	225	12	9			
Wages	697	16	3			
Repairs and maintenance, as follows: (a) buildings, £79. 0s. 9d.; (b) engines, boilers, £460. 8s. 9d.; (c) dynamos, transformers, etc., £40. 5s. 6d.; (d) other machinery, instruments, and tools, £27. 9s.	607	4	0			
				2,533	11	3
Distribution of Electricity.						
Wages to linesmen, etc.	41	10	4			
Maintenance of mains	4	8	6			
Maintenance and renewals of meters, switches, fuses, and other apparatus on consumers' premises	200	7	4			
Maintenance of apparatus at distributing stations	30	6	5			
				276	12	7
Public Lamps.						
Attending and repairs	295	10	11			
Renewals of lamps	1	16	6			
				297	7	5
Rents, rates, and taxes				357	5	2
Management Expenses.						
Salaries—engineers' department	452	5	0			
Stationery and printing	12	16	8			
General establishment charges	41	19	2			
				507	0	10
Special charges—insurances, etc.				28	10	5
Total expenditure				4,000	7	8
Amount carried to net revenue account				2,519	13	11
				£6,520	1	7

Cr.	£	s.	d.
Sale of current per meter	5,117	8	6
Public lighting	1,175	0	0
Rental of meters and other apparatus on consumers' premises	149	16	9
Sale and repairs of lamps	53	3	6
Sale and repairs of other apparatus	24	12	10
	£6,520	1	7

GENERAL BALANCE-SHEET.

Liabilities.	£	s.	d.
Capital account—amount received	46,110	0	0
Overdraft on account of loans sanctioned	5,524	8	2
Sundry creditors	251	9	8
Net revenue account—balance due to general district rate account	188	11	1
Balance	2,090	4	4
	£54,164	13	3

Assets.	£	s.	d.
Capital account—amount expended for works	51,634	8	2
Stores on hand at Dec. 31, 1897: coal, £39; oil, waste, etc., £32. 16s. 11d.; general, £167. 19s. 4d.	239	16	3
Sundry debtors for current supplied to Dec. 31, 1897	2,216	6	7
Other debtors	74	2	3
	£54,164	13	3

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			400,590
Quantity sold	Public lamps	96,379	351,762
	Private consumers by meter	255,383	
Quantity used on works			5,032
Total quantity accounted for			356.794
Quantity not accounted for			43,796
Number of public lamps			87
Total maximum supply demanded (kilowatts)			376

Melbourne (Victoria).—The Telegraph Department of the Victorian Government Railways are inviting tenders for the supply of alternating-current transformers and one main switchboard. Tenders to the Telegraph Superintendent's Office, Spencer-street, Melbourne, by March 21.

COMPANIES' MEETINGS AND REPORTS.

BRITISH INSULATED WIRE COMPANY, LIMITED.

The report of the directors of the British Insulated Wire Company, Limited, for the eight months ended Dec. 31 last, to be submitted to the first general meeting to be held at Liverpool on Wednesday next, states that the result of the working for the period shows a profit of £33,281, and the directors regard this result as very satisfactory, especially as there has been considerable interference with the manufacturing business, owing to the construction of the new buildings. No benefit accrued to the Company last year from the new buildings and machinery, as they were not ready for use. They are now approaching completion, portions being already in use, but, owing to the extensive character of the new works and rearrangements, it will be some time yet before the whole is available. It is satisfactory to find that the rate of profits actually realised has been in excess of the estimate inserted in the Company's prospectus. After deducting administration expenses, interest on debentures, the dividend on the preference shares, and writing off depreciation and a portion of the preliminary and reconstruction expenses, there remains a balance of £17,754, from which the directors recommend a dividend at the rate of 15 per cent. per annum on the ordinary shares for the eight months, leaving £1,629, of which the directors have decided to transfer to patents and goodwill account £1,500, carrying forward the balance of £129. The volume of business in the hands of the Company continues to be exceedingly satisfactory.

LONDON ELECTRIC OMNIBUS COMPANY, LIMITED.

An extraordinary general meeting of this Company was held at Winchester House, London, on the 4th inst., to receive the report of a committee of shareholders appointed on Dec. 30 last to consult with the directors on the position and requirements of the Company. Major S. Flood Page presided.

The committee's report, which was read by **Lieutenant-Colonel Turnbull**, after going into the causes of the present state of the Company, stated that with an increased working capital of not less than £15,000, and under economical and careful management, the committee were satisfied the Company has a splendid future before it, with a large earning capacity. The committee also found in existence a contract with the Electric Street Car Manufacturing Syndicate, of Wolverhampton, its main object being the building of suitable omnibuses in an expeditious manner for this Company. Provided these were secured on advantageous terms, this contract should prove to be to the interests of the Company.

Mr. J. Elliott Condict seconded the adoption of the report, and added that the tests of the Sola accumulator were highly satisfactory; it weighed only one-half of any of the other accumulators that had been tested. The late test of the omnibus was a most satisfactory one, because they were able to find the exact amount of voltage and the number of amperes used. The steering gear also worked admirably. Having this data before them, and knowing that they could purchase the current from electrical companies at the rate of 2d. per unit, they were able to verify all the statements that had been made in the prospectus. The committee were thoroughly satisfied that the Company would be a complete success if the necessary capital could be raised.

On the motion being put, it was carried unanimously.

On the motion of **Mr. Brook** a sum of £100 was voted to the committee, to be paid so soon as the Company was in possession of funds.

A vote of thanks to the committee and the chairman terminated the proceedings.

HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY LIMITED.

Directors: Henry Ramié Beeton, chairman; William Page, managing director; William Reginald Davies; Robert Arthur Germaine; William Francis Leese. Manager: Henry W. Bowden. Secretary: Thos. J. Owens.

Abstract of the report of the directors and statement of accounts for the year ended Dec. 31, 1897:

The revenue account shows a credit balance of £12,033. 4s. 11d., which, with the balance of £43. 12s. 6d. brought forward, and £177. 6s. 8d. dividends and balance of interest received, makes a total of £12,254. 4s. 1d. After deducting £2,250 for interest on debenture stock paid and accrued, and £1,403. 19s. 2d. for interim dividend paid on the 7 per cent. cumulative preference shares, the directors recommend that the sum remaining—viz., £8,600. 4s. 11d.—be dealt with as follows: to credit of depreciation account, £3,000; to payment of the remainder of dividend to Dec. 31, 1897, on the 7 per cent. cumulative preference shares, £1,750; in reduction of preliminary expenses account, £1,391. 4s. 8d.; to payment of a dividend on the ordinary shares for the year at 4 per cent., £2,232. 14s. 5d.; and that the balance of £226. 5s. 10d. be carried forward to the next account—total, £8,600. 4s. 11d. The sums of £11,926 received as premiums on the last issue of shares and of £1,097. 6s., profit on sale of 300 Yorkshire House-to-House shares, have been applied in extinction of the balance of preliminary expenses account and construction business development account. The increase in the number of lights connected during 1897 was equivalent to 11,099 8-c.p. (35-watt) lamps. The revenue from electricity has increased by £3,200. 12s. 6d., while the expenses have increased £366. 16s. 10d. Additions and alterations to the plant and mains have been made at a cost of £24,326. 16s., and the expenditure for 1898 is estimated at £28,000. This outla[y] be provided by the proceeds of the ordinary and prefe[rence] shares issued under the agreement with the holders of fou[nders'] shares. The Leeds and London Electrical Engineering Com[pany] Limited, having resolved upon voluntary liquidation, notice to determine the agreement with this Company. directors have decided, in view of the consequent unsatisfa[ctory] position of this asset, to write off the whole. The rel[ations] between the two companies are receiving the careful [con]sideration of the Board. A portion of the capital expendit[ure] recent years having been incurred in superseding earlier an[d] efficient plant, it will be necessary to make proportionately l[arger] annual contributions to depreciation account than hither[to] order to preserve the capital intact at the expiry of the conce[ssion]. On the other hand, the revenue account will in future be re[lieved] by the extinction of preliminary expenses now effected. agreement with the holders of the founders' shares whic[h] passed by the shareholders having received the approval [of the] High Court, has now been carried out. During the year a f[urther] 1,661 ordinary and 3,322 7 per cent. preference shares hav[e been] issued. Mr. H. R. Beeton and Mr. R. A. Germaine retir[e from] the Board by rotation, and, being eligible, offer themselv[es for] re-election. Messrs. Miall, Wilkins, Randall, and Co., the a[uditors] of the Company, offer themselves for re-election.

General Balance Sheet, Dec. 31, 1897.

Dr.	£	s.	d.	£
Capital—11,661 ordinary shares of £5 each				58,305
10,000 preference shares of £5 each				50,000
100 founders' shares of £5 each				500
				108,805
4½ per cent. debenture stock				50,000
Sundry creditors on open accounts and for debenture interest accrued				5,344
Doubtful debts reserve account				166
Depreciation account—provision against depreciation of leasehold buildings and other expenditure, included in capital account				10,000
Net revenue account, balance at credit thereof				4,209
				£178,524
Cr.				£
Capital account—amount expended for works				158,114
Stores on hand at Dec. 31, 1897: coal, £157. 15s. 11d.; oil, waste, etc., £326. 12s. 11d.; general, £30				514
Sundry debtors for electricity supplied to Dec. 31, 1897				8,550
Other debtors and prepaid charges				1,922
Cash at bankers: Parr's Bank, Limited				2,358
Cash at office				64
Preliminary, debenture, and preference share issue expenses and foundation of business account as per last balance sheet	£2,142	11	5	
Expenditure during the year	38	2	3	
	2,180	13	8	
Less written off, and proportion of profits on sale of Yorkshire House-to-House shares	2,180	13	8	
Construction business development account, as per last balance-sheet	13,500	0	0	
Less amount realised	1,266	3	0	
	12,233	17	0	
Less premiums and balance of profits on sale of Yorkshire House-to-House shares	12,233	17	0	
Loans against securities				7,000
				£178,524

Revenue Account, Year ended Dec. 31, 1897.

Dr. Generation of Electricity.	£	s.	d.	£
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£2,399	4	6	
Oil, waste, water, and engine-room stores	283	7	11	
Proportion of salaries of manager and superintendents	846	8	10	
Wages and gratuities at generating station	1,218	3	5	
Repairs and maintenance as follows: (1) buildings, £50. 3s. 6d.; (2) engines and boilers, £143. 4s. 11d.; (3) dynamos, exciters, motors, etc., £5. 18s. 9d.; (4) other machinery, instruments, and tools, £66. 12s. 4d.	265	19	6	
Cartage of ashes	84	3	6	
				5,09[illegible]
Rents, Rates, and Taxes.				
Rents payable	333	2	0	
Rates and taxes	800	11	10	
				1,13[illegible]

Distribution of Electricity.

…n of salaries of manager …gineers	75	0	0			
…	100	16	4			
…and maintenance of mains …lasses	45	19	4			
…maintenance, and renewals …sformers, meters, and other …tus on consumers' premises	63	9	0			
				285	4	8

Management Expenses.

…' remuneration, £1,500; less …waived, £700	800	0	0			
…g directors' special remune- …	200	0	0			
…f secretary and clerks	504	0	0			
…'s salary	126	7	6			
…y and printing	98	10	9			
…stablishment charges	248	13	8			
… of Company	42	0	0			
… of the Board of Trade	37	0	0			
				2,056	11	11
…ges				3	1	8
…s				149	12	5
…ation to trustees of debenture stock …s and sundry other charges				51	13	0
				8,777	5	2
…carried to net revenue account				12,033	4	11
				£20,810	10	1

	£	s.	d.
…lectricity per meter (less discounts)	19,426	17	1
…f meters and other apparatus on con-…' premises	1,296	15	8
…fees, £55. 15s.; and students' instruction, …. 4d.	86	17	4
	£20,810	10	1

…GS AND ST. LEONARDS-ON-SEA ELECTRIC LIGHT COMPANY, LIMITED

…: of the directors (with abstract of accounts) to be …d at the ordinary general meeting to be held at the …Hotel, Hastings, on March 15, 1898, at 4 p.m.:

…rectors have again to congratulate the shareholders upon …asing business of the Company, and they point with much …on to the fact that the increased income has been obtained … small increase of cost. The receipts for the past year …eded those of 1896 by £1,633, whilst the expenditure or …t has only increased £157. This result has been obtained …nt watchfulness of the staff, in the expenditure of fuel, and …vements made in the machinery, whereby greater economy … possible. Since the last ordinary general meeting the …ion has taken and paid for the mains, lamp-posts, and …nt relating exclusively to the public lighting, and conse-…he repairs to and renewals of such plant now fall on the …on, although the Company is still supplying the current, …probably continue to do so for some time longer. Your …have also (with the sanction of the shareholders) entered …visional contract with the Corporation for the sale of the …ing, and the Corporation are applying to the Board of … a provisional order to enable them to carry the contract …t, but in the meantime the directors are carrying on the …for the benefit of the shareholders as if no such contract … The result of the past year's trading is exceedingly …ry, and shows a net profit of £1,990. 18s. 4d., out of …e directors recommend a dividend at the rate of 6 per …hich will exhaust £1,633. 4s.) to be paid; £300 to be …reserve, and the balance of £57. 14s. 4d. to be carried … Messrs. Geo. Roddis and A. L. Ward retire by rotation …directorate, but they are eligible and offer themselves for …n. Consequent on the death of Mr. Tibbetts, of the firm …Tibbetts, and Co., who have long acted as auditors to the …, the directors recommend the appointment of Mr. Edward …the same firm, in their place.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1897.

Generation of Electricity.

				£	s.	d.
…other fuel, including dues, …ge, unloading, storing, and …ses of placing the same on …rks	£2,212	15	4			
…te, water, and engine-room …	201	4	10			
…on of salaries of engineers, …ntendents, and officers, as …d by the managing director, …an, or engineer	80	16	8			
…nd gratuities at generating …s	710	9	8			
…and maintenance, as follows: …gs, £58. 13s. 2d.; engines, …, £508. 1s. 11d.; dynamos, …, transformers, motors, etc., … 1s. 5d.; other machinery, …ents, and tools, £93. 9s. 5d.	702	15	11			
				3,908	2	5

Distribution of Electricity.

Proportion of salaries of superintendents and officers, as certified by managing director, chairman, or engineer	35	6	8			
Wages and gratuities to linesmen, fitters, and labourers	54	2	5			
Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same	50	15	11			
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises	81	12	4			
Repairs, maintenance, and renewals of apparatus at distributing stations	6	13	1			
				228	10	5

Public and Private Arc Lamps.

Attending and repairs	345	19	5			
Renewals of lamps	3	1	10			
				349	1	3

Rents, Rates, and Taxes.

Rents payable	100	11	3			
Rates and taxes	194	15	4			
				295	6	7

Management Expenses.

Directors' remuneration	200	0	0			
Salaries of managing engineers, secretary, accountants, clerks, messengers, as certified by managing director, chairman, or engineer	256	5	0			
Stationery and printing	39	8	1			
General establishment charges	47	0	1			
Auditors of Company	15	15	0			
Auditor appointed under the provisions of the order	22	1	0			
				580	9	2
Law and parliamentary charges				3	3	0

Special Charges.

Insurances, superannuation, etc.	75	3	0			
Bad debts	15	5	7			
				90	8	7
Total expenditure				5,455	1	5
Balance carried to net revenue				3,425	17	0
				£8,880	18	5

Cr.	£	s.	d.
Sale of current per meter, sale under contracts, public lighting, rental of meters and other apparatus on consumers' premises, sale and repair of lamps (arc or incandescent), sale and repair of other apparatus	8,734	18	5
Rents receivable	146	0	0
	£8,880	18	5

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	50,470	0	0
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc., to Dec. 31, 1897	1,992	0	9
Reserve fund account	75	11	10
Depreciation fund account	502	17	0
Bankers' loan account	2,033	12	1
Ditto, new share account	80	5	8
Net revenue account, balance to credit	1,990	18	4
	£57,145	5	8

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	51,534	12	8
Stores on hand at Dec. 31, 1897: coal, £118. 7s 3d.; oils, waste, etc., £13. 16s.; general stock, £631. 2s. 11d.	763	6	2
Expenses incurred in issue of new capital	163	5	10
Telephone rent unexpired, £8. 15s.; poor rate in advance, £13; Queen's taxes, £13. 17s.; insurance unexpired, £55. 17s. 9d.	91	9	9
Sundry debtors for current supplied to Dec. 31, 1897	3,297	4	0
Other debtors	111	0	8
Cash at bankers, £1,183. 13s. 3d.; in hand, 13s. 4d.	1,184	6	7
	£57,145	5	8

CHELSEA ELECTRICITY SUPPLY COMPANY, LIMITED.

Directors: J. Irving Courtenay, chairman; Nugent Daniell; Major-General Webber, C.B. (retired, R.E.); Emile Garcke; G. N. Marten. Managing engineer: Frank King. Secretary: S. J. Cluer.

Report of the directors (with abstract of accounts) to be presented to the shareholders at the annual ordinary meeting of the Company to be held at their head office, 19, Cadogan-gardens, S.W., on Thursday, March 17, at 2.30 p.m.

In October, 1897, an issue of 8,000 ordinary shares of £5 each was made and was fully subscribed. The final instalment on these shares, due on Jan. 1, 1898, has now been paid, and a Stock Exchange quotation for the new issue has been applied for. The balance of premium received in 1897 in respect of this issue, after deducting the expenses of issue, amounts to £21,983. 5s. 6d., and following the course adopted in the accounts of previous years, a portion of this has been applied to the extinction of the legal and other extraordinary expenses incurred during the year. The balance remaining—£20,851. 15s. 5d.—has been placed to the reserve fund, making the total of that fund £36,717. 9s 5d. The sum of £2,000 has been added to the renewals and depreciation fund out of the net revenue. After deducting this amount, and after payment of interest on debenture stock (£2 700), there remains a balance available for distribution of £11,344. 5s. 2d., including £1,526. 17s. 4d. brought forward from last year. The directors recommend that this balance shall be applied as under: interim dividend of 6 per cent. per annum on the preference shares for the half-year to June 30, 1897 (paid July 1, 1897), £900; interim dividend on 26,000 ordinary shares for the half-year to June 30, 1897, at the rate of 5 per cent. per annum (paid July 1, 1897), £3,250; dividend of 6 per cent. per annum on the preference shares for the half-year to Dec. 31, 1897, £900; dividend on 26,000 ordinary shares for the half-year to Dec. 31, 1897, at the rate of 7 per cent. per annum, making a total dividend of 6 per cent. for the year, £4,550; dividend at the rate of 6 per cent. per annum on the instalments of £1 per share from the due date of the instalment to Dec. 31, 1897, on the new issue of 8,000 shares, £92. 1s. 1d.; balance to be carried to next account, £1,652. 4s. 1d. The number of lamps connected on Dec. 31, 1897, was 96,638, an addition of 16,178 during the year. A large part of the capital expenditure has been incurred in the purchase of freehold land in Pavilion-road, and building thereon a substantial sub-station, in the extension of the new generating station at Alpha-place, and also in the purchase of some leasehold property. Considerable amounts have also been spent on generating machinery and on mains to supply the increase in demand. At an extraordinary general meeting, held on Feb. 2 last, the shareholders confirmed their approval of a Bill for the compulsory purchase of certain properties required for the development of the business. The retiring director, Mr. G. N. Marten, being eligible, offers himself for re-election. The auditors, Messrs. Cooper Bros. and Co., also offer themselves for re-election.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1897.

Dr.		£ s. d.
Generation of Electricity.		
Coal or other fuel, including expenses on the same	£3,869 14 6	
Oil, water, cotton waste, and engine-room stores	632 13 11	
Wages of men and proportion of engineers' salaries	1,317 14 7	
Repairs, maintenance, and renewals as under: buildings, £161. 13s. 2d.; engines and boilers, £557. 2s. 11d.; dynamos, £13. 4s. 9d.; instruments, tools, and sundries, £72. 18s. 10d.	804 19 8	
		6,625 2 8
Distribution of Electricity.		
Wages at out-stations, meter winding and reading	786 0 5	
Stores used at out-stations	122 0 3	
Repairs, maintenance, and renewals as under: mains, £101s. 8s. 8d.; accumulators and apparatus at distributing station, and motor transformers, £447. 12s. 5d.; meters on consumers' premises, £37. 16s. 3d.	586 17 4	
		1,494 18 0
Rents, Rates, and Taxes.		
Rents payable	623 7 0	
Rates and taxes	1,216 19 4	
		1,840 6 4
Management Expenses.		
Directors' remuneration	1,000 0 9	
Salaries of staff	1,081 0 4	
Salary or commission of collector	120 0 0	
Stationery and printing	109 15 6	
General establishment charges	242 2 1	
Auditors of Company	52 10 0	
		2,605 7 11
Law and parliamentary expenses		30 13 1
Special Charges.		
Insurance	224 7 7	
Wayleaves	7 0 0	
		231 7 7
Balance carried to net revenue account		14,554 11 7
		£27,382 7 2

Cr.	£ s. d.
Sale of current (less allowances made)	25,564 9 8
Rental of meters	1,047 1 4
Transfer fees	44 10 0
Rents receivable, discounts, and sundry small accounts	726 6 2
	£27,382 7 2

Dr. GENERAL BALANCE-SHEET, DEC. 31, 1897.	£
Capital account—amount received	241,740
Sundry creditors for plant and buildings	3,729
Sundry creditors on open account	2,939
Debenture stockholders for interest accrued	1,305
Reserve fund, being balance of premium	36,717
Net revenue account—balance at credit thereof, £11,344. 5s. 2d.; less interim dividend paid, £4,150	7,194
	£293,625

Cr.	£
Capital account—amount expended, £273,809. 17s. 3d.; less renewals and depreciation fund account, £6,840	266,969
Stores on hand: coal, £262. 11s. 6d.; general stores, £3,273. 11s 6d.	3,536
Sundry debtors for current supplied, etc., less bad debts deducted	12,261
Sundry expenses (the subject of litigation)	1,101
Cash at bankers, £9,728. 3s. 7d.; cash in hand, £29. 1s. 9d.	9,757
	£293,62

RICHMOND (SURREY) ELECTRIC LIGHT AND P COMPANY, LIMITED.

The fourth ordinary general meeting was held on the 3
at the offices, Moorgate-court.
The **Chairman** (Mr. Frederick W. Reynolds), referring
proposed payment of a dividend on the ordinary shares
rate of 3 per cent. per annum, said that the receipts from
of current showed an increase of £1,116 for the year, wh
net profit, after payment of interest and allowing for depre
and all charges, amounted to £1,072, as compared with
odd for 1896. The capital expended during the past y
£3,828, bringing up the total capital expenditure to £44,7
Dec. 31 last, the total number of lamps connected was equ
to 9,512 8-c.p., being an increase of 2,387; and since then
tions had been received for 425 more lamps. The un
amounted to 138,916. It was the intention of the Board
down additional plant in time for next winter's lighting, a
to extend their mains in Richmond. He concluded by mov
adoption of the report (published in our last issue), whi
seconded by the **Chevalier Soares**, and carried unanimous

BIRMINGHAM ELECTRIC SUPPLY COMPANY, LIM

Directors: Henry Buckley, chairman; Geo. S. Albright
Albright; A. B. Holmes; G. H. Johnstone; Francis
Mitchell; J. C. Vaudrey, managing director.
Eighth annual report of the directors (with abstract of ac
submitted to the shareholders at the ordinary general me
the Company held at the offices of the Company, Birming
the 10th inst.:
The amount of net profit, including the balance of
15s. 6d. brought forward from last year, is £13,656. 1s. 7
of this sum, after placing £4,460. 8s. 6d. to the credi
depreciation reserve fund, the directors recommend the
of a dividend of 5 per cent., absorbing £8,206. 9s.
carrying forward a balance of £989. 3s. 9d. The pr
obtained on the issue of the remaining portion of the Co
capital amounted to £5,475 8s. 1d. Out of this the direct
added the sum of £3,366. 17s. to the special reserve agai
visional orders; with this addition the cost of the pr
orders, amounting to £4,027. 4s. 8d., is now fully prov
The balance of the above premium, amounting to £2,108.
has been carried to the general reserve fund. On mak
above appropriations, the total reserves and undivided pr
amount to £22,536. 16s. 6d. There has been a steady inc
the Company's business during the past year, the total nu
16-c.p. lamps, or their equivalent on order, Dec. 31, 1
25,876, and on the same date in 1897 the number was
The additions since the close of the financial year have
the number up to 40,707. The expenditure on capital
during the past year has been £35,250. 9s. 4d.
in the capital expenditure during the past year are t
pletion of the works in connection with the new boiler
Dale End station. The extension at the Company's Wat
depôt in equipment of steam plant was completed in tim
winter's supply. Extensions have been made in the und
main system in various parts of the Company's parliament
The reductions in the Company's charges for current, in
in the early part of the year, although slightly decrea
revenue per unit, have been amply justified by the
increased demand for current. The Company during
have carried out through the wiring department a con
number of installations for consumers from the Company
system. Included in this work has been the entire instal
the general hospital. Hitherto the working of the de
has resulted in a surplus to the Company's funds. Th
however, of last year's work has been a loss amounting
2s. 3d., which has been written off the profits for the ye
directors have always looked upon this portion of the bu
a necessary feeder to the Company's system, and as th
question has been entirely due to the tedious and
nature of the work carried out at the general hospital

likely to recur. A large number of motors have been :he system during the year, and the economy and con- of electricity as a source of power are now generally !. In view of the continued increased output, orders placed for further engines and boilers for the Water- oöt for completion by the end of the summer. The the Company is now subscribed, paid up, and expended. capital outlay is necessary during the year, a resolution omitted to the meeting to authorise the increase of the the creation of 20,000 additional shares of £5 each to at the discretion of the Board when necessary. In e with the articles of association, two directors, Mr. Albright and Mr. Francis W. V. Mitchell, retire by and are eligible for re-election. The auditors, Messrs. rsons, and Co., also retire, and are eligible for re-election.

BALANCE-SHEET, DEC. 31, 1897.

Capital and Liabilities.		£	s.	d.
lled up		200,000	0	0
'alls in arrear		73	10	0
		199,926	10	0
editors		13,834	11	0
ion reserve fund, as at Dec. 31, 1896, 8s. 6d. ; additions to date, £4,460. 8s. 6d.		14,411	17	0
serve fund, £3,108. 11s. 1d., and special against provisional orders, £4,027. 4s. 8d.		7,135	15	9
l loss account—Balance from Dec. 31.	£1,042 15 6			
year to date	12,613 6 1			
	13,656 1 7			
ct amount applied to depreciation reserve	4,460 8 6			
		9,195	13	1
		£244,504	6	10

Property and Assets.	£	s.	d.
l buildings as at Dec. 31, 1896, £38,193. ; balance of further outlay to date, 11s. 10d.	41,525	12	0
nachinery and plant, furniture and , meters and electrical instruments as . 31, 1896, £141,606. 10s. 2d. ; further to date, £31,917. 17s. 6d.	173,524	7	8
	215,049	19	8
rovisional orders to Dec. 31, 1896	4,027	4	8
and, £15 ; at bankers, £12,017. 5s. 3d.	12,032	5	3
lebtors (less reserve)	11,752	0	1
stores and work in progress as per signed ook	1,642	17	2
	£244,504	6	10

'E ELECTRIC LIGHTING COMPANY, LIMITED.

ors: Colonel A. J. Filgate, R.E., chairman; Colonel H. .B., vice-chairman; Harold A. Hoare, Esq.; Carleton F. Esq. Engineers: Messrs. Crompton and Co., Limited, and Chelmsford. Secretary: Francis R. Reeves, Esq.

report of the directors (with abstract of accounts) pre- at the annual general meeting of the shareholders at Terminus Hotel, Cannon-street, E.C., on Monday last:

directors have pleasure in submitting the accompanying nt of accounts and balance-sheet of the Company, made ec. 31, 1897, from which it will be seen that the progress provement in the position of the Company continue satis- . As stated in their report last year, the directors made a nsiderable reduction, from Jan. 1, 1897, in the price of , charging the consumers for the first hour 8d. per unit and current subsequently consumed 4d. per unit only. This ion, which practically amounts to 20 per cent. in the charge rent, has had the effect anticipated of increasing the r of consumers and the consumption of electricity to such ent that the large reduction is more than compensated for e increased consumption. The revenue from the sale of nt has increased to £6,838. 17s. 10d., and after debiting and loss account with the cost of generation and distribution ectricity, and management expenses, there remains a net for the year of £3 602 9s. 8d., compared with £3,114 d. in 1896. To this amount must be added £183. 7s. 10d. ht forward from last year, increasing the amount to ealt with to £3,785. 17s. 6d., and after deducting ture interest paid and accrued and the interim dividend n October last, there remains a net balance of £2 092. 7s. 11d. e credit of the revenue account. The directors propose to the sum of £150 off preliminary expenses account, to place to the reserve fund, to declare a dividend (payable on 15 next) at the rate of 6 per cent. per annum for the ar on the share capital (making, with the interim dividend, cent. for the year), and to carry the balance of £218. 7s. 2d. d. The number of lamps attached to the Company's increased to the equivalent at Dec. 31 last of 27,777 , and the number of consumers to 397, compared to s and 314 consumers at Dec. 31 1896. Out of the which has to be set aside for repairs and maintenance, ance with the contract with the Hove Commissioners, xpended sum of £390. 13s. 11d. has been placed to the tion and maintenance reserve fund, bringing the total of this account to £914. 10s., while the general reserve fund by the addition now proposed to be made will stand at £2 259. 17s. Since the date of the last report the directors have issued £2,400 of 4 per cent. debenture stock, bringing the total amount issued at the present date to £17,000. The increase of the Company's business, and the continued applications for supply of current from residents in new streets, entail upon the Company further outlay on mains and machinery, for which additional capital is required. The directors therefore propose to increase the capital of the Company to £50,000 by the creation of 2,000 new shares of £5 each ranking *pari passu* with the existing shares, and the necessary resolution for giving effect to this proposal is contained in the notice of meeting. The directors propose to make an early issue of 1,000 of these shares, which will be offered to the whole of the members of the Company, *pro rata*, at a premium. A resolution will also be submitted for consideration, increasing the limit of the directors' borrowing powers from £25,000 to £50,000. In accordance with the articles of association, Colonel H. Wood, C.B., retires from the Board by rotation, but offers himself for re-election. The auditor, Mr. Robert Payne, F.C.A., also offers himself for re-election.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1897.

Dr.		£	s.	d.
Generation of Electricity.				
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£804 18 1			
Oil, waste, water, and engine-room stores	119 5 10			
Proportion of salaries of engineers, superintendents, and officers	254 12 0			
Wages and gratuities at generating station	532 2 6			
		1,710	18	5
Repairs and Maintenance.				
Amount expended	209 6 1			
Balance set aside in accordance with the contract with Hove Commissioners	390 13 11			
		600	0	0
Rents, Rates, and Taxes.				
Rents payable	133 3 4			
Rates and taxes	50 11 4			
		183	14	8
Management Expenses.				
Directors' remuneration	450 0 0			
Salaries	401 4 4			
Stationery and printing	43 12 2			
General establishment charges	135 5 7			
Auditor of Company	10 10 0			
		1,040	12	1
Special charges—Insurances		131	16	6
Total expenditure		3,667	1	8
Balance carried to net revenue		3,602	9	8
		£7,269	11	4

Cr.	£	s.	d.
Sale of current (268,243 units)—private consumers, after allowing rebates and providing for bad debts	6,650	3	10
Public lighting	188	14	0
	6,838	17	10
Rental of meters and other apparatus on consumers' premises	426	1	0
Transfer fees	4	12	6
	£7,269	11	4

GENERAL BALANCE SHEET, DEC. 31, 1897.

Liabilities.	£	s.	d.
Capital account—amount received	39 550	0	0
4½ per cent. debentures	7,300	0	0
4 per cent. debenture stock	17,000	0	0
Sundry creditors, due on construction of plant and machinery, fuel, stores, etc., to Dec. 31, 1897	1 617	3	5
Consumers' deposits	56	0	0
Creditors for interest	162	6	10
Unclaimed dividends	37	12	4
Reserve fund	1,659	17	0
Depreciation and maintenance account reserve fund	914	10	0
Net revenue account, balance at credit	2,092	7	11
	£70,389	17	6

Assets.	£	s.	d.
Capital account—amount expended for works	66,896	9	4
Stores on hand, Dec. 31, 1897: coal, £30. 11s. 11d.; oil, waste, and general stores, £43. 5s. 11d.	73	17	10
Sundry debtors for current supplied, etc., to Dec. 31, 1897	2,989	14	7
Cash at bankers, £399. 8s. 9d.; in hand, £30. 7s.	429	15	9
	£70,389	17	6

At the meeting, **Colonel A. J. Filgate**, who presided, said the capital expenditure had increased during the year by £4,874, the total amount spent to the end of 1897 being £66,896. The demand for the supply of electric current in new streets necessitated increasing the sizes of the conductors in many places and the con-

struction of about 2¼ miles of new mains, bringing the total length of mains constructed up to Dec. 31 last to 12 miles. The increase under meters was due to the expansion of their business, and also to the introduction of the demand-meter system, which necessitated their providing demand meters in addition to the ordinary supply meters. In order to meet the increased expenditure thus caused, they now asked the shareholders' approval to increase their share capital by 2,000 shares of £5 each; and they further took advantage of the opportunity to ask for an advance of the borrowing powers from £25,000 to £50,000. They had no present intention, however, of increasing their debentures beyond the £25 000 now authorised. The revenue account showed a satisfactory result, notwithstanding the large reduction they had made in the prices charged to their customers for current, amounting to about 20 per cent. This reduction had no doubt increased the number of their customers and the consumption of current. The gross revenue for the year had been £7,269, or £751 more than that for the previous year, while the working expenses had been £3,677, showing an increase of £263 over those of 1896. Considering the large increase in units delivered to customers, which amounted to 34 per cent., their work had been conducted economically. Up to the 3rd inst. the units delivered to customers from Jan. 1 reached 81,400 compared with 61,700 delivered up to the same date last year. The directors hoped the shareholders would approve their policy of strengthening the reserve, which they regarded as a matter of first importance in a business such as theirs.

Colonel H. Wood seconded the motion, which was adopted, and a dividend at the rate of 6 per cent. per annum was afterwards declared, making, with the interim dividend, 5 per cent. for the year.

Resolutions were afterwards passed increasing the share capital and the borrowing powers to the extent mentioned by the chairman.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN

Warschau.—Tenders will be called shortly for electric installation for light and power. Particulars may be obtained from the Mayor of the town.

Edinburgh.—Tenders are invited for the additions and extensions to the electric lighting at the City Chambers. For particulars see advertising columns. Tenders by March 22.

St. Chamond (France).—Tenders are invited for lighting the town by electricity or otherwise. Particulars are to be obtained from, and tenders addressed to, Municipal Authorities at above place (Department Loire) by March 31.

Alexandria (Egypt).—Tenders are invited for indiarubber tubes, etc., for the Post and Telegraph Department. Specifications may be obtained from, and samples inspected at, the Gabbary Stores, and tenders are to be addressed to the President of the Council of Administration, Cairo, by March 28.

Madras.—The Secretary of State for India in Council announces that the time allowed for the receipt of tenders by the Chief Engineer for Irrigation, Madras, for the utilisation of water power of the Periyar Lake has been extended from Oct. 31, 1897 to July 1, 1898.

Seraing (Belgium).—Tenders are invited for electric installation for public and private lighting and for power transmission for 30 years, to commence from Feb. 1, 1899. Particulars are to be obtained from, and tenders addressed to, Municipal Authorities at Seraing, Belgium, by April 1.

Kolding (Denmark).—For complete establishment of electric lighting works, etc. Specifications are to be obtained from Byraadets Udvalg for Electricitätsvaerket, Sugförer Edv. Lau. for 50 kroner (£3. 3s.) to be returned on receipt of bona fide tender, and tenders addressed the same at Kolding by March 24.

Badajoz (Spain).—Tenders are required for the sole right of public lighting by electricity for 20 years. The deposit required is 700 pesetas (350 provisional). Particulars are to be obtained from, and tenders addressed to, the Local Government Administration Department, either at Madrid or Zafra. Tenders by March 29.

London.—Tenders are invited for the supply of the lightest possible form of motor (to be complete with tank, tender, or other fuel supply), capable of developing energy of 9 h.p. on brake test, at a spindle revolution of 500 per minute. Dimensions and total weight of the machine to be sent to Mr. B. Morley Fletcher, A.M.I.C.E., 7, Victoria-street, Westminster.

Santander (Spain).—Tenders are required for the sole right (20 years) of lighting the town by electricity, and for working the water-supply in that town by the same means (lifting). The deposit required is 4,000 pesetas (1,000 provisional). Particulars are to be obtained from, and tenders addressed to, the Local Government Administration Department, Madrid or Santona. Tenders by March 21.

Ipswich.—The Electric Lighting Committee are prepared to receive from responsible firms full detailed offers for carrying out the provisions of the Ipswich Electric Lighting Order, 1897, including terms upon which the undertaking could be acquired by the Corporation at certain dates if so desired. Offers, endorsed "Tender," to be sent to the Chairman of the Electric Lighting Committee, Town Hall, Ipswich, by March 25.

Salford.—Competitive plans and estimates are invited for erection of a new generating station. All information may be obtained from the Electrical Engineer, Walness-road, Salford, on or after 14th inst. Sealed plans and estimates, endors
Station," addressed to the Chairman of the Electric Li
mittee, to be delivered at the office of Mr. Saml. Br
clerk, Town Hall, Salford, by 9 a.m. on 25th inst.

Derby.—The Corporation invite tenders for the elec
of their lunatic asylum and premises at Rowditch, Derb
fications, etc., may be obtained from the Engineer an
of the Electric Lighting Works, Sowter's-road, Derby, o
of £1. 1s., which will be returned on receipt of a bona f
Tenders, marked "Asylum Lighting," and addressed to
Gadsby, town clerk, are to be sent in by 24th inst.

Bournemouth.—Tenders are required for motor vehic
collection of house refuse, street scavenging, and con
road materials. Specification, etc., accompanied by
should be delivered at the office of Mr. F. W. Lacey,
borough engineer and surveyor, Municipal Offices, Bou
in a cover marked "Tender for Motor Vans," by Apr
line specification and form of tender can be obtained
tion to the Borough Engineer's Office.

Plymouth.—The Corporation invite tenders for the
electricity meters (alternating-current) for the 12 mont
March 31, 1899. Specification, with form of tender
obtained by bona fide meter manufacturers or their
agents on application to Mr. John H. Rider, borough
engineer, East-street, Plymouth. Sealed tenders,
"Electricity Meters," must be delivered to Mr. J. H.
clerk, Plymouth, not later than March 23.

St. Pancras.—The Vestry invite tenders for buildin
chimney, shaft about 240ft. from the foundations. Copie
cation, conditions of contract, and form of tender are to b
at the Electricity Department Offices, 57, Pratt-street
Town, N.W., on payment of a deposit of £1, whic
returnable on receipt of the specification accompanied
fide tender. Tenders to be sent to Mr. C. H. F. Barr
clerk, endorsed "Tender for Chimney," by 12 noon on M

Devizes (Wilts).—Tenders are invited for two 40-kw. c
current belt-driven dynamos and for two high-pressure
compound engines of 70 b.h.p. each for driving ele
machinery. Specifications and particulars may be obta
Messrs. Massey and Allpress, 25, Queen Anne's-gate, W
on payment of £1. 1s., which will be returned on receip
fide tender. Tenders to be sent to Mr. Joseph T. Jac
to the Visiting Committee, Wilts County Asylum, D
March 21.

Darwen.—Tenders are invited by the Corporation for
revolution steam-engines and dynamos; (B) steam a
pipes, etc.; (C) accumulators; (D) switchboards, balan
ratus, etc.; (E) underground mains, etc.; (F) arc lam
etc. Conditions, etc., may be obtained at the offi
Borough and Electrical Engineers, on payment of £2
cation, or £5 for the entire set of specifications, which
returned on receipt of a bona fide tender. Tenders b
March 28.

London, S.W.—The Secretary of State for War is
receive offers in writing, accompanied by competitive d
specifications for the supply of portable electric
apparatus. General particulars as to requirements can
on application, either by letter or personally, to A. Maj
of army contracts, War Office, Pall-mall, S.W. The
designs must be delivered at the War Office, Pall-ma
S.W., by April 27, addressed to the Director of Army
and marked on the outside "Designs for Search-Light A

Leyton.—The Council invite tenders for the supply a
of (No. 1) two dynamos, one continuous-current balan
former; (2) two gas-engines and connections; (4) sw
Specifications to be obtained from Mr. H. Collings
electrical engineer, Cathall-road, Leytonstone, on
March 21, on payment of £2. 2s. for each copy, which
refunded upon the receipt of a bona fide tender. Tend
panied by a £10 Bank of England note to be enclose
tender and to be forfeited if the tender is withdrawn
contract is signed, must be received at the Town Ha
Essex, by April 4.

Victoria (Australia).—Tenders are invited by the
the city of Hawthorn for the supply and erection,
supply only, of: (Section A) buildings only; (B) boi
heater, pumps; (C) engines, dynamos, switchboard,
mains, transformers, meters, arc lamps, insulato
instruments; (D) supply of poles and their erection;
the plant for three years. Specifications and forms of
be obtained at the office of the Agent-General for Victo
General Sir Andrew Clarke, G.C.C.M., Victoria
Victoria-street, Westminster, London, S.W., on p
£1. 1s., which will be returned on receipt of a bona
Sealed tenders, endorsed "Tender for Electric Ligh
addressed to the Mayor of Hawthorn, Victoria, Au
June 24, at 5 p.m.

Egremont (Cheshire).—The Wallasey Urban Distr
invite tenders for the following works—viz., (a) engine,
and exciter; (b) two Lancashire steam boilers and one
steam-boiler; (c) condensing apparatus. Copies of th
tions may be obtained on application to the engineer
Crowther, Gas and Water Works, Great Float, near
A charge of £2. 2s. will be made for copy of each spec
be returned on receipt of a bona fide tender. Sealed
the form provided for the purpose, addressed to the C
the Gas, Water, and Electricity Committee, and endors
for Engine and Alternator," or any other contract,

be, to be delivered at the office of Mr. H. W. Cook, clerk, ic Offices, Church-street, Egremont, Cheshire, by 4 p.m. on h 17. Contractors will be required to enter into a bond with oved sureties for the performance of contract.

atford.—The Urban District Council invite tenders for the ly and erection of the following plant : (Section A) generating , water-tube boilers and fittings, economiser, feed pumps, tors, etc., steam alternators and exciters, condenser, oil filter, gs, etc., steam exhaust, blow-off and sundry pipes, valves, r tank, etc.; (B) switchboard and all connections ; (C) over travelling crane ; (D) conduits and mains for general supply ; public lighting and adaptation of existing public lamps ; ransformers, sub-stations, and switching gear ; (G) arc lamps posts. Tenders may be sent in for any section or sections or e whole of the sections, but not for part of a section. The d plan of works, plan of streets, etc., and specifications forms of tender, may be obtained at the offices of Mr. W. C. C. layne, consulting engineer, Mansion House-chambers, 20, lersbury, E.C., on payment of £5. 5s , which sum will be ned on receipt of a bona fide tender. Tenders, sealed and ed "Tender for Electric Lighting," must be addressed to H. Morten Turner, clerk to the Council, at the Council s, Watford, and be delivered on or before 12 noon on l 16.

kpool.—Tenders are invited by the Corporation for the y and erection of the following plant at the Corporation city works—viz. : Contract No. 1—(Section A) one tubular with superheater ; (B) superheaters for five existing Lanca- oilers ; (C) surface condensers, pumps, pipes, and storage (D) two 55-light rectifiers ; (E) 10 15-kw. boosters. Con- o. 2—(Section A) high and low tension lead-covered cables ; 50-kw. transformers. Contract No. 3—(Section A), 20 arc illars ; (B) 100 arc lamps. Tenderers are at liberty to tender section, but not for part of a section. Specifications, conditions, forms of tender, etc., may be obtained from Mr. C. Quin, borough electrical and tramway engineer, el, on prepayment as to Contract No. 1 (Sections A to D, re bound up together) of the sum of £5. 5s., and as to No. 1 (Section E), Contracts No. 2 and 3 (Sections A f the sum of £2. 2s. for each section, which respective l be returned on receipt of a bona fide tender on the pre- orm and within the prescribed time. Duplicate copies of No. 1 (Sections A to D) and Contract No 2 (Section A) charged £1. 1s. each, which will not be returned. The ion require the erection and completion of above plant ur months from the date of order. Tenders, endorsed city Works Extension (Contract No. —, Section —)," addressed and delivered to Mr. T. Loftos, town clerk, ll, Blackpool, before 10 a m on March 22.

BUSINESS NOTES.

...th.—It is intended to instal the electric light into the ...eet Baptist Church.

...y.—It appears that very rapid progress is being made ...ew electric tramway.

...ster.—The electric light works are expected to be opened ...pril or May ; good progress is being made with them.

"...ical Engineering."—Our American contemporary has ...from 214, Monroe-street to 443, The Rookery, Chicago.

...rwell.—A special meeting of the Vestry is announced ...l 6 to receive the report of the General Purposes ...s fully set forth in our issue of the 25th ult.

... Hill.—The Urban Council have resolved to send a ...to the Postmaster-General in favour of the application ...w Mutual Telephone Syndicate for a license.

...gall and Co.—We are informed that the offices of this ...occupy the whole of the building at 55, Victoria-street, ...the firm intend shortly adding several new departments.

...y.—At a special meeting of the Vestry on the 7th inst., ...t of the committee of the whole Vestry *re* the transfer of ...ic lighting order was considered. The debate was again ...

...—It is stated that the Russian Admiralty has decided ...se into Russian ships of war electrical apparatus for ...d working guns according to a system in vogue in the ...vy.

...th.—The Council have adopted a resolution of the ...ighting Committee that application should be made for ...al order empowering the Council to supply electric light ...district.

...th.—Owing to an explosion at the generating station, ...e of the electric light supply occurred last week. The ...ting was soon restored, but the service to private users ...r days to repair.

...l.—The corporate common seal was on the 9th inst. ...the agreement between the Sheffield Electric Light and ...mpany, Limited, and the Corporation, for the sale and ...the undertaking of the company to the Corporation.

...At the monthly meeting of the Town Council a letter ...from the Electric Light Supply Corporation asking if ...would sell their electric light provisional order, and ...clerk was instructed to reply that it was not in the

Stirling.—The Police Commissioners discussed at their last meeting a report by Prof. Kennedy in favour of electric lighting by water power. It was moved that the conclusions of the report be adopted, but an amendment that a specialist in water power be employed to give a further report was carried by 11 to 8.

British Thomson-Houston Company, Limited. — We are informed that, owing to increase of business, this Company have opened new showrooms at 26 and 27, Bush-lane, Cannon-street, E.C. This address is now the headquarters of the supply department, under the management of Mr. A. J. Ireland.

Cork.—The Corporation at their last meeting discussed at length their position with regard to their expired electric lighting order and the future position of their gas company in the event of another company applying for an order to provide the electric light. Ultimately the matter was referred to a committee of the whole house.

Exeter.—At the last meeting of the Council, in replying to a question, the Chairman of the Town Hall and Electric Lighting Committee stated that it had been resolved to charge private consumers 7d. per unit for the first hour and 2d. per unit afterwards. The system of charging was that brought out by Mr. Wright, the electrical engineer at Brighton, and it had been found to work well in many other towns.

Liverpool.—At a meeting held on the 4th inst., the Lighting Committee of the Corporation decided to extend the electric mains in Manchester-street and School-lane. The Electrical Engineer reported that in consequence of the unsatisfactory state of the lighting in Bold-street, due to the failure of some of the lamps, it had been decided to adopt another kind of lamp, which it was hoped would be of a more satisfactory character.

Morecambe.—An enquiry was held at Morecambe on the 9th inst. by Colonel R. J. Hepper, on behalf of the Local Government Board, into an application by the District Council to borrow £10,000 for the extension of the electric lighting works. The Clerk explained that with reference to the recent arbitration case with the old electric light company the Council had been awarded as their share £1,179. There was no opposition to the scheme.

Greenock.—The sub-committee on electric lighting agreed on the 3rd inst. to recommend the Police Board to extend the electric light in the town at a cost of about £28,000. The site is estimated to cost an additional £3,000 or £4,000. The proposal provides for the erection of about 40 arc lamps and pillars along the main streets. The extension of the installation, should such a demand arise, would also be provided for in the sub-committee's scheme.

Edinburgh.—At the fortnightly meeting of the City Council the following notices of motion were tabled : To remit to the Electric Lighting Committee (1) to consider and report on the charges to be made for electric energy, for public and private lighting, and also for power from May 15 next ; (2) to consider and report upon the salary of the present electrical engineer ; (3) to take into their immediate consideration the lighting of Melville-street by electricity.

Accrington.—The Council have resolved to obtain on lease part of some land, with the option of purchase of the whole, for the erection of a destructor, to be worked in connection with the electric lighting plant, and on condition that they have the use of the water flowing down the Hyndburn for condensing and steam purposes, and direct access for all purposes on to the land from Hyndburn-road. An offer from the Municipal Electric Supply Company to undertake the supply of electricity within the borough has been declined.

Crompton and Co., Limited.—We are informed that this Company have closed their office at 35, Queen Victoria-street, at which address they have hitherto been carrying on the sale of electrical cooking and heating appliances, and that this branch of their business will be carried on at the Arc Works, Chelmsford. In future, Messrs. Crompton and Co. will supply the trade only with their electrical heating and cooking appliances, but will forward on application the name and address of the nearest agent from whom the goods can be obtained.

St. Olave, S.E.—At the last ordinary meeting of the Board of Works, it was resolved, on the recommendation of the Works and Finance Committee, to co-operate with the Corporation of London by making an application to the Treasury for an enquiry to be held as to the cost and efficiency of the telephone service in London, and all matters relating thereto ; also that delegates be appointed to a conference proposed to be held in relation thereto. The same delegates were appointed to attend a proposed conference at St. Martin's-in-the-Fields in reference to laying telephone wires underground.

Coventry.—The annual report upon the Coventry electric lighting, presented at the last meeting of the City Council, stated that there were 100 consumers, and the profit on working in 1897 was £106 ; but interest on borrowed money and sinking fund had to be allowed for, and then there was a net charge on the rates of £1,558, as against £1,706 in 1896. It was said that the consumption per light in Coventry was only 11½ units, which was much lower than the consumption in other towns ; also that sufficient was not being charged to consumers, to each one of whom the city was making a present of £15 per annum.

Kingswood.—At the last meeting of the Urban Council, a letter was received from the solicitors of the Western Counties Electric Lighting Syndicate asking when the purchase of the electric light plant and apparatus was likely to be completed by the Council. The Chairman mentioned that as soon as the Local Government Board enquiry had been held, and their loan was

sanctioned, they would suggest a time for the settlement of the purchase. They had now Mr. Parfitt's list in for the lighting extension, and the whole matter would come up at the enquiry. After discussion it was resolved to write the solicitors in question confirming the letter mentioned.

Paisley.—At a special meeting of the Town Council in committee on the 8th inst., it was resolved to affirm the agreement between the British Electric Traction Company and the Paisley Tramway Company, whereby the traction company would take over the lines and work them by electric haulage. The lines, it is stated, will be extended west to Johnstone, south to Potterhill, north to Renfrew, and east to the terminus of the Glasgow tramway lines should the necessary powers be granted. It is understood that the trolley system will be used. The electrical engineer has been instructed to make enquiries at the various centres where the system has been adopted, and to report to the Council.

Southampton.—At a meeting of the Southampton Town Council a lengthy debate arose upon the motion for the adoption of the report of the Electric Light Committee, especially the part referring to the extension of the electric light mains at a cost of £4,000. It was stated that of the 176 answers received, 19 only consented to take the current, 30 did not require it at present, and that meant that these would not take it at all, and 127 absolutely refused. Eventually it was agreed that Mr. Manville should be instructed to submit report and plans upon the proposed position of the standards to carry the arc lamps for public lighting, with a view that the same standards should be used for trolley wires for the tramways.

Bath.—At the last meeting of the Electric Lighting Committee, Mr. W. Jeffery, accountant, presented the figures for the first year's working under the Corporation, showing the revenue account at the electric light works. The report dealt (says the *Bristol Times and Mirror*), in reality, with a year less seven days, and showed a net profit of £645. The consulting engineer (Mr. Hammond) pointed out, however, that in addition to this amount £600 had been set aside for depreciation and £707 had been paid for bank interest. This, he contended, ought not to be taken in the revenue accounts. It was the custom with other corporations not to include depreciation. In the electrical Press he should say Bath showed a profit of £1,950 on the year. It was decided to supply each member of the Council with a copy of the returns, according to the Board of Trade form.

Cheltenham.—The electrical engineer's report states that steady progress has been made with connection of customers to the mains. The total number of services connected was 241, and the equivalent number of 8-c.p. lamps was 14,600. He was daily expecting delivery of an additional transformer for the sub-station, from which most of the customers at Montpellier were supplied, which would enable him to put in fuses with a considerably larger factor of safety, and pending this transformer being fixed at Queen's-circus, it would be best to attempt to supply the whole of the Ladies' College on Wednesday evenings only. The Town Council at its last meeting resolved that this suggestion be approved. The electrical engineer submitted an estimate of the probable extensions to mains and plant, etc., and it was resolved that application be made to the Local Government Board for sanction to a loan for £17,200.

Dundee.—The work of introducing electric light into the streets is proceeding rapidly, and already a large number of the pillars have been erected in central thoroughfares. The current was turned on on Tuesday last for the first time so far as concerned Reform-street. Altogether four lamps were lit in that thoroughfare, and the result was very satisfactory. The gas lamps were lighted as usual, presumably in case of emergency, but the experiment of electric lighting was not attended by any breakdown. It is proposed to switch the current on to the other lamps as they are erected. At a meeting of the Gas Committee of the Town Council, a representation was made by proprietors and tenants in Crichton-street requesting that the scheme for the electric lighting of the city be extended by erecting one or two electric lamps in Crichton-street. The matter was remitted to the electrical engineer to report upon.

Crieff.—A report was recently furnished to the Town Council by Mr. R. F. York, electrician, referring to the formation of a company for electrically lighting the town, the motive power for which is proposed to be supplied by the Falls of Turret, some three miles north-west of the town. Previous to this the Town Council obtained a report on the whole matter from Mr. Arnot, late electrician for the Corporation of Glasgow, and he advised the Council against the project of adopting water power. Sir Patrick Keith Murray, Bart., of Ochtertyre, on whose estate the waterfalls are, and who offered the water power free, has now made a thorough examination into the capabilities of the Falls of Turret as a motive power to produce a sufficient supply of electric light for the town. He now states that an eminent electrician in London, to whom the result of these calculations were submitted, has reported that the power of the waterfalls referred to is insufficient for the purpose.

African Work in Hand.—The *British and South African Export Gazette* contains the following items of electrical work in contemplation in Africa: An electric lighting installation is under contemplation for the Monastery diamond mine, Orange Free State. An electrical tram installation is proposed for the Sheba gold mine to replace the present steam tram. The provision of an electric light installation for Woodstock, Cape Colony, is under consideration by the Town-Council. The proposed *electric lighting plant for East* London will include 43 2,000-c.p. arc lamps, 327 32-c.p. incandescent lamps, 2,304 16-c.p. descent lamps, five continuous-current machines for arc ing, three direct-coupled alternators for the incandescent service, two switchboards, and other accessory materi also announces that tenders ranging from £12,000 to £ have been received by the Bloemfontein (Orange Free Town Council for the proposed electric lighting installation town.

Perth.—Lord Provost Dewar submitted and read to a m of the Sandeman Bequest Committee a report by Messrs. bell, Douglas, and Morison on several methods submitt Messrs. Anderson and Munro, electrical engineers, Glasg lighting the Sandeman public library by electricity, with mates of the cost of installation. As the library would ulti be lit by electricity, it would be a saving of cost if the bu were wired for the purpose now. The meeting approved suggestion, and remitted it to a committee to instruct the tects to get estimates for the works, and to see to its being out. At a subsequent meeting a letter was read from the tects with reference to a second-hand engine and dynamo, q prices at which such articles could be obtained. After disc the committee resolved that, with the exception of havi building wired, no further steps should be taken in the ma for the introduction of a private installation of electric light library.

Aberdeen.—At the last meeting of the Council the prop the Gas and Electric Lighting Committee to charge 6d. f first hour daily of the maximum demand for electricity for power, and thereafter 1½d. per Board of Trade unit, was se to the committee. The accounts of the electric lighting ment for the past year were submitted by the Chairman Committee, who said that since the new system of chargi been adopted, a good many complaints had been receive consumers who formerly paid 5d. on the first hour's consum and were now charged 6d. The system, which had been a by other corporations, was introduced last year. The e had informed him that during the past half-year there ha something like £300 spent in connection with the cha system, which would not occur again for a considerabl Had it not been for that they would have had a consi balance. They hoped by next winter, after the Harbour missioners had got the quays fully lighted, they would still further to reduce the price of electricity. The account passed.

Dorking.—A public meeting was held at the Oddfellow last week in pursuance of a resolution passed by the Urban C to afford an opportunity for questions to be asked and in tion given in reference to the alternative proposals for intro the electric light in Dorking. The notice convening the m stipulated that no resolutions were to be submitted. Mr. Chaldecott, who was voted to the chair, in explaining the of the meeting, stated that the parochial electors and rate had had a statement put before them, and a postcard on they were asked to inform the Urban Council as to which schemes they considered preferable. It was thought wise, i to give every person an opportunity of informing himself or as to the respective merits of the two proposals, that a m should be held at which either the members of the Council consulting engineer on the one hand, and the representat Messrs Edmundson on the other, should be present to gi information upon the facts and figures which had been sent the public After the discussion, the Chairman assured the ing that before the Council plunged the town into this matt would endeavour to get full and accurate information upo possible point.

Glasgow.—At the last monthly meeting of the Corporati Tramway Committee submitted a report from the general m and engineer regarding the Springburn route, and stat having considered the report they had sent copies to each m of the sub-committee, and that the Statute Labour Com should be approached to ascertain if they would sancti lowering of the level of Springburn-road underneath the donian Railway bridge to the extent of 15in., at the e of the Tramways Department, and under the supervi the master of works. A subsequent minute stated that t mated cost of the work was £2,280, and the committee mended that it should be proceeded with. The committee recommended that four double-decked cars, two on bogies with ordinary axles, of a design submitted by the general m be built by the department, and placed on the Springburn along with the single-decked cars already decided on and n built; and that nothing further be done regarding the co tion of different types of cars until the two types above be thoroughly tested. It was said that the above estimate in the lowering of the gradients as well as the lowering of th way under the bridge. The line down the High-street w laid in a few months. The report was adopted.

Eccles.—The electrical engineer (Mr. Clirehugh) attend last meeting of the Council and submitted a report on the p of the electric lighting works, in which he stated that the exc necessary for the walls and foundations of the boiler and engi have been taken out, and the trenches are now ready for The foundation for the chimney was now level with the A visit to Messrs. Browett, Lindley, and Co.'s works had him that excellent progress had been made with the ma The boilers should be ready in about four months. He ha his London partner to inspect the dynamos at Messrs. and Phillips. He had also inspected the cables in course o facture; all the copper was stranded and the insulating

The manufacturers would begin laying at the end of Mr. Clirehugh's recommendation *re* "free wiring" is that mittee advertise for offers from companies willing to instal s and fittings. This recommendation was accepted. Mr. gh also requested the committee to take into consideration tion of the method of charging private consumers for the of electrical energy. He recommended the adoption of 'right" system, and suggested that the charge should be unit for the first hour and the succeeding charge 2d., which ave an ample margin of profit over the cost of produc- 'he committee adopted the recommendation.

sey.—A special meeting of the County Council was held k to consider an application from Messrs. Land and solicitors, Halifax, for the sanction of the Council to the d electric railway from Llanfair to Beaumaris. Mr. making the formal application to confirm their resolution last year approving of the project, said that the London rth-Western Railway Company would give this project arty co-operation, and would facilitate the exchange of Llanfair. He might say that they had given instructions aring plans of the proposed railway from Valley to Amlwch The representatives of the Llanfair Parish Council, the ris Town Council, and the Menai Bridge Urban District supported the application. Representatives of villa resi- ong the route and others appeared in order to oppose the on the ground that half the road would be occupied by the railway; that it depreciated the value of villa residences to ailway passing their entrances; and it would be dangerous s driving along the road. After discussion, the follow- lution was carried: "That we, the County Council of y, do hereby ratify and confirm the previous sanction the construction of the proposed light electric railwsys sey, as being beneficial to the community at large, and in r we approve and sanction the one from Llanfair to ris as the pioneer line in Anglesey, provided always that cil reserves the right to appear before the Light Railway ssioners or the Board of Trade to make any objection to s that they may consider necessary, and that the Beau- se be completed within two years from the date of the

F.—At a meeting of the Lighting Committee of the Cardiff tion last week, the temporary appointment of Mr. J. E. as electrical assistant was made permanent, subject to the nditions as to notice, and his salary was increased by £20 m. The Electrical Engineer (Mr. Appelbee) submitted a le of reduced charge for the supply of electric light to consumers. The present rate is 6d. for the first two hours' daily use, and 3½d. afterwards. The proposed rate would r the first hour and 3½d. afterwards, while in the case of nsumers only using the light on an average one hour a small class mostly consisting of places of worship—the suggested that the charge should be a uniform one er unit, with the option of being placed on the differential he supply of electricity for 1897 had increased by 34.000 r the preceding year, the total revenue was £6,968, and plus on the year's working would probably be about Such a reduction he considered was quite as much as advisable to make at present, while it would tend fitable increase of business. On last year's consump- wever, such a reduction in the rates would have meant 667 less in the revenue. If 6d. per one hour were on the same consumption, the revenue would be reduced 7, or about 15 per cent. The latter he considered would great, and would result in the department working with on the wrong side, necessitating further calls upon the the detriment of those ratepayers who had not the oppor- using electricity at present. The rates proposed, while g unusually low, were in no way high. Shoreditch, which ntly quoted in the local Press as supplying "record lectricity," were now only proposing 6d. for the first and then 2d., which equalled for three hours' use 1s., Cardiff's present rate of 1s. 3½d., and proposed rate of r for two hours' use Shoreditch 10d, Cardiff 10½d. If a eduction should appear desirable, he would suggest it take of a 2½ per cent. discount for cash within 14 days after an has been rendered, as the consumers undoubtedly needed ucement to pay up more promptly. It might appear to mittee more desirable to reduce the present two hours at y, 1½ hours at the same—*i.e.*, 6d.—and then commence at sed rate of 3½d.; but he had proposed one hour on account ing the present scale on the maximum demand indicators. rman advocated a slightly further reduction by making it ad of 3½d. after the first hour. This, he said, would in ability induce the large class of small householders to take . After discussion, the question was deferred for further tion at another meeting.

PROVISIONAL PATENTS, 1898.

FEBRUARY 28.

Improved method of distribution of news and music by telephone. Lancelot Edward Wilson, 43, St. Peter's-terrace, Ravenscourt-Park, London.

rovements relating to joints of telegraph wires. rew Ainslie Common, 6, Bream's-buildings, Chancery-lane, London.

4895. **Improved manufacture of insulating conduits for electrical conductors and appliances employed in connection therewith and for laying the conductors therein.** Frank Tom Woodcock, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

4903. **Improvements in primary batteries.** J. Ensign Fuller, 40, Chancery-lane, London. (Complete specification.)

4910. **Improvements in and relating to primary batteries.** Carl Koenig, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

4926. **Improvements in and relating to portable electric lamps and batteries therefor and for other purposes.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Leonard Paget, United States.)

4929. **Improvements in or relating to electric railway conduits and conductors.** Alfred Julius Boult, 111, Hatton-garden, London. (Raymond Soyers, Belgium.) (Complete specification.)

MARCH 1.

4995. **Improvements in electromagnets or magnetic closers for use on electric railway vehicles.** John Notley Thomas, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

4999. **Improvements in and relating to electric railways.** William Milton Brown, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

5001. **Improved controlling system for electric railway vehicles.** Sidney Howe Short, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

5029. **Improvements in regulating apparatus for arc lamps.** Henry Leitner, 37, Chancery-lane, London.

5034. **Improvements in or relating to electrolytic electrical meters.** Charles Orme Bastian, 31, Southampton-buildings, Chancery-lane, London.

5042. **Improvements in electric meters.** Evershed and Vignoles, Limited, and Sydney Evershed, Woodfield Works, Harrow-road, London.

5043. **Improvements in alternating-current motors.** William Stanley, 1, Queen Victoria-street, London. (Complete specification.)

5054. **Improvements in current collectors for dynamo-electric machines.** George William Nell, 47, Lincoln's-inn-fields, London. (Complete specification.)

5062. **Improvements in incandescent electric lamps.** William Phillips Thompson, 6, Lord-street, Liverpool. (John Thomas Lister and William Selah Chamberlain, United States.) (Complete specification.)

5064. **Improvements in non-synchronous electric meters.** Reginald Belfield, 322, High Holborn, London. (Benjamin Garver Lamme, United States.)

5065 **Improvements in arc lamps.** Reginald Belfield, 322, High Holborn, London. (Harry P. Davis and Frank Conrad, United States.)

5066. **Improvements in electric switches.** Reginald Belfield, 322, High Holborn, London. (Harry P. Davis and Ernest F. Harder, United States.)

5067. **An improved means for feeding the carbons in electric arc lamps.** Charles Wood, 11, Burlington-chambers, New-street, Birmingham.

5068. **Improvements in and relating to the carbon-feeding mechanism of electric arc lamps.** Charles Wood, 11 Burlington-chambers, New-street, Birmingham.

MARCH 2.

5066. **An improved means of and apparatus for varying the strength of electrical currents.** Robert Hope-Jones, 55, Argyle-street, Birkenhead.

5130. **Method of utilising the interior of electric incandescent lamps for advertising purposes.** Laurence Bishop, 23, Ark street, Great Clowes-street, Lower Broughton, Salford.

5133. **Improvements in electric lamp fittings.** Jan Meines Huisman and Henry Charles Gover, 62, St. Vincent-street, Glasgow.

5162. **Improvements in the manufacture of waterproofing coating compositions for wearing apparel, covers, engine and other packings, acid-tank linings, electrical insulating compositions, and for other uses.** Charles James Grist, 55, Chancery-lane, London.

5172. **Improvements in telephone transmitters.** Joseph Vincent Collingwood, 6, Lord-street Liverpool.

5176. **Improvements in means or apparatus for starting and regulating electric motors.** John Henry Holmes, 46, Lincoln's-inn-fields, London.

5177. **Improvements in dynamo-electric machines.** William Brooks Sayers and Mavor and Coulson, Limited, 46, Lincoln's-inn-fields, London.

5178. **Improvement in the manufacture of electrical transformers and other alternating-current apparatus having iron cores.** Arthur Francis Berry, 46, Lincoln's-inn-fields, London.

5185. **Improvements in electrical conducting apparatus for tramways, railways, and the like.** Carl Friedrich Philipp Stendebach, 18, Buckingham-street, Strand, London. (Complete specification.)

5186. **Improvements in or relating to secondary batteries.** Reginald Haddan, 18, Buckingham-street, Strand, London. (Henri Dolter, France.) (Complete specification.)

MARCH 3.

5208. **Improvements in electrically-operated gas valves for burners.** The Actiengesellschaft für Fabrikation von Broncewaaren und Zinkguss vorm., J. C. Spinn, and Sohn, and S. J. von Romocki, 47, Barton-arcade, Manchester.

5252. **Portable exploring X-ray lamp.** Alfred Ernest Dean, 73, Hatton-garden, London.

5260. **An improved primary battery.** Edward Albert Mitchell, 322, High Holborn, London.

5287. **Improved coin-freed mechanism for making and breaking electrical contacts.** Reginald Haddan, 18, Buckingham-street, Strand, London. (Maurice Vidal, France.)

5288. **Improvements in globes or bulbs for electric incandescent lamps for decorative, advertising, and other purposes.** Peter Herre, 18, Buckingham-street, Strand, London.

MARCH 4.

5300. **Improved means for lighting railway trains electrically.** Richard Rogers Meacock and Arthur James Harper, 37, Bedford-row, London, W.C.

5343. **Improvements in fluids for impregnating bodies or suitable fabrics, threads, fibres, or the like for electric incandescent lighting purposes.** Fred. Pearce Foster and Gerhard (Bodo) Puchmüller, 25, Bartlett's-buildings, Holborn-circus, London.

5344. **Improvements in fluids for impregnating bodies or suitable fabrics, threads, fibres, or the like for incandescent lighting purposes.** Fred Pearce Foster and Gerhard (Bodo) Puchmüller, 25, Bartlett's-buildings, Holborn-circus, London.

5379. **Improvements in the manufacture of deep-sea telegraph and telephone cables.** W. T. Henley's Telegraph Works Company, Limited, and George Sutton, 53, Chancery-lane, London.

MARCH 5.

5418. **Improvements in electric telephony.** Charles Adams-Randall, 63, Chancery-lane, London.

5423. **An automatic electric switch for hoists and cranes.** James Goddard, 284, Oldham-road, Bardsley, Ashton-under-Lyne.

5449. **Improvements in "oscillographs" or apparatus for indicating or recording rapidly varying electric currents or potential differences.** William Du Bois Duddell, 47, Hans-place, Chelsea, London.

5469. **Improved system of electric traction and apparatus therefor.** Alfred Julius Boult, 111, Hatton-garden, London. (Joseph Paul Anney, France.) (Complete specification.)

5478. **Improvements in alternating electric current transformers.** John Alexander McMullen, 323, High Holborn, London.

SPECIFICATIONS PUBLISHED.

1896.

24084. **Switches for electromotors, etc.** Hall and Craven. (Amended.)

25036. **Electric batteries.** Dobell.

1897.

3120. **Incandescent electric lamps and their connections or holders.** Thompson. (Pope.)

4442. **Electric batteries.** Dobell.

5383. **Primary galvanic batteries.** Walker.

7645. **Means for preventing installations for electrical transmission of energy, in particular electrical railways, from causing disturbances in telephonic circuits.** Siemens Bros. and Co., Limited. (Siemens and Halske.)

7823. **Electric switches.** Cowan and Still.

7877. **Apparatus for controlling and registering the time of working of electric lamps.** Lake. (Société Anoyme des Horloges Electriques Cauderay.)

8416. **Electrical switches.** Davy and Thomas-Davies.

9194. **Heating by electricity.** March.

9561. **Means of controlling carbon-feeding mechanisms for electric lamps.** Hunter.

26727. **Electric brakes for cars.** Menzies and Bell.

27120. **Apparatus for electrically illuminating and displaying letters, numerals, devices, and the like for advertising and decorative purposes.** Martin.

29055. **Alternate-current meters.** Feldmann and Helios Elektricitäts-Aktiengesellschaft.

30627. **Electric railways.** The British Thomson-Houston Company, Limited. (Potter.)

1898.

67. **Holders for electric glow lamps.** Gover, Proctor, and Pipkin.

305. **Device for preventing the displacement of the roller receiving the current from the cables of electric railways with overhead conductors.** Meyersfeld.

TRAFFIC RECEIPTS.

Dover Tramways.—The traffic receipts for the week [illegible] March 5 were £99. 15s. 0d. The total receipts for the [illegible] 1898 are £948. 5s. 9d. The mileage open at present is 2¼ mi[illegible]

Bristol Tramways.—The traffic returns for the week [illegible] March 4 were £2,322. 7s. 9d., compared with £2,101. 1[illegible] for the corresponding period of last year, being an incre[illegible] £220. 9s. 8d.

Birmingham Tramways.—The traffic receipts for the [illegible] ending March 5 were £3,416. 11s. 8d., as compared [illegible] £3,263. 7s. 2d. in the corresponding week in 1897, bei[illegible] increase of £153. 4s. 6d.

Liverpool Overhead Railway.—The traffic receipts [illegible] railway for the week ended March 6 amounted to £1,3[illegible] compared with £1,315 in the corresponding week of the pr[illegible] year, being an increase of £49.

City and South London Railway.—The returns for th[illegible] ended March 6 were £1,089, compared with £1,062 for the [illegible]sponding period of last year, being an increase of £27. Th[illegible] receipts for the half-year amount to £10,719, compared [illegible] £10,775 for the corresponding period last year, being a de[illegible] of £56.

South Staffordshire Tramways.—The traffic returns f[illegible] week ending March 4 were £559. 11s. 5d., as compared [illegible] £596. 7s. 7d. in the corresponding week of the previous [illegible] The aggregate receipts for the year are £5,255 11s. 1[illegible] against £5,130. 16s. 4d. in the corresponding period [illegible] previous year.

Dublin S.D. Tramways.—The traffic receipts for the [illegible] ending March 4 were £378. 16s. 7d., as compared [illegible] £436. 15s. 7d. in the corresponding week in the previous [illegible] being a decrease of £57. 19s. 0d. The number of pass[illegible] carried was 65,343 in 1898 and 69,824 in 1897. The agg[illegible] returns up to date are £3,594. 9s. 4d., as compared [illegible] £3,913. 7s. 6d. last year, being a decrease of £318. 18s. 2d. [illegible] mileage open is the same as last year—viz., 8 miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Pr[illegible] Wed[illegible]
Birmingham Electric Supply Company	*	[illegible]
Brush Company, Ordinary	3	[illegible]
—— Non. Cum., 6 per cent. Pref.	3	[illegible]
—— 4½ per cent. Debenture Stock	100	[illegible]
—— 4½ per cent. 2nd Debenture Stock	100	[illegible]
Callender's Cable Company, Debentures	100	[illegible]
—— Ordinary	5	[illegible]
Central London Railway, Ordinary	10	[illegible]
——	6	[illegible]
—— Pref. Half-Shares	1	[illegible]
—— " "	5	[illegible]
Charing Cross and Strand	*	[illegible]
—— 4½ per cent. Cum. Pref.	5	[illegible]
Chelsea Electricity Company	5	[illegible]
—— 4½ per cent. Debentures	100	[illegible]
City of London, Ordinary	10	[illegible]
—— Prov. Cert. 80,001-90,000	10	[illegible]
—— " 90,001-100,000	2	[illegible]
—— 6 per cent. Cumulative Pref.	10	[illegible]
—— 5 per cent. Debenture Stock	100	[illegible]
City and South London Railway, Consolidated Ordinary	100	[illegible]
—— 4 per cent. Debenture Stock	100	[illegible]
—— 5 per cent. Pref. Shares	10	[illegible]
—— " " " '96	10	[illegible]
County of London and Brush Provincial Co., Ordinary	10	[illegible]
—— 6 per cent. Cum. Pref.	10	[illegible]
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	[illegible]
—— 5 per cent. Debentures	—	[illegible]
Edison and Swan United Ordinary	3	[illegible]
—— 5 per cent. Debentures	5	[illegible]
—— 4 per cent. Deb. Stock, Red.	100	[illegible]
Electric Construction, Limited	2	[illegible]
—— 7 per cent. Cumulative Pref.	2	[illegible]
Elmore's Copper Depositing	1	[illegible]
Elmore's Wire Company	3	[illegible]
W. T. Henley's Telegraph Works, Ordinary	10	[illegible]
—— 7 per cent. Preference	10	[illegible]
—— 4½ per cent. Debentures	100	[illegible]
House-to-House Company, Ordinary	5	[illegible]
—— 7 per cent. Preference	5	[illegible]
India Rubber and Gutta Percha Works	10	[illegible]
—— 4½ per cent. Debentures	100	[illegible]
Kensington and Knightsbridge Ordinary	5	[illegible]
—— 6 per cent. Pref.	5	[illegible]
London Electric Supply, Ordinary	5	[illegible]
Metropolitan Electric Supply, Limited, Ord. No. 101-50,000	10	[illegible]
—— " " " 50,001-82,300	10	[illegible]
—— 4½ per cent. First Mortgage Debenture Stock	100	[illegible]
National Telephone, Ordinary	5	[illegible]
—— 6 per cent. Cum. First Pref.	10	[illegible]
—— 6 per cent. Cum. Second Pref.	10	[illegible]
—— 5 per cent. Non. Cum. Third Pref., No. 1-119,234	5	[illegible]
—— " " " 119,235-250,000	5	[illegible]
—— 3½ per cent. Deb. Stock, Red.	100	[illegible]
Notting Hill Company	10	[illegible]
Oriental, Limited, £1 shares	1	[illegible]
—— £5 Shares	5	[illegible]
—— £4½ shares	4½	[illegible]
Oriental Telephone and Electric Company	1	[illegible]
Royal Electrical Company of Montreal	—	[illegible]
—— 4½ per cent. First Shares Mortgage Debentures	100	[illegible]
South London Electric Supply, Ordinary	3	[illegible]
St. James's and Pall Mall, Limited, Ordinary	5	[illegible]
—— 7 per cent. Pref.	5	[illegible]
—— 4 per cent. Deb. Stock, Red.	100	[illegible]
Telegraph Construction and Maintenance	12	[illegible]
—— 5 per cent. Bonds	100	[illegible]
Waterloo and City Railway, Ordinary	100	[illegible]
Westminster Electric Supply, Ordinary	5	[illegible]
Yorkshire House-to-House	5	[illegible]

NOTES.

ic Lighting in Japan.—Of the 42 largest Japan, from Tokio, with 1,368,000 population, those of 26,000, electric lighting systems are 1 24, 18 being without electric lights.

al Society.—At the meeting of this society on Mr. Shelford Bidwell, president, in the chair, a read by Prof. J. D. Everett on "Dynamical s of Certain Optical Phenomena," and by Prof. eldt on "The Properties of Liquid Mixtures."

-to-the-City.—The proposed City and Brixton way is estimated to cost £818,000 altogether. ill be 3½ miles long. The capital will be fixed 00, with powers to raise £400,000 of debentures. in Baker, without whom no electric railway is rill be the engineer.

and Flour Adulteration. — Messrs. A. d Labesse state, in *La Nature*, that they have detect the presence of 3 per cent of foreign tter in flour by using the X-rays. The approxi- ration to a greater extent than the above can rmined with fair accuracy.

Ends.—At last, says *Cassier's Magazine*, a use and for the unburnt ends of carbon taken from lamps. We perused the following paragraphs l were somewhat disappointed to find that the burn the carbon tips in a fire. With this on, we are told, a charcoal fire of great heat is obtained.

der-running Trolley Case.—In the recent ween the Thomson-Houston Electric Company Railway Company and Walker Company, it mbered a preliminary injunction was granted. tion of the solicitors for the defendants, the has been stayed for 30 days from February n appeal may be brought before the Circuit

Railway Journal."—The March number of contains a somewhat novel feature in technical —that is, a digest of the contents of the issue , French, and Spanish respectively. These ll be useful to foreign engineers uncertain of h, and will enable them to gather the gist of before taking up the translation of any

s and Kites.—The president of the Inter- mmission for the Exploration of the High has issued a circular announcing that a con- be held at Strassburg on March 28 to discuss lready obtained by the ascent of free balloons, rmine the measures to be taken to collect regis- vations. The kite-balloons used in Germany merican meteorological kites will also form discussion.

ert Medal.—The council of the Society of their members to forward to the secretary, on pril 18, the names of such men of high distinc- y may think worthy of being awarded the al for 1898. The medal was struck to reward d merit for promoting arts, manufactures, or Its past recipients include such well-known of. D. E. Hughes, F.R.S., Sir J. Lowthian Bell, H. L. Helmholtz, Sir Frederick Abel, Lord J. P. Joule, and Thomas Alva Edison. We the members may be unanimous in their

Honour to M. Z. Gramme.—The banquet in honour of M. Gramme, the father of the modern dynamo, is to be held in Brussels on Sunday, 27th inst., when a testimonial will be presented to him. The banquet is also to commemorate the fact that M. Gramme has been made a Commandeur de l'Ordre de Léopold. As announced in our report of the proceedings at the last meeting of the Institution of Electrical Engineers, subscriptions are invited from English electricians. Commemorative medals are to be struck, and one will be awarded to each contributor. The medal will vary with the amount of the subscription.

Terrestrial Magnetism.—Observations have, says our contemporary, the *Scientific American*, been made recently to determine the extent and cause of the extraordinary deflection of the magnetic needle which takes place over a vast tract of Central Russia. The line selected for observation was one of about 850 miles between Moscow and Kharkov. The widest aberrations are found to exist in the province of Kursk, the capital of which is about 600 miles south of Moscow. In the south-east portion of this province, about 150 miles south of Tim, the needle is deflected more than 96deg., and points almost due east and west instead of north and south.

Book in the Press.—We are told that the "Electric Wiring and Fitting Details Book," by W. Perren Maycock, M.I.E.E., will be published by Messrs. Whittaker and Co. next month. The book is intended to afford an expeditious, convenient, and methodical means for noting down all details concerning the wiring and fittings for any building, large or small. It consists of a number of blank forms, ruled and headed in a special manner, which has been carefully thought out and tested in practical work; provision being made for inserting every particular concerning any proposed or projected installation on any system of wiring. The forms are perforated at the binding so as to be detachable.

The Pacific Cable.—The feeling in the Colonies in favour of the laying of this cable appears to be steadily increasing. Thus we gather that a conference of the different Australasian premiers was held on the 11th inst. in Melbourne to consider the question. They agreed that if England and Canada will guarantee two-thirds of the cost, Australia will provide the balance. A resolution to this effect was passed, but we suppose it will have to be confirmed by the individual colonies. At Ottawa on the same day the committee of the British Empire League discussed the Pacific cable question with the Premier. A proposal was made for the creation of a trust under the authority of the several Governments concerned, with power to raise funds to establish and operate the line.

Institution of Junior Engineers.—On Saturday last the Institute of Junior Engineers held a conversazione at the Westminster Palace Hotel. The guests were received by the president and Mrs. Aspinall, and by the chairman and Mrs. Vorley. There was a large number of visitors. There was a large and interesting display of models, including one of an old railway carriage, and many scientific instruments. The cinematograph was exhibited. Demonstrations of signalling without wires were given by Mr. Leslie Miller, and 16 instruments, connected with various places of entertainment, were available in the electrophone room. In the large hall Mr. W. M. Day's band played a selection of airs during the evening, and Mr. T. E. Gatehouse performed a violin solo.

Philosophical Society of Glasgow.—Mr. William Arnot, formerly electrical engineer to the Corporation of Glasgow, recently read a paper on the distribution of electricity in the house before the architectural section of this

society. He said that no one yet knew what electricity really was, but that it could be measured as accurately as any matter by its effects. He detailed the different fittings in a house and the different systems of wiring. He expressed the opinion that switches should not be spared, as they tended to reduce the annual bill for current. Fuses should only be placed in suitable boxes, and not scattered over the house in inaccessible places, even though the resultant cost was a trifle more. He thought more taste could be expended on fittings—not so much brass and more light—and that the positions of the lights should tend to decorate a room rather than burden it.

Side or End Doors.—The relative advantages of side doors or end doors on railway carriages where rapid transit is required is largely a matter of the most rapid loading and unloading of passengers. We regret to see that two reputable American journals are fighting tooth and nail over this subject. The *Scientific American* has upheld our system of side doors, and claimed that the trains on the Underground stop less time at the stations than do the trains on the New York Elevated, where end doors are used. This is considered to be rank heresy by the *Railroad Gazette*. The editor of this journal considers that 30 persons can pass through one door quicker than 30 persons through, say, four doors. We should not care to be going for the one door if the rush were on at Farringdon-street Station about 6 p.m., and are sure that, apart from the personal error introduced by the nationality of the travellers, the side doors are easier of access to a crowd.

A 108-Mile Transmission.—The 108-mile electric transmission plant is again under consideration in Southern California. The undertaking involves the erection of a dam across the Kern River, in Kern County, Cal., and the construction of a line to convey the high-tension current to Los Angeles. The Kern River drains an area of some 2,345 square miles, and a total of about 12,000 h.p. can be obtained. A pressure of 30,000 volts is proposed for transmission. While this is exceptionally high, the dry atmosphere and infrequent rainfalls warrant its adoption. The dam will form a storage reservoir, with a volume of about 13,721,400,000 gallons. Should the project be carried out, says our New York namesake, it would be by far the longest electric power transmission line in the world. In all such schemes the actual length is not so much commendable as the fact that the concern will pay. Thus the historical Lauffen-Frankfort line, which was practically the father of all subsequent transmission lines, conveyed power for over 100 miles, but the quantity of power available did not warrant the plant being used after the exhibition was closed.

Electro-Harmonic Society. — At the smoking concert on Friday evening next, March 25, the following will be the programme. Part I.: overture, "Souveraine" (Herman), the orchestra; song, "Friend of the Brave" (Dr. Callcott), Mr. Robert Hilton; humorous song, Mr. W. Carlton Smith; pianoforte solo, "Impromptu C sharp Minor" (Chopin), Mr. Alfred E. Izard; song, "The Eternal Spring" (Löhr), Mr. James Gawthrop; idyl, "Evening Breeze" (Langey), (by desire) the orchestra; humorous recitation, "The Perils of Invisibility" (Gilbert), Mr. W. G. Churcher; trio in G, "Poco Adagio," "Cantabile," and "Rondo all' Ongarese" (from trio No. 1) (Haydn), Messrs. T. E. Gatehouse, George and Harold Pywell. Part II.: graceful dance, "Incidental Music to Henry VIII." (Sir A. Sullivan); new song, "Drake's Drum" (W. Hedgecock), Mr. Robert Hilton; humorous song, Mr. W. Carlton Smith; violin solo, "Aria and Gavotte" (from suite) (Vieuxtemps), Mr. T. E. Gatehouse; song, "Jeannette" (Leipold), Mr. James Gawthrop: quartet, "Scherzo," "Adagio," "Allegro" (from Op. 125, No. 1) (Schubert), Messrs. Gatebo[use] Pywell, S. Venables, and G. Pywell; humorous rec[itation] "Madame Eve" (Anon), Mr. W. G. Churcher; "Festal" (Sir George Elvey), the orchestra.

Lectures on Electric Tramways.—The inh[abitants] of Dundee are apparently qualifying themselves as in electric traction. A few weeks ago we noticed a delivered to them on the subject by Mr. A. G. S and now this last week Mr. George Balfour lect the Gilfillan Hall on the electric tramways and r The lecturer made the usual review of the history subject. He spoke with no uncertain voice as Thus: "To begin with, this country took the lead enterprise, but for 14 years practically nothing ha done in Britain to keep abreast of the times Americans had taken advantage of British ideas, a thoroughly developed them. They were now sel engineers in this country materials for tramway wo he considered it nothing short of a disgrace to Britis that they should have allowed themselves to be outstripped in this respect." Finally, after de different systems of traction, Mr. Balfour stated the case of Dundee he advocated an overhead trolley for all but the streets in the very centre of the city, a conduit should be laid. The change of connectio conduit to trolley could be easily effected, and this had already been adopted in various places.

Waste in Power Stations.—There is no doubt many of the small auxiliary engines in central stati most wasteful of steam. The *Engineer* of New mentions a notable example of this, "where a powe consuming over 60,000 tons of coal per year rearranged that by dispensing with some of the ' eating' auxiliaries, improving the action of others, u exhaust steam, etc., more than one-half of the fu saved, even with a greater output of work." It i probable, however, that steam auxiliaries may befor be the exception rather than the rule in all power and, indeed, in many other places, and be supersed electric motors deriving their energy either from th engines or at least from engines of satisfactory ec This solution of the problem is quite in keeping wi present tendency toward the introduction of electric in workshops, and the conditions in both cases a dissimilar. Frequently "group driving" may be u advantage, and the favour with which this arrangem meeting in shop work should cause it to be give sideration in other places. In any case it will be that a careful consideration of the subject will sh best arrangement to be adopted for that particular in

Para and Amazonian Rubber.—A report fr Majesty's Consul at Para states that the total amo Amazonian rubber exported from Para, Manaos, I and Peru during the twelve months ended June 30, was 22,216 tons, of which 12,368 tons were s Europe, and 9,848 to the United States. The Ama crop during the same period amounted to 22,315 t which 9,100 tons belonged to the State of Para. value of the rubber exports from Para during th 1896-97 was £1,977,596, and the duties collected value amounted to £415,295. Rubber of the best is produced throughout the continent watered b Amazon between Para and the Andes mountains of and the majority of authorities on the subject are of o that there is absolutely no fear of the exhaustion supply of rubber in the Amazonian states. Distanc rapids are not insurmountable obstacles, for in some this produce is transported as much as 6,000 miles it reaches Para; and, when rapids impede the way,

heir cargoes are hoisted out of the water and rolled the banks, sometimes for several miles, until ible water is reached. This causes much delay, and xpense, but it is found in the end that distance and ged transportation have improved the rubber, so hen it arrives at its destination it sells for higher than that collected near the mouth of the river.

erprise in Tramway Promotion.—The London Tramway Company are sparing no effort in their our to introduce electric traction in the West of L. Mr. J. Clifton Robinson has this matter largely d, and we fancy we can recognised his handiwork *Chiswick Electric Tramway News* now being issued . The price charged for this populariser of electric i is one penny, and the number for March 12 is adable. The leader gives advice to the Chiswick re the opposition offered by it to the company's w before Parliament. This advice concludes as : "Electric traction for the tramways means in great benefit to Chiswick; and in addition the y offers many extra advantages—such as cheap and d workmen's cars, cheaper fares all round, and rapid to an important circle of towns. The company will, give freely much more than the Council could screw it by ligitation, and in return for all these benefits nothing more than the right to improve its traffic in every possible way. Why should the Council ? To fight in Parliament will mean huge expendi- the Chiswick ratepayers and a certain victory to pany. After the battle the victors will not be in a to make many gifts to the vanquished, even if re in the mind." We shall have the tramway y claiming for a technical education grant from the County Council if their present policy goes on.

phone Reformers.—The Corporation of the London are still moving in telephonic matters in the failure of their recent legal attempt to prevent ound wires being used without a reduction in the charges for telephones. Their next move was to Treasury to grant an enquiry which drew forth owing chilly reply from Mr. Hanbury, for which indebted to the *Daily Mail*: "It is assumed that, g for the institution of an enquiry as to the cost iency of the telephone service in London, the ioners of Sewers refer to the City of London, ey represent. It appears evident, however, that ice in the City of London cannot properly be as unconnected with the rest of the service in the metropolitan area, and the suggested enquiry erefore serve no useful purpose." Sir John then explained that "it was not for a moment ated that the enquiry asked for by the late ion of Sewers should be confined to the City of . What is desired (as stated in the application), uiry into 'the cost and efficiency of the telephone in London, and all matters relating thereto,'" and that he should feel obliged by the Treasury ing the matter from this point of view. To this bury replied, through one of the officials, that he the Treasury could not accept the authorities of s speaking for the whole of the London area. invitation of the City Corporation to the various and local boards throughout the Metropolis to meet s an opinion.

the Incandescent Lamp.—Light without much desired end yet to be attained by the engineer. At present all our sources of act us more as heat radiators than as light The most efficient source of light in this respect is the one using the highest temperature, as the percentage of light rays increases with the tempera- ture. Thus, the arc lamp takes the palm as the most efficient source of light, and next to it comes the incandescent lamp. In this latter case the heat given off is not inappreciable, and the *Lancet* sends a note of warning against such lamps as a probable source of fire. We are told that by burning a lamp in cotton wool, the heat is sufficient to cause the wool to begin to scorch and ultimately to burst into flame. In one experiment the bursting into flame of the wool was accompanied by a loud report, due to the implosion of the lamp. In other words, as you stop the radiated heat the temperature will rise. So shopkeepers are warned that the lamps are dangerous when placed near inflammable material. As a rule, however, shopkeepers use such lamps for illuminating purposes, and not to modestly "hide under a bushel," as described by the *Lancet*. As long as this smoothing up of the lamp which renders it useless as a source of light is not carried to excess, the lamp is never dangerous. We know of only one case where such ignition was obtained, and that was at a theatre where, rather than go to the switch to turn off a lamp, the gasman wrapped it up in an oily cloth. The leader of the *Lancet* reminds us of an article by Barry Paine in *To-Day*, in which he calls attention to the danger of placing one's head in a gas flame at any period of one's life, unless totally bald.

A Daily Paper Run by a Corporation.—The *Glasgow Daily and Weekly Mail* is congratulating itself that it is run by the Corporation, but we doubt if the profits from the running go to the Corporation or ratepayers. In fact, the running referred to is the driving of the printing machinery by electricity supplied from the Corporation mains. In the words of the above paper, "The Corpora- tion has agreed that a special rate be made for electricity supplied for motor purposes between the hours of 9 p.m. and 6 a.m. The Glasgow Corporation, therefore, has added to its claims as the leading Corporation of the Empire. It not only runs the water and gas supply of the city, its hydraulic and electric installations, and its tramways, but will shortly be the only corporation in the world that runs a daily newspaper by motors driven from its electric mains." The fitting-up of the motors and other electric plant, as well as the work of making the necessary connections with the Corporation mains, is under the special supervision of Mr. Wm. Arnot. This is a good lift up for the leading Corporation of the Empire, but we note that the Hon. John Boyd Thatcher, mayor of Albany, New York, accuses Glasgow of going too far in municipalising, and their great sin is in providing cheap lodging for bachelors. He says he considers that these cheap, comfortable, convenient rooms are keeping men in an unmarried, and therefore in an unnatural, state, and, further, that where thousands of men are maintained happily on 7½d. or 10d. per day—including lodging and breakfast and supper—one of two things must come to pass: either this vast army of bachelor labourers will compete with and drive out of the labour market another vast army of married labourers who enjoy none of these cheap comforts, or else this vast army of bachelor labourers will work but one day in the week at the sustained and regular rate of pay, thus earning enough to keep themselves in idleness and at possible mischief the remaining six days.

A Big Brake Trial.—The *Journal of Electricity* gives details of a futile attempt of a Prony brake test in the power-house of the Power Development Company of Bakersfield, Cal. It was deemed advisable to measure the output of the turbines direct without reference to the generator with

which they were direct connected, and although it was not believed that it would be possible to absorb 750 h.p. by a Prony brake under the conditions which existed, it was thought best to try. The wheel upon which the brake was applied was the Girard governor wheel. It is 6ft. in diameter, having a 10in. face, and ran at 257 revolutions per minute. The brake was constructed of wood baulks clamped together against the rim of the wheel. The lower horizontal arm was something over 13ft. in length from the centre of the shaft to the centre, where the weight was applied. No water could be used for cooling purposes on account of the surroundings, hence the heating effect was excessive. The experiment proved a failure from this cause, which lead to the burning of the wooden shoes While this result was foreseen as probable, as stated, it was hoped that the heat generated in the small time required for a trial would not be of too great an intensity to render the apparatus inoperative. So much time was, however, required to handle the brake in adjusting the waterwheel to the proper load and speed, that sufficient heat was generated to char the brake shoes to such an extent as to render them totally unfit for service. The spectacular effects of the experiment were startling, for with the scream of the brake, the spitting of fire, and the vicious smoking of the timbers, the scene was one to be remembered. Had water been available, or rather had it been possible to have applied water to carry off the heat generated, it is thought that no trouble would have occurred, as a similar brake has since been used at the same place with water applied, and good results obtained. In this latter experiment 125 h.p. was absorbed from a pulley having a diameter of 18in. with a 12in. face.

"**L'Etincelle Electrique.**"—This sparkling little journal publishes an article on the underground electric railways of London, by Jules Buse fils. The author of this article speaks most highly of our underground railway communications, and, above all, of the work done by the late Mr. Greathead. The name, however, causes trouble as to whether the final "e" or "a" should have precedence. Thus the author says it is difficult to give even an approximate idea of the enormous amount of work carried out by "Mr. Greathaed" in his too short life. The spelling gets worse later on, when we learn that the boilers for the Central London line will be provided by "Babeock & Wilcocae." Then we are told that "it is remarked that in the underground electric railways in London neither the electric plant nor rolling-stock bear the mark, 'Made in England.' If you ask the reason of the English they will tell you," says the author, "that the cause of this check, which is not flattering to their immeasurable pride, that the English manufacturers have not the facilities to enable them to deliver the material in the short time allowed." The author even thinks this reply too light for our enormous self-satisfaction, and incline to believe Mr. Rathenau, of the Allgemeine Elektricitäts-Gesellschaft, when he states that "There is besides England one country which knows nothing about electricity; this is France. Meanwhile all the best inventions in electricity come from France." It seems that Mr. Rathenau made this conclusive speech to Mr. Charles Bos, who was acting on behalf of the Paris Council, and as we know the first-named gentleman to be a thorough commercial man, we quite understand the context. Still, the terrible blot remains that Messrs. Mather and Platt and Messrs. Siemens Bros. have not stamped the machinery installed by them in the pioneer electric underground railways as "Made in England." Mr. Jules Buse has thus been deceived, as he is sure the "Made in Germany" stamp is enforced by our Government *in order that we may know that* the article is the best obtainable. We would advise the gentlemen in questi to correct his information even at a further damage to h spelling.

Liquid Air.—Prof. J. A. Ewing's recent lecture befo the Society of Arts on Linde's method of producin extreme cold and liquefying air is most interesting readin The apparatus required is fully described, but the oth information given opens up new ground. Thus Dr. Lind finds that on allowing liquid air to evaporate, the nitroge goes off much more rapidly than the oxygen. Thus, aft all but 20 per cent of the liquid has been evaporated, th proportion of oxygen in the residue is as high as 60 p cent., and eventually nearly pure oxygen is left. Th most interesting application of the liquid which h hitherto been tried on a commercial scale is to make explosive by mixing it with carbon. When liquid a enriched by the evaporation of a large part of its nitroge is mixed with powdered charcoal, it forms an explosiv comparable in power to dynamite, and which, like dynami can be made to go off violently by using a detonator. T make the explosive, Dr. Linde pours the liquid, containin about 40 or 50 per cent. of oxygen, on fragments o wood charcoal, two to four cubic millimetres in siz These are kept from scattering under the ebullition of th liquid by mixing them into a sort of sponge with abo one-third of their weight of cotton-wool. The liquid whic remains is, of course, richer in oxygen than that which originally applied, and when the mixture is allowed t stand for long all the liquid evaporates and the explosiv power disappears. The cotton wadding impregnated wi coarse charcoal powder can take up more than enoug of the liquid to supply oxygen for its complete combustio and when put quickly into thick insulating cases, made o paper, it retains its full explosive power for five or te minutes. After an interval which ranges from 15 t 30 minutes, according to the size of the cartridge, explosive power is lost. This is a decided advantage f some purposes. The process has been tried commerciall in some coal mines in Germany, and found to be sati factory. The temperature produced by the explosive lower than that required to ignite firedamp.

Galvanease.—We have obtained a pamphlet on th "'Galvanease' genuine electric boots and shoes" now bein pushed extensively in London. The logic in this lit book is worthy of notice, perhaps more so than the boot which aim at the prevention of tired and tender feet. Th we learn that "motion is philosophically regarded as th first attribute of life. An electric current is electricity motion, and it is an established fact that continuou currents of electricity actuate the circulation of blood, a are, indeed, the very propelling power which stimulates in its onward course: therefore 'the blood is the life,' b 'electricity is the life of the blood." Coming down the feet, we learn that "the sole of the foot is one the most delicate parts of the human system, owing to t quantity of sensitive nerves with which it is supplie therefore, as the electric apparatus acts directly on the nerves, it cannot fail to have a comforting and benefic effect. Undoubtedly voltaic electricity is the best mea of exercising electric influence on the human syst shocks being felt. The reparative action of 'conti current' produces effects analogous to those of the n currents in the body whilst the latter is in a state o whereas the effects of the intermittent current (a on the system is analogous to those produced ' discharges of animal electricity, owing to m exertion, and thus tends to exhaustion of vital Coming to the construction of the boot, we find th of the Pulvermacher Company's "chain band" batt

is inserted in the felt inner sole. The cells consist of equal lengths of zinc and gilt copper wire wound on a flexible flat band and separated from each other by an insulated thread. The moisture from the feet does the rest, and the mild invigorating currents for which the Harness electropathic belts were noted are produced. The mechanical construction of this chain is not illustrated, but, like the Harness belt cells, if a current is produced and applied continuously, sores are also produced, which are not wanted on the soles of the feet. No connection between zinc and copper and good faith on the part of the wearer are the great desiderata to make these boots both harmless and useful, but the faith might be exercised on a pair of ordinary boots and the saving in first cost devoted to charity.

Independent Telephone Exchanges.—The great demand now growing in this country for cheaper rates for telephones, and for exchanges to be established on the co-operative principle, gives interest to the speculation as to whether the competition so obtained will be an ultimate boon. With more subscribers due to cheaper rates and equal trunk-wire facilities, it would appear that much good would result, but it is hardly likely that the National Telephone Company would allow their lines to be used for distributing trunk messages. In that case mutual co-operation between the independent exchanges would be necessary to make this opposition at all powerful. It is interesting in this respect to see what has been done in the States. From the technical Press it is difficult to gauge the true state of affairs. Certain journals, starting as advocates of the independent exchanges, have veered round, and now damn them as being merely company-promoting schemes. Still, the Bell Company is rich, and may have called the tune in these instances. At any rate, we are glad to see the *Western Electrician* take up the independent exchanges. In their leader of the current number the editor states that: "The magnitude and vitality the independent telephone movement in America to-day surpasses the fondest hopes of its most earnest advocates. It has spread with wonderful rapidity, especially in the enterprising western cities and villages, which have been entirely neglected previous to the advent of the opposition companies or subjected to the ordeal of higher prices and less modern service than now prevail. Those who enjoy the superior advantages of modern equipments for large cities cannot fully appreciate the gladness with which the residents of smaller towns greeted the advent of an opposition company offering a service correspondingly as good; but it is only necessary to understand the condition of the country generally in the way of telephone service at the inception of the independent movement to realise the extent of the field that was opened up by the expiration of the fundamental Bell patent. The field has been assiduously cultivated ever since, many of those engaging in the independent movement having had their experience with the old concern, and being thoroughly alive to the opportunity and demand awaiting them. Naturally, they have profited by the mistakes of their old masters; they are cultivating public favour, and the popularity of their course is everywhere indisputably proved. It may surprise some who have not followed the matter closely to learn that already an intercommunicating system has been established between the cities and villages of many localities, and that the idea is likely to be developed further. When it is considered that there are in round numbers in the neighbourhood of 2,500 independent exchanges in operation in the United States to-day, the possibilities of such a system will be better understood. The outlook is certainly promising, and judging from the success already established by those identified with the opposition interests, there is every reason to anticipate a splendid future for the independent telephone movement." We only trust that the opposition movement will not degenerate into an amalgamation in favour of all but the shareholders, as has been the case in cable work.

Electric Power from Central Stations.—Mr. G. L. Addenbrooke read a long paper on the above subject before the South Staffordshire Institute of Iron and Steel Works Managers at Dudley on the 5th of this month. As Mr. Addenbrooke is engineer to the Midland Electric Corporation, which is trying to get parliamentary powers to establish works and distribute power in the Midlands, his paper amounts largely to a general explanation of the proposed schemes of this company. The author commenced by referring to the great success of distribution of power derived from waterfalls abroad, and then compares the alternative caused by substituting coal for water as the source of power. Thus: "In both cases the motors will be the same; the cables and wires will also be similar, except that on the average there will be some advantage in favour of the coal-derived power, because large waterfalls are often not very accessible, and the power may have to be transmitted a long way to the point where it can be utilised. Further, the dynamos, switching arrangements, and the building containing them will differ very little. If we put the cost of the turbines, turbine pits, sluice gates, and general arrangements against the cost of steam-engines of similar power, we shall not probably be very far out. We have then the cost of the boiler plant, with condensers and economisers, against the cost of any canals, tunnels, embankments, weir, or dams needed for the utilisation of the water power. Now, the whole boiler plant as above could be erected for £4 per horse-power." And the author estimates that the average first cost of the water-power plant would be more. Coming to the question of annual cost of working, Mr. Addenbrooke says: "It is clear that the difference in annual cost between water or steam power, supplied on a large scale for general purposes, is practically the cost of coal and stoking or handling it, and the whole of this difference can only be debited against the coal power on the assumption that no rent is paid for the water power, nor any inordinate sums for its conservation and utilisation." Then to arrive at the annual cost per indicated horse-power with coal, the author assumes the following: good steam coal at 5s. per ton, 2¼lb. of coal per average indicated horse-power hour, 8,000 hours' full load run per annum. With these figures, which are extreme ones as far at least as hours run is concerned, he arrives at £2 per annum per indicated horse-power. Other charges, such as stoking and boiler repairs, bring this cost of steam up to £2. 10s. Then it is argued that for a less use per annum the cost goes down, for says the author: "If the power is supplied to works operating only 54 hours per week little more than one-third of the coal and stokers' wages will be needed, all the other items remaining the same in both cases, or being similarly reduced. This is what does not happen. The cost of wages per indicated horse-power hour, which was the author's original basis, goes up with the decrease. The cost of coal also goes up if the engines are not fully loaded, and, above all, the capital charges increase exactly in the inverse ratio of the decreased hours of use. The real problem the author only refers to, again to pass over without solution. We mean the capability of such a central station to compete with large isolated plants when coal is cheap. This is the crux of the whole matter, and in nearly all cases the success of the water-power distribution plant has been due to the high price of coal in the district round.

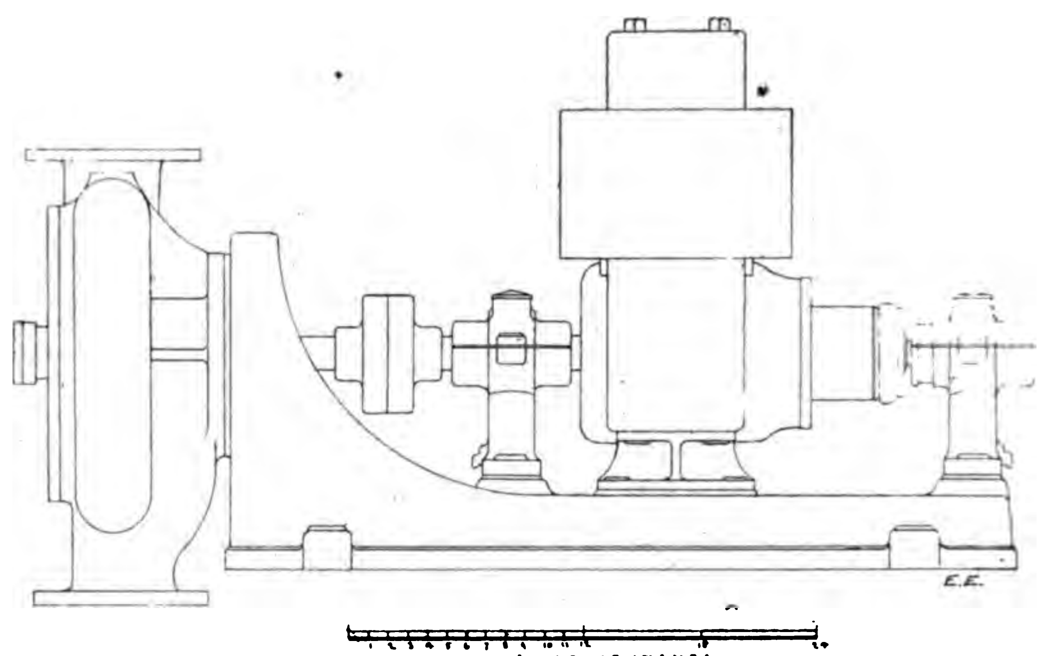
THE GLASGOW DISTRICT SUBWAY.

(Concluded from page 295.)

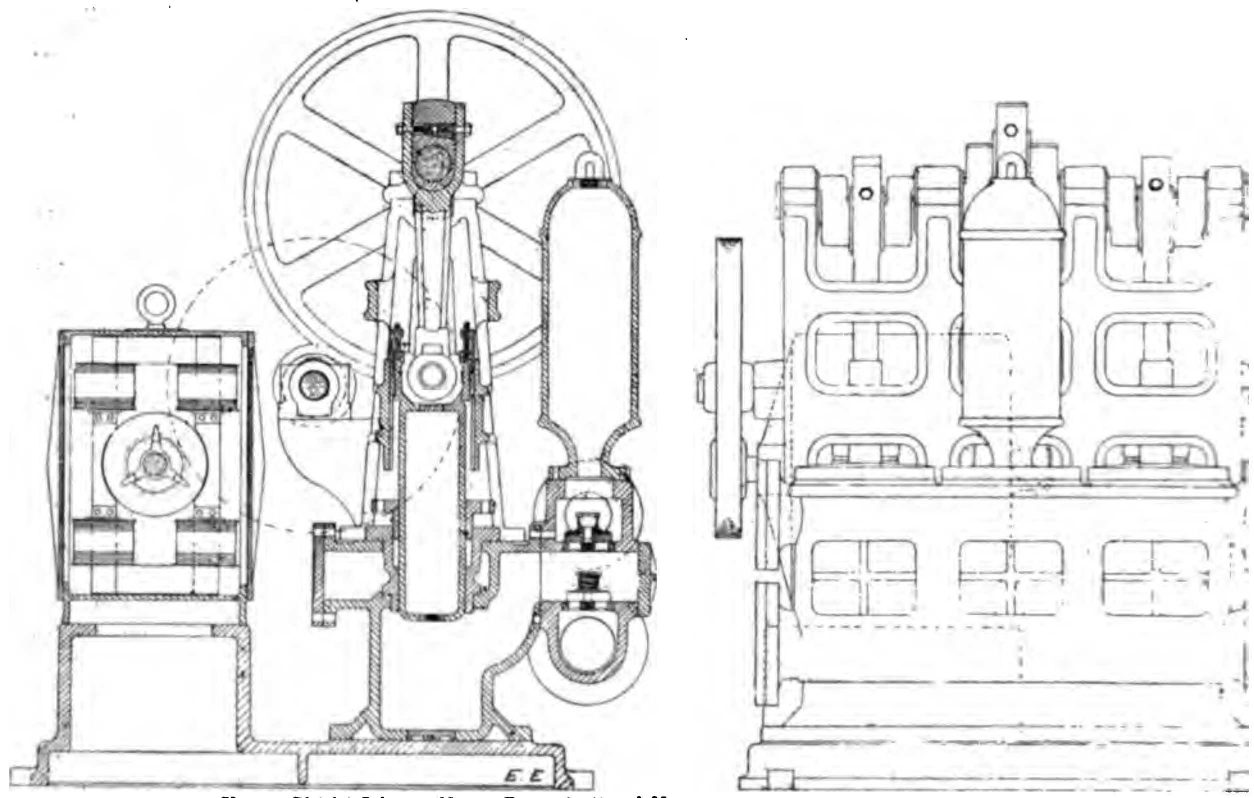
The Pumps and Lifts.

It is evident in such an undertaking as this that the pumping arrangements are of paramount importance. The general formation of the line is such that the whole of the upper portion of the line—that is to say, the portion from St. Enoch's Station round *viâ* St. George's Cross to Partick—is self-draining, and whatever water there is in the tunnels in these portions drains down to sumps at St. Enoch's and Merkland-street Stations.

The most important pumping plant is placed at St. Enoch's Station, and it consists of two Silvertown open-type motors direct coupled to centrifugal pumps, as shown in the diagram. Each pump is capable of delivering 220 gallons of water per minute against a head of 30ft., and when running at 1,200 revolutions per minute. At this station there is also arranged an Otto gas-engine, which, in the event of an entire breakdown of the electrical plant, could be belted on to the pumps and so keep the tu from getting flooded. Two similar centrifugal pump motors are fitted at Govan Station, and similar but s plants were supplied for the power station, West- (two), Kinning Park, and Merkland-street. At Go pump was required to be placed under the Clyde to the tunnels clear in the dip there, and owing t distance a centrifugal pump was not suitable. A throw ram type of pump was therefore adopte coupled to a Silvertown enclosed type of motor. Th ditions of work are extremely severe in this instan the pump cannot be approached at all during the that the cars are running. This pump is shown i accompanying diagram. It might be mentioned further use for electric motors is in the power s where a small workshop is being fitted up, and th are all being driven by this means. Recently four f sets of electrically-driven pumps have been ordered Messrs. Ernest Scott and Mountain, of Newcastle-on- and it is proposed to fit these further pumps at G

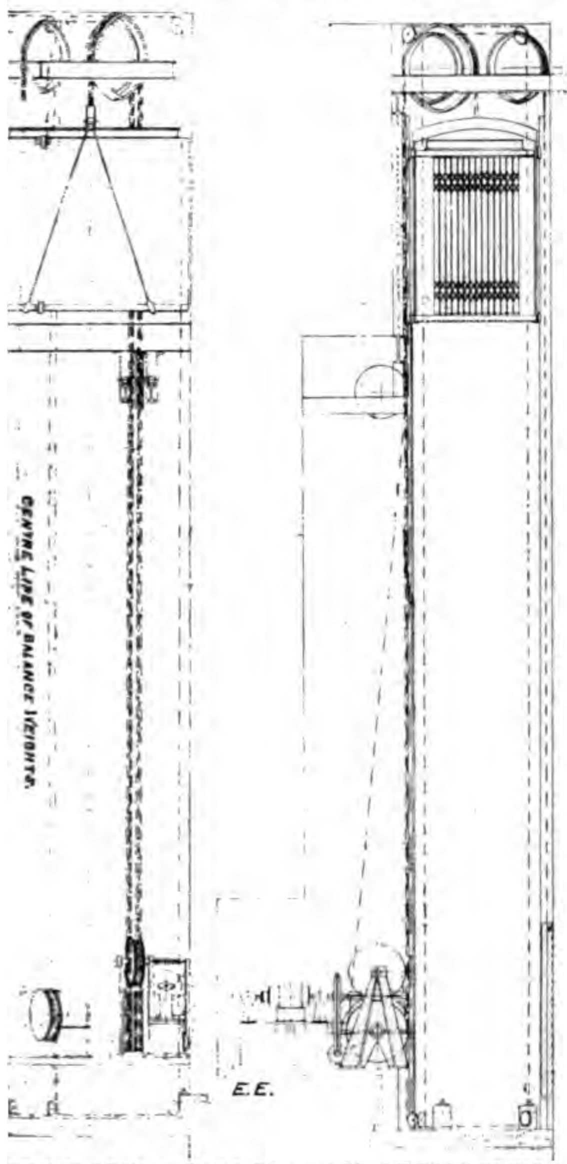


Glasgow District Subway—4½-h.p. Motor and Centrifugal Pump.



Glasgow District Subway—Messrs. Ernest Scott and Mountain's Three-Throw Pump and Enclosed Motor.

s-road, Copeland-road, and Merkland-street Stations. ɪumps are of the vertical three-throw type, with on rams 5½in. diameter by 6in. stroke. The rams in slipper guides, and are driven from a crankshaft ɪ three-throw type, the shaft running in adjustable ɪgs; the pump valves and seats are of gunmetal, ɪe valve boxes are fitted with valve covers in a very ible position, so that the valves can be readily got at amination. The pumps are driven through machine-rorm gearing by an electric motor of two effective power, the motor being of Messrs. Scott and Moun-improved enclosed type, the armature of the Gramme The coils are wound in slots, ensuring a positive and also preventing the motor running away. The ɪtators are of copper mounted upon a gunmetal ɪ and insulated with mica. The motor casings are of



...gow District Subway.--Electric Passenger Lift at Kelvinbridge Station.

iron, and fitted with large hinged doors, one on each ɪ enabling the motor to be readily examined by opening doors. In addition, however, sight holes are fitted in door, so that the brushes can be examined whilst the r is running. The brushes are of the carbon block in special holders. Special lubricators are fitted to motors to provide for continuous running, and the n on the end of the motor shaft is of raw hide to noiseless working. The motors are stopped and y liquid starting switches, each switch being pro-h screw and hand wheel.

been already mentioned, arrangements were made tion of electric lifts at Buchanan-street Station, 's Cross Station, and Kelvinbridge Station, and able run round from the power station for this However, up to the present, only the lift at the ed station, Kelvinbridge, has been fitted, and the contract for this was placed in the hands of Messrs. Easton, Anderson, and Goolden, of Erith Ironworks, Kent, and the general arrangement is shown in the diagram. The ropes, of which there are four in number, each equal to taking the full load, are taken from the cage over a rope sheave fixed above, down the side of the lift well to the driving gear as shown, up and over rope sheaves fixed at the top to a cast-iron balance weight, balancing the weight of the cage and half the load, in accordance with this firm's patented arrangement. Safety gear is provided on the cage, which will prevent the latter from falling if any one of the ropes break or become unduly stretched. The cage is guided by palms running on round iron guide rails. The switch is actuated by a hand rope passing through the lift cage, and automatic stops are provided for preventing the cage from over-running, also an emergency switch worked by the cage, should the latter overrun in consequence of the hand rope breaking. A magnetic brake is provided, so arranged that when the current is on the brake is released, but immediately the current is cut off the brake is put on. The motor is of Messrs. Easton, Anderson, and Goolden's F/D type, starting compound, and is fitted with carbon brushes and self-oiling lubricators. As will be seen on reference to the diagram, the driving gear is self contained, and occupies a very small space; it is situated on a dug-out recess at the bottom of the lift shaft, and a good deal of trouble has been experienced owing to the amount of moisture there is down here. Owing to the method of balancing employed, it will be seen that when half the maximum load is being raised, all the current required is only that necessary to overcome the friction of the working parts.

The Signals and Signalling Arrangements.

The question of signals required very careful consideration by those in charge of the equipment of the line. One point that has been aimed at throughout the equipment is the means by which the labour bill should be reduced to the lowest possible point, and it is easily seen that if a signalman at each station could be avoided a large saving is at once manifest. It was therefore decided to make the whole of the signalling arrangements semi-automatic, and as simple as possible, consistent with the safe working of the traffic. The line is worked on the absolute block system, but without signalmen, the stationmasters at their respective stations doing the requisite manipulations.

The line is divided into 15 sections, from station to station; thus it will be seen that the number of trains on each circle is limited to 15, but as this number could give about a two minutes' service, the promoters considered that this would meet all possible demands, especially as the power of augmenting the size of each train was still left. The equipment at each station consists of two semaphore starting signals, one for each circle, fixed at the entrances to their respective tunnels at the ends of the platforms. In connection with these are the automatic arrangements to be subsequently described. Red and green lamps are also provided for use at night and in some of the dark stations; these lamps are fitted with double filament electric lights in place of the more ordinary oil lamps. These signals are lowered from the centre of the station, where are also fitted, in glazed damp-proof cases carried on a couple of light iron girders, telegraphic block instruments, consisting of small semaphore arms, and an alarm bell, worked electrically by the passage of the train. About the train's length in front of the station are fitted two electric slots or controllers, worked by the passing of the trains, one operating the locking arrangement of the signal at the station just left and the other releasing that of the signal at the previous station.

The method of working is as follows: All being clear for a train to start, the previous train having left the station in advance, the block instrument stands at "Line clear," the controller is set, and the starting signals can be lowered. As soon as the train has passed its own length in advance of the starting signal, it passes over the electric contact maker or treadle, which puts the block instrument to "Line blocked," and the semaphore signal to "Danger," in which condition it must remain until again released. When the train has passed by its own length the next

station in advance, it acts upon another treadle, which puts the block instrument at "Line clear" in the station behind, releasing the starting signal for the following train. We might mention that the station officials have the power to hold the starting signals to "Danger" if necessity arises, but have not the power of lowering them unless released by the treadle, which is automatically worked by the train.

The electric slot or controller consists of a small iron box placed alongside the rails some 50ft. in front of the station; this box contains two small mercury-cups, about ½in. above which are arranged contacts of platinium wires, so that the passage of the train depresses them and completes their respective circuits. One of these circuits is in connection with the starting signal at the station just left, which by the completion of the circuit is locked at danger, rendering it impossible for the station official to clear the line when in that state; the other circuit is in connection with the starting signal at the previous station, by the completion of which the signal is unlocked, although the semaphore arm still stands at danger until lowered by the station official. At the same time as the signal is unlocked the current passes round an electromagnet which attracts a polarised disc and allows the small indicating semaphore arm to fall, as well as indicating this fact by the ringing of a bell, thus indicating to that station official that the section in front is clear and that his signal is unlocked. In the same way the slot instrument that locks the signal at the station immediately behind sends a current in the opposite direction round the electromagnet of the small indicator, attracts the polarised disc, and replaces the indicating semaphore at "Danger." These signals were at first worked with Leclanché batteries, 40 cells being fitted, in four sets of 10 in series, but they were not found to be at all satisfactory, and the company's electrical engineer is replacing them all with small eight-volt accumulators of Allen and Adamson's make, which are found to answer very well; a 230 ampere-hour accumulator averaging some 18 to 20 weeks without recharging.

The cables used consist of a three-wire cable, which was fixed by the electric light contractor, and is carried along on the same bracket as previously described for the lighting cables. There is also telephonic communication arranged between each station and the power-house, and each station also has communication direct with the station in rear of it. There is also an independent system of signals by means of bells and plungers hand worked; also a plunger is fixed at each station direct to the power-house, which rings a bell there, and is the signal for the cable to be immediately stopped. For stopping at night the signals can be hand controlled from the car shed until there is a train on each section of the line.

Conclusion.

In conclusion, we must thank the various officials of the Subway Company, of the Silvertown Company, and the engineers, for their kindness and courtesy in placing the various information within our reach. In particular we would thank Mr. A. H. Morton, through whose kindness we have been allowed to reproduce one or two of the illustrations from his interesting "Souvenir" of the subway. We are also indebted to Mr. W. W. Best and Mr. Purdon, of the Silvertown Company, for information relating to their work. We must not either forget to acknowledge the kindness of the subway company's engineer, Mr. M'Lean, for allowing us access to the works when we required it, or to their electrician, Mr. Meickle, for his useful description and particulars of various points in connection with the undertaking.

Although in one way this station cannot be considered a large one from point of size, when looked at in another way—viz., the area of supply—it is something very much out of the common. For example, when it is considered that some three-quarters of the whole of the Glasgow Corporation network is contained within the small corner on the north-east of the subway circle and bounded by the river on the south and a line drawn down from about St. George's Cross Station to the river, some idea can be formed of the area of supply and the distant points to which this subway station supplies current.

Again, this station is claimed to be the first to be laid down on a 220-volt system, or, rather, with 440 volts across the outers, although, of course, there ar stations now that are only making new connectio the 220-volt mains, and even some which have over the whole of their consumers on to the highe

Whether the system selected is the best or not be definitely proved by experience, but we trust interesting station and its electrical equipment remain a credit to all concerned in its incep construction.

NOTES ON ACCUMULATOR CONSTRUCT

BY DESMOND G. FITZ-GERALD.

[*Copyright.*]

XCII.

"For traction cells," says *l'Industrie Electriq* preferable to construct the recipient entirely of c I should not like, myself, to incur the responsi such a statement. The compounds known to the "celluloid" are far too dangerous for use outsi laboratory, excepting when immersed in a non-inf liquid. Contact with flame, or with a wire, or other solid, however minute, at a temperatu 350deg. F., causes it to burn furiously—indeed explosively—with the evolution of suffocating fu laboratory experiment (which I have had occasio plain of as somewhat too popular) is to partly water or dilute acid a small vessel constructed of and then to set fire to it by means of a heated wi point of interest in this experiment, which unfo involves its too frequent repetition, is to notice the celluloid will burn so as to leave a thin lay material where it is in contact with the liquid, obviate any spilling of the latter; the uninterest is the opening of the laboratory windows unti becomes respirable. Even less than an ounce loid produces a small sensation in the for flare, with results that are unpleasant to having lungs of ordinary delicacy. We may then what would be the results in the case of a battery, or any other accumulator, with containin of this material, under the not unlikely continger heated wire, an incandescent particle from a toba or a match or fusee not "warranted to ignite onl box." Except on the smallest scale, the most prudence must forbid the use of this substance for contain accumulators or other batteries. Althoug not yet heard of any serious accident arising f use, I remember—and, doubtless, some of my o from the Hanover-square School of Electrical En will recollect—some rather startling phenomena d heating of a wire which had accidentally short-ci cell in some "Union" batteries which had been pl upon a shelf. In this battery the receptacles for the were not made of celluloid, otherwise the con would no doubt have been very serious, but this was used for the cross-pieces supporting the eleme

Were it not for this absolutely prohibitive c celluloid would be the material *par excellence* fo boxes. Electricians who are acquainted only with glass, lead-lined teak, or vulcanite might, perhap astonished to hear that some youthful aspirants in fession had actually made temporary use of a battery box as a *football*, but they might be sur find that the receptacle in question was not ap damaged by such treatment. My reluctance to with the use of this material led me some tim devise a process for coating it with *mica*; but, wrongly, the few persons to whom this pro suggested exhibited no signs of interest in it. I have invented and experimented with a pyrox pound which will burn only so long as it is in con flame, and which therefore I have named *acremat* has been more favourably received, and I hope t of this material may shortly be forthcoming. It be mentioned, by the way, that the latest of the g conflagrations is said to have originated in the ignition of some celluloid buttons attached t "ulsters."

XCIII.

questions here arise: what is celluloid? and can iaterial be advantageously used in connection with terior and submerged parts of accumulators? Now confess that I have never been inside a celluloid actory: for my small laboratory, of which a corner en for a long time past devoted to pyroxylin coms, certainly cannot be dignified by this title. But all amples of "celluloid" I have examined have been sed of pyroxylin—this being mainly the di-nitro n ($C_6H_8 2NO_2O_5$) for which the term "pyroxylin" generally reserved—in admixture with camphor $_{16}O$) and occasionally with small proportions of bodies, added probably to increase flexibility, besides ntal impurities. The difference between the various es may be sufficient to account in some degree for the nce in the verdicts which have been given in relation luloid when used as a "separator" or otherwise within ectrolyte in accumulators. The *raison d'être* of the or becomes manifest when you attempt to pass gh a pair of rollers the more or less plastic but ive mixture of pyroxylin blended with a highly-le solvent, the presence of which is necessary to ain the plasticity. The camphor, with a boiling near 400deg. F. (instead of something between g. and 160deg.), not only retains the other solvent vents, but itself adds greatly to the plasticity, and ates the operation of rolling into sheets. From the of view of the manufacturer, therefore, camphor may most valuable adjunct; from that of the electro-t it must be considered, I think, as altogether detri-l. In other words, celluloid, as distinguished from in component, pyroxylin, should not be admitted in nstruction of the elements of storage batteries. Even re pyroxylin, as we shall see, should be admitted, if not advantageously be dispensed with altogether, only construction of the *peroxide element* of such appliances. ylin itself may be regarded as indestructible by ion in the cold, but this cannot be said of pyroxylin ixture with camphor—*i.e.*, celluloid. And pyroxylin, pure condition or otherwise, is by no means ructible under the action of reducing agents—*i.e.*, nces which are capable of abstracting oxygen from it. verdicts adverse to the use of celluloid in accumulators think, mostly due to its camphor component, and in r affect the question as to the use of pure pyroxylin. have recently stated, "Pyroxylin—the basis of id—is, under the temperature of 300deg. F. *bien* s, one of the most inoxidisable bodies known, as be inferred from the fact of its being generated in of the strongest nitric and sulphuric acids. The or which is present in celluloid and the impurities may be associated with it, are oxidisable enough, t the pyroxylin."*

iphor ($C_{10}H_{16}O$) may, in fact, be converted by its into several acid bodies, notably into camphoric $H_2C_{10}H_{14}O_4$). This substance is sparingly soluble in us liquids, such as dilute sulphuric acid, as well as hol, ether, and the essential oils. Its calcium and a salts are freely soluble in water, and are crystallisable. products of the oxidation of camphor are camphoronic $H_2C_9H_{10}O_5$), which crystallises from water in slender s; hydroxycamphornic acid ($H_2C_9H_{12}O_6$), which llises in long prisms; and campholic acid ($H_2C_{10}H_{16}O_2$), is also somewhat soluble in water. These acids, present in the electrolyte of lead storage batteries, very possibly exert an action which is far from being ental to the working of the cells (XXI.); but their tion at the expense of the celluloid used for separators sings affords a very probable explanation of the ioration of this material which has frequently been lained of. Not only is camphor affected by oxidants; y become converted into cymol ($C_{10}H_{14}$) by abstraction e elements of water, or into camphol ($C_{10}H_{18}O$) by ination with hydrogen.

XCIV.

e younger members of the electrical profession have been often—but, I think, not too often—urged to give more attention to the work to be done in the direction of electro-chemistry. Those who are able to follow this advice should certainly study the nitrous derivatives of cellulin ($C_6H_{10}O_5$), a compound which is also termed cellulose* or lignin. These derivatives are frequently all included under the term *pyroxylin*; but this is now generally taken to indicate the di-nitro cellulin ($C_6H_8 2NO_2O_5$), a compound which, when made from starch (this having the same chemical composition as cellulin) is also called *xyloidin*. In similar manner the term guncotton is now taken to indicate the tri-nitro cellulin ($C_6H_7 3NO_2O_5$). It is the former compound which is likely to become of even far greater importance in the peaceful arts than is the latter in the art of war.

Cellulin, or lignin, which is found nearly pure in cotton and linen, must not be confounded with ligneous or woody fibre, which contains, besides cellulin, a substance termed *bastose*, which appears to belong to the tannic acid group. Cellulin, which is represented also by unsized paper, and by the pith of the elder tree and that of the *Aralia papyrifera*, from which rice paper is prepared, is scarcely acted upon by dilute acids; although, as those who are brought into contact with accumulators know to their cost, if dilute sulphuric acid is allowed to become concentrated by the effect of drying, it becomes most destructive to linen and cotton fabrics. Cellulin is, in fact, converted by strong sulphuric acid into *dextrin*—known in commerce as "British gum"—and, by boiling, into *glucose*, or grape sugar, these two bodies being *metameric* with cellulin and starch—*i.e.*, having the same chemical composition though differing in their chemical reactions.

If cellulin in the form of unsized paper be immersed for a few seconds in oil of vitriol diluted with half its weight of water, and then washed with water, it becomes converted into the substance known in commerce as parchment paper or papyrin. If it be dipped in similar manner into nitric acid of specific gravity 1·42, a somewhat similar effect is produced, and the tenacity of the paper is greatly increased. But if the paper be dipped into nitric acid of specific gravity 1·5, and quickly plunged into water, it not only obtains the appearance of parchment, but, when dried, is found to be almost explosively combustible. It has, in fact, undergone, quietly and almost instantaneously, a very remarkable change, in which peroxide of nitrogen (NO_2) has become substituted for certain molecules of hydrogen. Our innocent cellulin has acquired properties which, as we shall see, render it analogous to nitro-glycerine ($C_6H_{10}6NO_2O_6$), and might enable it to emulate in a small way the destructive performances of this agent (LII.). This experiment was first made by Pelouze in 1838.

XCV.

But, so early as 1813, Braconnet had described a new substance obtained by the action of concentrated nitric acid on starch, sawdust, linen, and cotton wool. He named this *xyloidin*, from the Greek word signifying wood, and described it as white, pulverulent, neutral to test paper, and highly inflammable. At the meeting of the British Association at Southampton in 1846, it was stated that Prof. Schönbein had discovered a mode of rendering cotton so explosive as to form an excellent substitute for gunpowder. This at once drew attention to the new product, and a patent was taken out by Schönbein in April, 1847. In his specification he states that in treating the cotton he used nitric acid of specific gravity from 1·45 to 1·50 and sulphuric acid of specific gravity 1·85. These acids were to be mixed in the proportion of one part by weight of the former to three of the latter, the mixture is allowed to cool down to 50deg. or 60deg. F., and then rough but clean cotton-wool, in as open a state as possible, is to be immersed in the fluid until thoroughly soaked. The acid is then to be poured off, and the cotton, having been lightly squeezed so as to remove most of the acid, is to be covered over and left for an hour, then pressed, and washed in running water to remove all free acid. To ensure the complete absence of the latter, the cotton was then to be washed in a weak solution of carbonate of potash, and sub-

* ...rnal of the Institution of Electrical Engineers, No. 131 ...ary, 1898), p. 746.

* Prof. W. A. Miller suggested that the termination *ose* should be reserved for the different varieties of sugar, as above stated.

jected to pressure sufficient to leave it nearly dry. With a view to increase the explosive effect, Schönbein next immersed the cotton in a solution containing 1oz. of nitrate of potash to a gallon of water, it was then again pressed, and dried in a room heated by steam or hot water to a temperature of 150deg. to 170deg. F. Three parts of the cotton so prepared were, it was stated, equal in effect to eight parts of Tower-proof gunpowder. The temperature at which guncotton ordinarily explodes varies from 350deg. to 400deg. F.

In becoming converted into nitro-cellulin, cotton increases very considerably in weight, but the increase was very variously stated by different experimenters. Thus, whilst Pelouze stated it to be 75 per cent. exactly, Ransome found it to be only 65·4 per cent. Dr. Gregory stated it to be 69·5 per cent., which agreed with the formula given by Gladstone for the most explosive guncotton, whilst the formula given by Porrett and Teschemacher would *double* the original weight of the cotton. These differences first suggested what was soon recognised as a fact—viz., that, according to the strength (freedom from water) of the acids used, and to certain other conditions, several different compounds, and various mixtures of them, were obtained by the action upon cellulin of a mixture of nitric and sulphuric acids.

McWHIRTER'S SHIELDED MEASURING INSTRUMENTS.

It is interesting to notice the tendency among instrument makers and users to revert to the permanent magnet in the manufacture of ammeters and voltmeters and other

McWhirter's Shielded Measuring Voltmeter.

electrical measuring instruments. The causes underlying this change are twofold:

Firstly, there is no doubt that the production of finely-made instruments constructed on the d'Arsonval principle has tended to bring permanent magnets into favour, not because they are any better or more reliable than they were 10 years ago, but because instruments of this class possess so many good qualities that the main objection—viz., the unreliability of the best of magnets—has been lost sight of, and on all hands we hear of engineers using such instruments as standards, regardless of the fact that they are only fit for secondary standards. As such, instruments of the d'Arsonval type are admirable, but it should never be forgotten that occasional comparison with an absolute standard is essential.

The second, and perhaps the main reason for this reversion, is the failure of electromagnetic instruments to meet the demands of electrical engineers. The need for accurate measuring instruments is ever increasing, and electromagnetic instruments, in spite of the paramount advantage of permanence, fail in many respects to meet this great want. The engineer expects his instruments to give accurate results under all conditions of temp and in stray magnetic fields of great and ever strength, and as the field of the average electro instrument is comparatively weak, the stray field leads carrying, say, 200 amperes and upwards has substantial effect; also in cases where the switchbo to be close to the dynamo there may also be a very disturbance. In some cases these troubles can be by careful design, but in most cases this is impossib instruments which are described lead us to be the electromagnetic instrument is beginning to mov towards perfection than it has been doing lately them some of the most serious drawbacks to their either removed or greatly reduced in importance.

Mr. McWhirter's invention is very simple, and in the substitution of an iron-clad bobbin for the brass one. This modification, although so simple is shown in Prof. Jamieson's report, a very mark on the working qualities of the instrument, espe the matter of freedom from the disturbing effect magnetic fields. There have been several screened ments produced, the most general plan being the outside case of iron. The evil of this plan the outer case, being irregular in shape and th and having of necessity an opening through wh scale can be read, becomes polarised, and th screen itself becomes a source of the very dist it was designed to guard against. In the case McWhirter's screen the iron case is placed coil only, and, moreover, forms a part of the m circuit. Being of even thickness and symmetric it is not liable to polarisation, and as the outer is ¼in. thick, the shielding is, as shown by tests perfect.

It may be thought that such a mass of iron would

McWhirter's Shielded Measuring Ammeter.

a great increase in the error due to residual mag but this is not so, as the tests show the error is no than in the case of the ordinary instrument with was compared, and more recent instruments give considerably better than this. The iron-clad coil p other advantages, chief among which is the great tion in the power necessary to work the instr The power used in a McWhirter voltmeter is only of that necessary to work a corresponding voltme an ordinary coil, and it is thus possible to wind either entirely of manganin or with a much larger tion of this alloy than is possible when a greater nu watts are necessary; consequently the errors due to heating and to changes in atmospheric temperat reduced to an insignificant amount.

The accompanying tests were carried out by Jamieson on the advantages of the McWhirter coil manufacture of electrical measuring instruments.

The General Electric Company, Limited, of Victoria-street, London, and Peel Works, Manches the sole licensees and makers of these improved instruments.

TESTS OF McWHIRTER'S PATENT VOLTMETER.

I.—Watts Used in Voltmeter at Various Voltages. Watts $= \frac{E^2}{R}$.

...s at ...als.	McWhirter's Patent Voltmeter. Watts voltmeter cold—say 60deg. F. Resistance = 5,082·5 ohms.	McWhirter's Patent Voltmeter. Watts after having been in circuit for 20 consecutive hours. Resistance = 5,112 ohms.	Ordinary (Iron-clad) Voltmeter. Watts voltmeter cold—say 60deg. F. Resistance = 2,938·7 ohms.	Ordinary (Iron-clad) Voltmeter. Watts voltmeter hot after running for 20 consecutive hours at 100 volts. Resistance = 2,957 ohms.
	1·253	1·248	2·176	2·163
	1·607	1·579	2·754	2·736
	1·96	1·95	3·4	3·38
	2·37	2·359	4·114	4·089
	2·822	2·708	4·896	4·867

...ror Due to Temperature.—As will be seen by comparing the resistance when hot, after a 20 hours' run (5,112 ohms) ...sistance when cold (5,082·5 ohms), the error due to this cause is very slight, amounting in all to only ·58 per cent.

III. Retentivity Tests.—Behaviour with Rising and Falling Voltages. Effect of Reversing the Current.

Readings when Cold.

... of ...	McWhirter Voltmeter, No. 275. Terminals connected as marked. With rising voltage.	Percentage error.	With falling voltage.	Percentage error.	Ordinary (Iron-clad) Voltmeter. Terminals connected as marked. With rising voltage.	Percentage error.	With falling voltage.	Percentage error.
	79 0	−1·25	78·0	−2·5	82·0	+2·5	81·5	+1·8
	88·0	−2·2	89·0	−1·1	91·0	+1·1	91·5	+1·6
	99·3	−0 7	99·25	−0·75	101·0	+1·0	101·5	+1·5
	110·5	+0·45	110·0	−0·00	112·0	+1·8	111·5	+1·3
	120·75	+0·6	—	—	122·0	+1·6	—	—
	Current Reversed.							
	78·5	−1·8	80·0	·0	77·5	−3·1	80·5	+0·6
	89·5	−0·5	91·0	+1·1	87·25	−3·0	91·0	+1·1
	98·5	−1·5	99·5	−0·5	96·5	−3·5	99·5	−0·5
	111·0	+0·9	111·0	+0·9	111·75	+1·6	112·25	+2·0
	121·0	+0 8	—	—	122·0	+1·6	—	—

...sts of Shielding from External Magnetic Fields.—While the above voltmeters were indicating approximately 100 ...seshoe magnet was placed so as to produce a maximum deflection of the pointer, which was noted; the poles of the magnet ...versed, and the deflection in the opposite direction noted. The mean of the two readings was taken as the percentage ... the external magnetic field. The McWhirter voltmeter gave an error of 0·75 per cent., the ordinary voltmeter of 6·00 per ... new engine-room volt gauge of 5·00 per cent.

...—From the foregoing details of carefully-made tests in my laboratory I have to report that your newly-patented shielded ...less affected by external magnetism than any other electromagnetic one which I have seen. The temperature is also ...being only one-quarter of 1 per cent., at 100 volts after 20 hours in circuit.

Andrew Jamieson.

...FREE WIRING SYSTEMS.

BY JOHN H. RIDER.

...lowing is an interesting report by Mr. Rider on ... of houses to the chairman and members of the ... Committee of Plymouth Corporation:

...avouring to popularise the electric light, and to ...spective consumers to become actual ones, it is ...d that the outlay necessary for fitting-up the ...s a great stumbling block. The tradesman or ...er will acknowledge the superiority and many ... the light, and is prepared, if necessary, for an ...n his quarterly accounts; but the large initial ...ved in fixing the wires and lamps puts electricity ...ses out of the question. So he continues with ..., simply because he cannot afford to take the first ...e adoption of a good "easy-wiring" system ... once bring on to the mains a large number of ...who would never have otherwise been able to make ...s. These customers might individually take but a ...ber of lights, but collectively they would form a ...able accession to the undertaking, particularly ...who only require a few lights are more likely to ...burn all of them than those who have a large ... Also, a tradesman would not then confine the ...ight to his shop front, but would put it into ...rooms and back premises, where it would be most

...methods have been proposed to meet the case, ...prominent being that of the Free Wiring Syndicate, ...s company formed in 1896. The object of the ...is to enter into working agreements with corpora- ...ther owners of electricity supply undertakings, by ... wiring of consumers' premises should be carried out for the mutual benefit of both parties. Any person could have his premises wired and fitted up, ready for the supply of electricity, without any initial charge whatever, but he would be required to pay a small amount per unit more (from ¾d. to 1d.) on all electricity supplied to him than would be paid by a consumer who had paid cash for his wiring. The syndicate proposes that when person apply for free wiring, the corporation will give instructions to the syndicate to wire the premises, and as the quarterly bills for electricity were paid by the consumer, the corporation would pass on to the syndicate the ¾d. or 1d. per unit (as the case may be), which had been added to the accounts under the agreement. The consumers would have the option of purchasing the wiring and fittings outright at any time after five years from the date of completion, upon certain terms, but otherwise the extra charge per unit would go on indefinitely. This extra charge being a fixture, whatever the ordinary price per unit may be, it follows that its percentage will rise as the price per unit is reduced. Thus, at 8d. per unit an extra charge of 1d. would only be a 12½ per cent. increase, while at 4d. per unit it would be a 25 per cent. increase. It is also unfair to those consumers who use the light for long hours, as the more electricity they use, the more they have to pay for their fittings, while a man who uses a small quantity only pays a small amount to the syndicate, although his fittings may have cost as much as in the previous case. In other words, the syndicate has to base its charges upon the average consumer, and in consequence the good consumer is penalised for the sake of the bad. Taking one consumer with another, and the average of a number of towns, we find that about 18 units per 8-c.p. lamp fixed are consumed per annum, and as the cost for the fitting-up of a house comes to about £1 per lamp, an extra charge of 1d. per unit is equal to an interest of

$7\frac{1}{2}$ per cent. per annum on the capital outlay. The wiring is thus by no means "free." In fact, the only man who gets his wiring actually free under this arrangement is the one who never consumes a single unit, and such a one would not be welcomed by the syndicate.

Looking at the proposal from a commercial standpoint, it means that the corporation would act as the collector of the syndicate's debts. It is also a question as to whether the corporation would be entitled, under the Electric Lighting Acts, to make an agreement with a third party by which a certain class of consumer is made to pay an increased price for the energy used, in return for a free installation of wires and fittings. A much fairer system would appear to be to let each consumer actually pay the cost of his wiring, but to spread the payment over a considerable time. By this means the heavy initial cost would be done away with, the consumer would only pay the regular price for current, and at the end of the fixed period his payments on account of wiring would cease. A scheme on these lines was proposed by the writer to the Bolton Corporation in 1894, and it has been in successful operation ever since. The introduction of such a system was easy, as the Bolton Corporation had for some time been carrying out wiring work, and was therefore in a position to give long credit to its customers. But where the wiring work is in the hands of private firms, it becomes impossible for them to offer the same terms. In order to keep their doors open, in the face of such competition as always arises in electrical house-wiring, they must have cash payments on completion of the work.

Experience in many towns has proved that it is unwise for corporations themselves to undertake wiring work. The wiring contractor is an excellent friend to the electricity department, for in his own interests he vigorously canvasses the area of supply for orders, and every job he does means an increased revenue to the corporation. Wiring firms are now so numerous, and competition is so keen, that a more effective method of reaching possible consumers could hardly be devised than to make it worth the while of half a dozen contracting firms to work the district. In order therefore to meet the case, it would appear to be necessary for the wiring contractor to do the work, and for the corporation to give the credit. The scheme which I now propose to you is based on these lines. The wiring contractor would canvass for orders in the usual way, and could carry out work for any customer on his own terms without reference to the Corporation. But when a person wished to avail himself of the easy payment system, he would have to proceed in the following manner. The quotation to such customer would be made out upon a special form, binding the contractor to carry out the work to the satisfaction and under the supervision of the Corporation, and naming such a price for the work as would permit him to allow a discount of 5 per cent. for cash. If the customer agreed to this price, he and the contractor would notify the acceptance in writing upon a form of application to the Corporation. This form would set forth the terms of the proposed agreement, which would be somewhat on the following lines—viz., (*a*) that the contractor will carry out the work in accordance with the conditions, regulations, and other requirements of the Corporation, and to the entire satisfaction of the borough electrical engineer; (*b*) that the contractor will allow to the Corporation a discount of 5 per cent. from the quoted price, for payment within one month of the date of the work being completed and connected to the mains; (*c*) that the customer will pay to the Corporation the quoted price in full, by means of eight equal instalments, the first being sent with the application in the form of a deposit, and will pay a similar amount every three months from and after the completion of the work until the whole be paid; (*d*) that the work will remain the sole property of the Corporation until the full amount be paid; (*e*) that the customer will be responsible for any damage to the work (reasonable wear and tear excepted), while it remains the property of the Corporation; (*f*) that all lamp and fuse renewals will be carried out by and at the cost of the customer; (*g*) that in the event of a customer's payments being more than three months overdue, the supply of current will be liable to be *cut off without* notice, and proceedings taken for the recovery of the whole amount due; (*h*) that (i… by the Corporation) the customer to provide two… for his due fulfilment of the contract.

If the customer, contractor, and price appe… factory to the Corporation, instructions would b… the Corporation to the contractor to proceed … work, and upon the proper completion of the … Corporation would pay him the quoted sum, less … The first instalment being a cash payment of on… the full amount, the customer would receive cre… eighth of the full amount for the next three m… on each succeeding three months up to 21 mon…

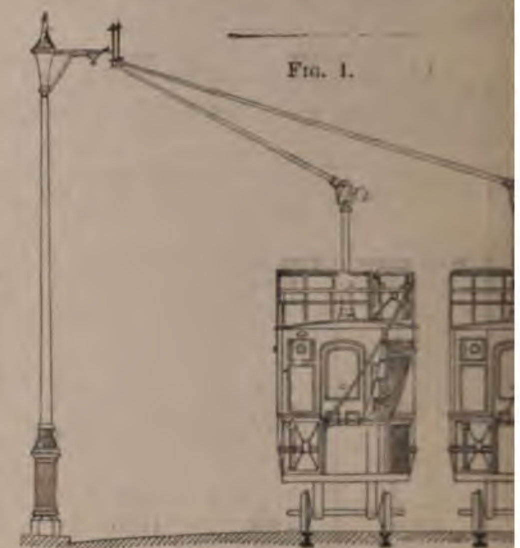


Fig. 1.

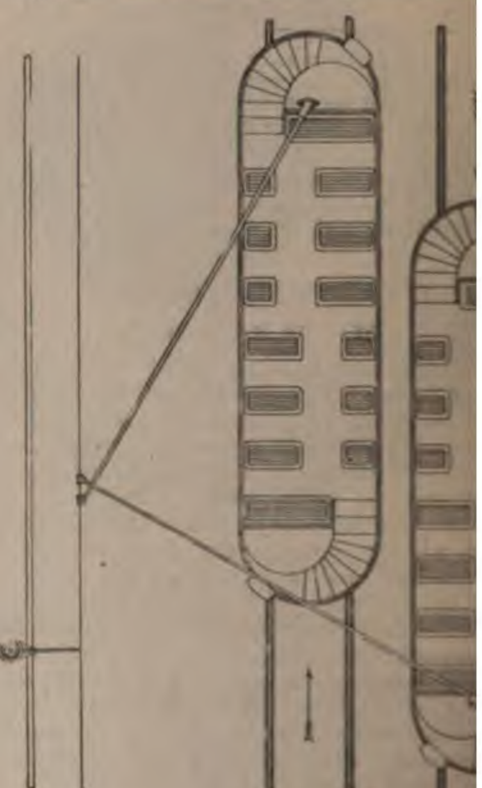


Fig. 2.

is equal to credit on the full amount for $10\frac{1}{2}$ m… which 5 per cent. is charged, or at the rate of ab… cent. per annum. The customer would of course… option of determining the agreement at any tim… payment of the balance of the amount due, less… discount.

The advantages of such a scheme as the foreg… be considered from the three standpoints of the… tion, the consumer, and the contractor.

To the Corporation the advantages would b… accession of a large number of consumers who wo… wise not be able to afford to adopt the electric… the excellent control the Corporation would b…

he wiring of the premises, and the consequent standard of work.

sumer the advantages would be: (*a*) the ectricity as an illuminant without any heavy (*b*) no extra price for current, as in the free ; (*c*) the cessation of all payments for wiring ı time, when the work would become the e consumer; (*d*) the guarantee of first-class ıe direct control of the Corporation.

actor the advantages would be: (*a*) a large ork in wiring premises; (*b*) the certainty of e satisfactory completion of the work.

Y SYSTEM OF ELECTRIC TRACTION.

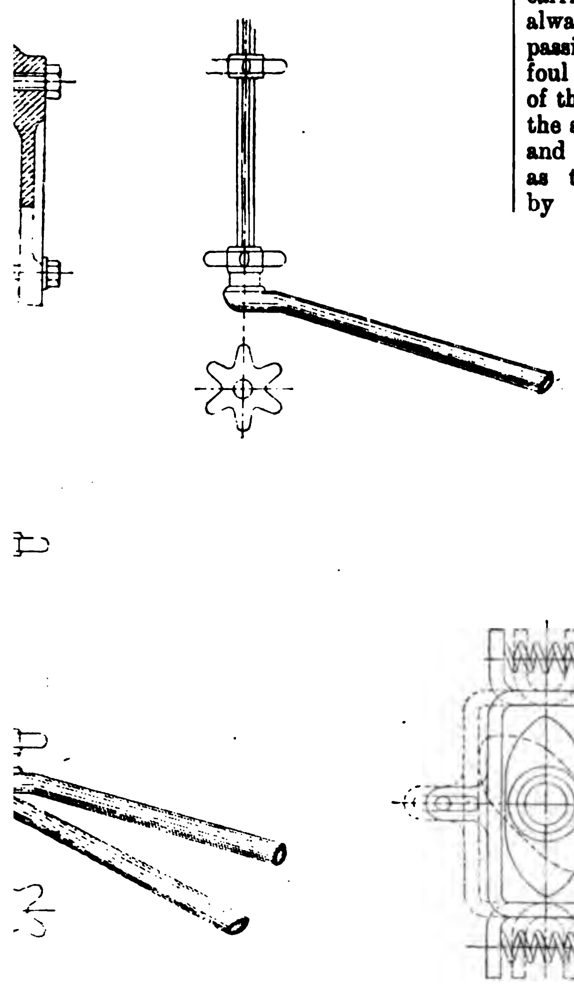
tem described below aims at the simplifica- rhead system of electric traction in a way h having some advantages, is not free from

on at Z Z. FIG. 6.

by means of the quadrant shown in Figs. 1 and 3. It can be fixed at that slope, this being such as to throw the vertical sliding bar, with which contact is made on the wire, to such a height as to properly engage with that wire as the car moves along the tramway. The arm is freely movable in a horizontal direction only, and is controlled by springs fixed to the roof of the car at the foot of the vertical standard, or by any other suitable means, in such a way as to always tend to place itself at right angles to the car on that side of the tramway to which the overhead wire is fixed.

By reference to the drawings and by the above description, it will be seen that inasmuch as the arms carried by the cars are of the same length and fixed at the same slope to the horizontal, their outer ends are supposed to remain at the same vertical height above the ground level, and when two cars are passing (as shown in Fig. 1 in end view and on plan in Fig. 2), the two collectors will come in contact as they approach each other when moving in opposite directions along the wire, but as the poles will not touch in passing except at the extreme ends, the pole carried by the car farthest away from the wire should always pass freely over that carried by the inner car; in passing there will then be no possibility of the poles falling foul of each other. Figs. 3, 4, and 5 show enlarged details of the swivelling trolley pole and collectors. Fig. 6 shows the small star-shaped plates or discs fixed at the bottom and top of the vertical slider. These are so designed as to prevent the slider being jerked off the wire by vibration due to the motion of the car. The

FIG. 5.—Section at Y Y.



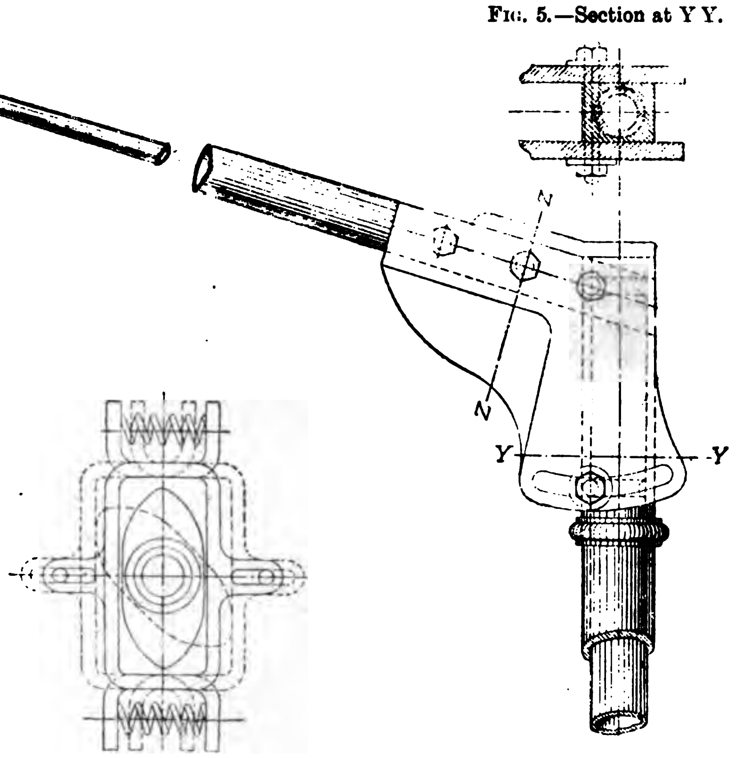


FIG. 7. FIG. 8. FIG. 3.

ther directions. The illustrations, prepared Kenway, the inventor, show the arrange- would be on a long straight line where no ıe, with the side-bracket suspension on the ıy system. On the convex curves, however, l arise, which Mr. Kenway has not up to own how to overcome. The system aims at ide bracket arm to a minimum, and increasing the trolley arm in proportion.

verhead wire is used, whether the line be ole. Instead of the trolley wheel, a sliding To enable the sliding bars belonging to two opposite directions on different lines of easily pass each other the bars are placed make contact with the side of the overhead with the bottom as heretofore. The arm ır, which replaces the usual trolley pole, is andard fixed vertically on the top of the car. It l within certain limits to any desired slope and

action of these star-shaped discs when two collectors are moving in opposite directions is shown in Fig. 7. They are supposed to cause a rotation of one collector over the other, and the tendency will decidedly be in that direction. The question which arises, however, in this connection is as to the effect of the blow between these two collectors meeting with a relative speed of about 16 miles per hour. The other point which occurs to us in considering this device is the effect of unequal loading of the cars on the vertical height of the collectors. Mr. Kenway provides for no vertical play in his collectors, so as to avoid any rubbing of the trolley poles when crossing. This means that the trolley wire must be always at one height, which is difficult to ensure on streets where the grades change much. Added to this, a slight side oscillation or the displacement of one rail of the track will produce a comparatively large vertical displacement of the collectors. This may give trouble, as any rubbing of the trolley pole may cause one or other to break contact with the wire,

thus causing an arc. In fact, the engaging shock of the two collectors when they meet is likely to break both contacts. We do not make these criticisms in a carping spirit, and trust that the inventor has a solution for the difficulties we mention, as the single-trolley wire, *per se*, is a great advantage.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared, and should be written on one side of the paper only. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time.

QUESTIONS.

46. In the paralleling of two alternators, what do you consider the best apparatus to use to show when they are in synchronism? Explain the working of the same.—ANON.

47. Discuss the advantages and disadvantages of the vertical engine for driving a flywheel alternator when the high-pressure cylinder is placed on one side of the flywheel alternator and the low-pressure cylinder on the other. Assume that a quick cut-off governor is used, and take up particularly the question of parallel running.—P. T.

ANSWERS.

Question No. 41. What are the objections in actual working to separate switch pillars to each generating unit in a central station?

Best Answer to No. 41 *(awarded* 10s.*)*.—It is assumed that the machine volt and ammeters, also the regulating resistance, are located in or by the switch pillar, which is situated by its machine. The chief objection in actual working is that it is not possible to give as steady a pressure as when the switches, meters, and regulating devices for all units are placed on the panels of one switchboard, and this objection applies most strongly when the separate units are run in parallel. This results from three causes. It is more difficult (1) to parallel; (2) to regulate the voltage when machines are running in parallel; (3) to switch out a machine satisfactorily.

1. *It is more difficult to parallel.*—Unless there be a paralleling voltmeter on each pillar—an expensive and therefore unusual arrangement—one has to parallel (*a*) by means of one placed centrally for all machines, and therefore at some distance from each, certainly farther from the switches than if a switchboard were used, and the accuracy with which a meter can be read is inversely as the distance from it; or (*b*) by the 'bus bar and machine voltmeters. This not being a zero method, it is impossible to read the 'bus bar voltmeter from a distance, and when one has taken its reading, calculated what the machine voltmeter reading should be (for one voltage does not *always* produce the same reading on different meters), and brought the machine volts to that reading, the probability is that, more load having come on, lowering the 'bus bar voltage, on switching the machine in a jump in the lights will be caused. Again, as hinted above, meters very frequently give different readings for the same voltage, and if they are far apart relative changes in their readings for the same voltage are not so readily detected.

2. *It is more difficult to regulate the voltage when machines are running in parallel.*—The normal position of the attendant is in front of the feeder voltmeters. The distance between this point and the regulating devices of machines being greater when switch pillars are used, the time taken to correct a high or low voltage will of necessity be greater. Again, when load is coming on, as it is necessary to go to a machine before its ammeter can be read, one may go first to a machine already fully loaded, causing a further delay.

3. *It is more difficult to switch out a machine satisf*
If the machine be automatically cut out, this
should not apply. However, even when the auto
out works, it is advisable to watch the machine
for no cut-out is infallible, and whilst one is wat
machine ammeter the voltage, if the feeder volt
some distance away, will probably suffer.

In cases where machines are not run in paralle
still the objection of greater distance apart of
regulating devices belonging to machines supplyin
districts, and if, as is frequently the case in
stations, one has to depend on the machine volt
regulate the pressure, as the attendant cannot h
all under his eye at once, it will be more difficult
steady pressure than in the case of parallel ru
further objection might be made on the ground
entail more work on the man in charge. Howe
one sees such large salaries offered to shift
one mentions this objection with some hesitati
PAYNE.

Question No. 42.—Give the advantages and disadv
using condensers in electric light stations:
whether separate or combined condensers are
approximate figures of saving effected.

Best Answer to No. 42 *(awarded* 10s.*)*.—The
of condensers in electric lighting stations are too
pass unnoticed, and a site for a station should b
where there is plenty of water, such as a rivers
etc. Surface condensing is by far the best meth
chief advantage of condensers is the saving of
feed water is hotter and fresh. The water not
much scale inside the boiler, the heat passes thro
water more readily, and the blow-down cock is
so much, thus avoiding loss of heat. The savi
varies from 15 to 25 per cent. The boilers do n
cleaning so frequently, saving labour, and prolo
lives of the boilers. When using high-pressure
economy of increased expansion is more fully rea
the boiler power may be reduced without any los
cated power. Say the vacuum gauge stands at 2
means that 13lb. of the atmospheric pressure
destroyed in the condenser, and the steam, i
having to exhaust before it comes down to 15lb
non-condensing engine, can be worked down to 2
it exhausts. If the steam-gauge shows 60lb.,
pressure = 60 + 13 = 73.

Disadvantages of Condensers.—The fresh water
scale on the boiler, causing it to rust; and i
engines where strong steam is used, decompositi
lubricant used for the internal parts takes place a
235deg. F., and ultimately coming into the boiler
to attack the iron. How this may be remedied i
question. In surface condensers the tubes foul b
and out, principally on the steam side, from the
the grease and oil in the exhaust steam. The ins
tubes fouls from the deposit from the water, bu
like the extent as the outside. Additional pumps
required for circulating the condensing water. T
tubes of surface condensers create complication,
are liable to leakage. There is an increased first
10 to 30 per cent. and cost of repairs. Taken
combined condensers are best, where each engine
own. In case of breakdown the exhaust pipe
fitted with two valves—one to condenser, the
communication with the chimney. Should the
give out, all that would be required would be
valve to condenser and open valve to chimney. A
condensing plant would necessarily be much la
take up more floor space. It would require a
engine to drive it, would need extra attention
in repair. In addition to this, it would be necess
duplicated, thus increasing the cost of maintenan
the event of one set breaking down it would be
thing if there was not another to fall back on. Th
coal consumption, assuming that 1lb. of coal e
8lb. of water, may be taken as follows: for non-co
engines, 3lb. to 5·5lb. per indicated horse power
condensing engines, 2lb. to 4lb. per indicated ho
per hour; compound non-condensing, 2·5lb. to

iorse-power per hour: compound condensing, 75lb. per indicated horse-power per hour; triple , 1·25lb. to 1·75lb. per indicated horse-power ·F. BRUTON.

'o *No.* 42 (*awarded* 5s.).—The advantage to be m the use of condensers in electric light stations imarily upon the situation. It may be broadly ; advantageous when an ample supply of water which can be obtained and operated without a cost. Central stations are often erected in stricts where ground space is at a premium, and ly the town water supply available. It then juestion as to whether the advantage obtained ndensers will be such as to pay for the increased plant, and this question can only be satisfactorily carefully considering the conditions in each case. That condensing engines have a great ver non-condensing engines is sufficiently obvious of little discussion—the increased vacuum pro- he condenser resulting in a saving of from lb. of steam pressure upon the piston, but the it in power will, of course, vary according to engine, steam pressure, etc. The greater the ı pressure the greater will be the improvement condenser. The use of steam in the cylinder pressure of 150lb. will give a theoretical gain of r cent. in the condenser over the use of steam tial pressure of 60lb. Although a little beside ı asked, it may be interesting to briefly notice t methods of condensing now in use, as it is pe of condenser used that the answer to the of the question to a certain extent depends. nt methods may roughly be considered under : (1) where there is a plentiful supply of water boiler feed water; (2) where there is a plentiful ıter which is unsuitable for use in the boilers; (3) ı is a very limited supply of water. In the first re two types of condensers available—the jet condensers. In both of these types the cooling exhaust steam come into direct contact, and ıer into the hot-well to be used for boiler pur- the second method three types are available— , ejector, and evaporative types. In this case condenser is most generally used, as the cooling steam do not come into direct contact. The ı into the hot-well for use over again, and being unfit for feed water, is allowed to run e river, canal, or from whatever source it been taken. The ejector type may be if adopted the improvement would depend on the increased vacuum, as the condensed d run to waste with the cooling water. The condenser may also be used, but it is under the that this type has a great advantage over any nser, being, in fact, the only one which could success be used under these conditions. Its is due to the very small amount of water r cooling purposes, this very rarely exceeding ; required for feeding the boilers, and is in some about half this quantity. The part of the ques- ing the use of separate condensers for each a plant sufficient to cope with the exhaust whole of the engines, must be governed by ions of each particular station, and is also as mentioned before, upon the type of con- d. For instance, the air and circulating pump o the jet or surface condensers make them too s and expensive to allow of using separate con- this type for each engine, unless the engines are able horse-power. Where it is thought advisable ar condensers—and this type has a great deal and its use in the way of cheapness and sim- are usually made in small sizes and fitted ngines, as they need no air-pump, and, if a of about 15ft. to 20ft. is available, a force ı be dispensed with. Another advantage for ondenser is that they can be used as spray ns using the condensed steam and cooling feed purposes at an increased temperature, or else, if the cooling water is not good enough for this, they can be used to simply condense the steam and thus produce the vacuum required. It is a very difficult matter to give even approximate figures as to the economy of the use of condensers, as they vary according to the difficulties in the way of laying down the plant and the conditions under which it is worked, but it may be taken for granted that there is a saving in fuel of from 15 to 25 per cent. effected.—F. A.

FORTHCOMING EVENTS.

FRIDAY, MARCH 18.

Royal Institution.—At 9 p.m., "The Bringing of Water to Birmingham from the Welsh Mountains," by James Mansergh, V.-P. Inst.C.E., F.G.S., M.R.I.

SATURDAY, MARCH 19.

Institution of Electrical Engineers.—Students' visit to the works of Messrs. Easton, Anderson, and Goolden, Erith. Train from Charing Cross, 10.2 a.m.

Institution of Junior Engineers.—Visit to Messrs. J. and E. Hall's refrigerating machinery works, Dartford. Train leaves Charing Cross at 2.30 p.m.

MONDAY, MARCH 21.

Society of Arts.—At 8 p.m., Cantor lecture, "The Thermo-Chemistry of the Bessemer Process," by Prof. W. N. Hartley, F.R.S.

TUESDAY, MARCH 22.

Institution of Civil Engineers.—At 8 p.m., further discussion on the paper by Henry Fowler, Assoc.M.Inst.C.E., on "Calcium Carbide and Acetylene." Paper to be read, time permitting: "Extraordinary Floods in Southern India: Their Causes and Destructive Effects on Railway Works," by E. W. Stoney, M.E., M.Inst.C.E.

Royal Institution, Albemarle-street.—At 3 p.m., Prof. E. Ray Lankester, M.A., LL.D., F.R.S., on "The Simplest Living Things."

WEDNESDAY, MARCH 23.

Institution of Civil Engineers.—At 7 p.m., Annual Dinner in the Middle Temple Hall; Sir John Wolfe Barry, president, in the chair.

THURSDAY, MARCH 24.

Institution of Electrical Engineers.—At 8 p.m., "Cost of Generation and Distribution of Electrical Energy," by R. Hammond.

Royal Institution, Albemarle-street.—At 3 p.m., Tyndall Lecture, "Recent Researches in Magnetism and Diamagnetism" (Lecture IV.), by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., M.R.I.

Finsbury Technical College.—At 8 p.m., L. J. Steele on "Electricity Meters."

FRIDAY, MARCH 25.

Physical Society.—At Burlington House, at 5 p.m., Papers will be read: "On the Circulation of the Residual Gaseous Matter in a Crookes Tube," by A. A. Campbell Swinton; and "On Some Improvements in the Roberts-Austen Recording Pyrometer, and Notes on Thermo-electric Pyrometers," by A. Stansfield.

Institution of Civil Engineers.—Students' meeting, at 8 p.m., "Internal Governor Friction," by H. O. Eurich.

Electro-Harmonic Smoking Concert at the St. James's Hall, at 8 p.m.

Colour Photography.—Lippmann, Joly, and Ives seem likely to be relegated to a back seat. On the 16th inst. Mr. Arthur W. Clayden, M.A., F.R.Met.Soc., principal of the new college at Exeter, while delivering a highly interesting and entertaining lecture on "Photographing Meteorological Phenomena," showed some views of clouds taken by him after a process which he had invented only a few weeks ago. These photographs showed beautiful blues in all their gradations, from ultramarine down to perfect white, various greys, and some brown, red, and greenish tints. The revolutionising feature of Mr. Clayden's process is that these coloured photographs are positives—that is to say, that he has succeeded in obtaining coloured prints by a purely chemical way of developing the same on a specially-prepared plate. It is true the process is up to the present restricted to lantern slides, but these are not coloured by painting, but by development. Coloured paper prints loom distinctly in the near future. Mr. Clayden says the bright reds have so far escaped him. Further experiments and probably a longer development will, however, even overcome that difficulty. As an intermediary stage between plate printing and paper, ivory or thin celluloid plates might be suggested. Mr. Clayden's process may easily turn out to be the most valuable photographic discovery since the days of Daguère.

THE

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TO CORRESPONDENTS.

 Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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GENERAL CLAUSES IN CONTRACT

When the two parties most interested in
work have settled matters to their own sat
there is not much to be said upon the s
outsiders. It is high time, too, that somet
settled in this matter of general conditio
matter was becoming critical. On the
there were many men who had had littl
experience of factory organisation or w
the tendency was to stipulate more and mo
conditions, each new man trying to come o
than his predecessors in order to show, we
his suitability for the position in which
placed. On the other hand were a body
facturers who knew that ofttimes the c
stipulated were impossible, and entered
contract with no intention of fulfillin
That there has been so little visible fr
one more proof of the good sense of both pa
of the exact compliance with verbal c
Now, however, we have, at any rate, sett
a definite starting point, and having agre
in future any changes found to be desirab
also be mutually agreed before the cha
actually made. Of course, the aim is not t
but the workable. Two conflicting inte
never each achieve its ideal. The manu
interest lies in one direction, the pu
in another; the former is quite willing
perfection, so far as the present knowled
science permits, at a fair price, but the latt
wants perfection at an impossible cost.
the existence of the two parties is spe
determination of what ought to be given
price the one party is determined to p
general clauses of every specification,
mostly clauses to guard against the degene
of the human nature to be found in most
careful examination of the proposed gener
will show that this is so, and that an agr
set of pains and penalties will be enacte
those whose degeneracy causes laxity in ca
the work entrusted to them. But while
the necessity of workable general clauses,
the manufacturers have as grave a c
to urge against the careless way in w
remainder of a specification is often dr
The minatory clauses can be generally ag
the special clauses depend for their exacti
verbal accuracy upon the individual. If
neer is at all uncertain, and owing to un
gives too much latitude to the manu
troubles must arise in the interpretation
inexact clauses. Stringency in the genera
is the result, not the cause; the cause i
uncertainty we have just referred to. Wh
we welcome any approach to general agree
must insist upon the necessity of some
paying closer attention to the other clause
specifications. Our trouble in discussing th
is the old one: that specific examples c
mentioned, which makes it exceedingly d
point a weighty moral. It is a simple matt
indefinitely word a clause that its interpre
a most difficult matter, and when, as is s

e, the framer of the clause is a little dubious the whole subject himself, the difficulty es greater. If the manufacturer hits the nail head and constructs something satisfactory, nsultant says nothing and takes the credit. vever, the manufacturer fails, the consultant has attempted something not meant by the of the clause.

REVIEWS.

Telephony. By J. BELL, A.I.E.E., and S. WILSON. lon: *Electricity*. Price 2s. 6d.

l the applications of electricity, telephony seems t wonderful as it is one of the most useful. Within n of Victoria, telegraphy, telephony, and electric have become general, and of these telephony entirely to the reign; nay, more, it belongs to quarter of the nineteenth century. The general of the telephone and the microphone is not to understand, nor is the apparatus used in . Messrs. Bell and Wilson have undertaken, and cceeded, in producing an elementary book suited wants of students reading for the City and Guilds Science and Art Department examinations. The have adopted a simple method in treating the In the first place, they briefly discuss the history elephone, then they touch on the requirements of one circuit, subsequently dealing with the apparatus fulfil these requirements in detail, with such a n of theory as will enable the student to underhe why and wherefore of the apparatus. Many forms of detail parts of apparatus are described, course, from the students' point of view, that is all equired, providing the description, as on the whole ubtedly is, is correct. If, however, the book is d to be more than this, rival manufacturers would that certain details they introduced are better than shown. A good deal of information dealing with ness organisation of lines and exchanges is given, as about auxiliary apparatus, but the whole is kept thin bounds, and does not go outside the special the book is designed to meet. We think it is a od first book on the whole subject, and cannot fail the student well.

t Dictionary of Electrical Words, Terms, and Phrases, g the Supplemental Matter to, or an Epitome of, the th Edition of a Dictionary of Electrical Words, Terms, Phrases. By EDWIN J. HOUSTON, Ph.D. New York: rican Technical Book Company.

olume of nearly a thousand pages can claim to be a ook, we have no objection to the claim, but prefer k outside rather than inside our own pockets. ise this is a dictionary, as it professes to be, ng itself to definitions; and as Prof. Houston is hor, it would be difficult to find a more competent y to compile such a book. The criticism of defini- a work of supererogation, for no two authorities ee upon the exact verbal rendering of a definition. works as this, however, we look upon the words and s explained rather than defined—a simpler task, and it may be more valuable. This, indeed, is what ouston has done, and the man of ordinary intelli- ill usually find the explanation clear and concise. k is excellently bound and printed.

ndard Electrical Dictionary. By T. O'CONOR SLOANE, L, Ph.D. Second edition, with appendix to date. London: sby Lockwood and Son. Price 7s. 6d.

ave largely used the first edition of this book, and t extremely useful. Many of the terms defined are nisms, but none the worse for that, as the majority aken root and flourish here. We wish that the appendix which has been added to bring the book up-to-date could have been incorporated in the text. People who consult reference books do not always think of appendices, and do not find what they seek. In this case, however, there is a good index, and before putting aside the book as not containing the word or term wanted the index should be consulted. The index saves a large number of cross references, and is better for the purpose required than cross references would be. This work is more than a dictionary, in that it gives more than definitions, and in many cases the brief descriptions and illustrations give all that is required to describe the apparatus.

LORD KELVIN'S PATENTS.*

(Continued from page 303.)

IMPROVED GOLD-LEAF ELECTROSCOPE FOR THE APPROXIMATE MEASUREMENT OF POTENTIALS ABOVE 500 VOLTS.

The instrument is an improvement upon the well-known electroscope, in which a pair of gold leaves, pith balls, or other light bodies are used for showing by their mutual repulsion some of the elementary phenomena of electrification. The object of the invention is to provide a convenient means of measuring approximately differences of potentials in cases where the accuracy of an electrometer is not required, and where its consequent expense would be a serious consideration. In the instrument to be described only one narrow gold leaf is used, and this is attached by a clamp to a broad plate of brass as shown in Fig. 6. This brass plate is supported on a block of

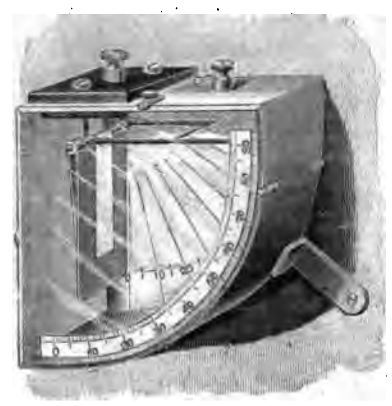

FIG. 6.—Gold-Leaf Electroscope.

vulcanite from the roof of the case, and has a binding screw attached to it. The case of the instrument—with the exception of the front, which is of glass—is of metal, and the portion below the leaf is cylindrical in shape so as to obtain from its inductive action a wide range of sensibility. A scale is engraved upon the back of the case, and another is placed in front close to the glass in order that the deflections of the instrument may be read off without error due to parallax. A hinged frame is attached to the repelling plate, which folds down over the leaf to prevent damage during carriage, and when turned up as shown in the figure it acts by repulsion as a guard which effectually prevents the leaf from touching the roof of the case at abnormally high potentials. Two terminals are provided; one is attached to the case, and the other on the vulcanite block is in metallic connection with the repelling plate and the gold leaf. The instrument, as above stated, is intended mainly as an approximate potential indicator for high-potential circuits, and it may be used with advantage as a constant indicator to test the equality of the pressures between earth and each of the two primaries of a high-tension system It is also useful to test that the potential of the secondary or distributing circuit is less than 200 volts. As a lecture-room instrument it will be found more convenient

* Abstract of paper read by Dr. Magnus Maclean to the Philosophical Society of Glasgow, Feb. 23.

and less liable to damage than the ordinary forms of electroscopes hitherto employed.

Standard Air Leyden Condenser for the Determination of Small Electrostatic Capacities.

The apparatus to be described affords, in conjunction with a suitable electrometer, a convenient means of quickly measuring small electrostatic capacities, such as those of short lengths of cable. The instrument is formed by two mutually insulated metallic pieces, which we shall call A and B, constituting the two systems of an air condenser, or, as we shall now call it, an air leyden. The systems are composed of parallel plates, each set bound together by four long metal bolts. The two extreme plates of set A are circles of much thicker metal than the rest, which are all squares of thin sheet brass. The set B are all squares, the bottom one of which is of much thicker metal than the others, and the plates of this system are one less in number than the plates of system A. The four bolts binding together the plates of each system pass through well-fitted holes in the corners of the squares; and the distance from plate to plate of the same set is regulated by annular distance pieces which are carefully made to fit the bolt, and are made exactly the same in all respects. Each system is bound firmly together by screwing home nuts on the ends of the bolts, and thus the parallelism and rigidity of the entire set is secured.

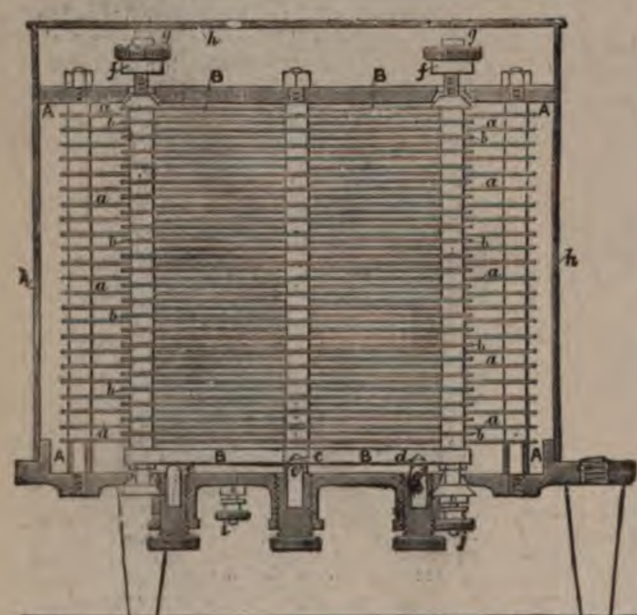

Fig. 7.

The two systems are made up together, so that every plate of B is between two plates of A, and every plate of A, except the two end ones, which only present one face to those of the opposite set, is between two plates of B. When the instrument is set up for use, the system B rests by means of the well-known "hole, slot, and plane arrangement,"* engraved on the under side of its bottom plate, on three glass columns which are attached to three metal screws working through the sole-plate of system A. These screws can be raised or lowered at pleasure, and by means of a gauge the plates of system B can be adjusted to exactly midway between, and parallel to, the plates of system A. The complete leyden stands upon three vulcanite feet attached to the lower side of the sole-plate of system A.

In order that the instrument may not be injured in carriage, an arrangement, described as follows, is provided by which system B can be lifted from off the three glass columns and firmly clamped to the top and bottom plates of system A. The bolts fixing the corners of the plates of system B are made long enough to pass through wide conical holes cut in the top and bottom plates of system A, and the nuts at the top end of the bolts are also conical in form, while conical nuts are also fixed to their lower ends below the base-plate of system A. Thumbscrew nuts, are placed upon the upper ends of the bolts after the pass through the holes in the top plate of system When the instrument is set up ready for use these thum screws are turned up against fixed stops, g, so as to be we clear of the top plate of system A; but when the instr ment is packed for carriage they are screwed down again the plate until the conical nuts mentioned above a drawn up into the conical holes in the top and botto plates of system A; system B is thus raised off t glass pillars, and the two systems are securely lock together so as to prevent damage to the instrume A dust-tight cylindrical metal case, h, which can easily taken off for inspection, covers the two syste and fits on to a flange on system A. The whole instrum rests on three vulcanite legs attached to the base-plate system A, and two terminals are provided, one, i, on t base of system A, and the other, j, on the end of one the corner bolts of system B.

The air leyden which has been thus described is u as a standard of electrostatic capacity. To explain its in connection with an idiostatic electrometer for the dir measurement of the capacity of any insulated conduct suppose, for example, this insulated conductor to the insulated wire of a short length of submarine ca core, or of telephone, or telegraph, or electric li cable, sunk under water except a projected portion

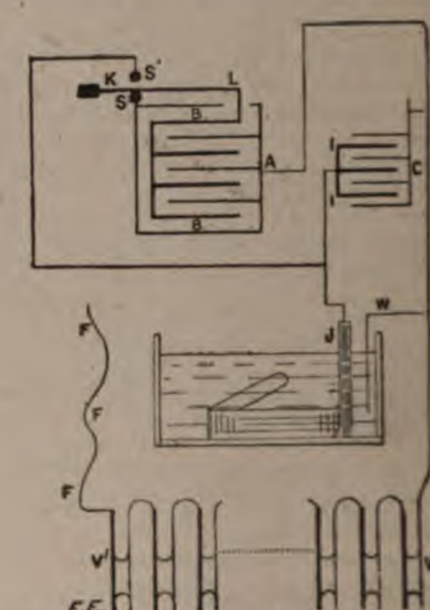

Fig. 8.

allow external connection to be made with the insula wire. The electrometer which is found most conven is the "multicellular voltmeter," rendered practically d beat by a vane under oil hung on the lower end of long stem carrying the electric "needles" (or mov plates). To give a convenient primary electrification the measurement, a voltaic battery, V V', of about 150 200 elements, of each of which the liquid is a drop water held up by capillary attraction between a and copper plate about 1mm. asunder. An ordin electric machine, or even a stick of rubbed sealing-w may, however, be used, but not with the same faci for giving the amount of electrification desired as voltaic battery. One end of the voltaic battery is joined metallically to a wire, W, dipping in the water which the cable is submerged, and with the case, C, of multicellular, and with the case and plates, A, of the ley and with a fixed stud, S, forming part of the opera key to be described later. The other end of the vol battery is connected to a flexible insulated wire, F used for giving the primary electrification to the insula wire, J, of the cable, and the insulated cells, I I, of multicellular kept metallically connected with J. insulated plates, B, of the leyden are connected spring, K L, of the operating key referred to above, w when left to itself presses down on the metal stud, S,

* *Thomson* and Tait's "Natural Philosophy," § 198, Example 5.

very perfectly insulated when lifted from contact by a finger applied to the insulating handle, K. A well-insulated stud, S', is kept in metallic connec- h J and I (the insulated wire of the cable and the d cells of the multicellular).

ake a measurement the flexible wire, F, is brought to touch momentarily on a wire connected with , S', and immediately after that a reading of the eter is taken and watched for a minute or two to er that there is no sensible loss by imperfect insu- the cable and the insulated cells of the multi- or that the loss is not sufficiently rapid to vitiate surement. When the operator is satisfied with this

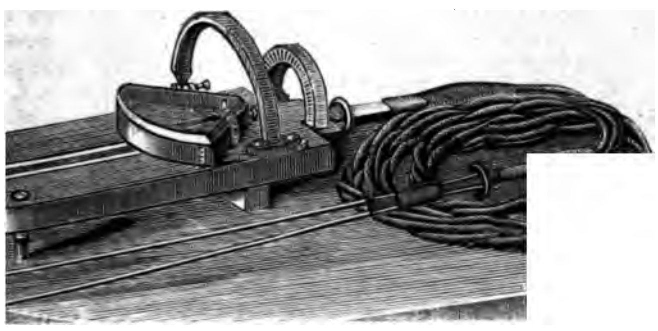

FIG. 9.

ls his reading of the electrometer, presses up the , of the key, and so disconnects the plates, B, of m from S and A, and connects them with S', J, I. r twenty seconds of time suffices to take the thus d reading of the multicellular, and the measure- omplete. The capacity of the cable is then found nalogy: as the excess of the first reading of rometer above the second is to the second, so apacity of the leyden to the capacity of the small correction is readily made with sufficient for the varying capacity of the electrometer to the different positions of the movable plates, ding to the different readings, by aid of a table tions determined by special measurements for for the purpose on the multicellular.

POTENTIAL GALVANOMETER.

nstrument is shown in Fig. 9, and consists essen- a coil of insulated copper or German-silver wire, C, ance of which is generally over 5,000 ohms, fixed d of a platform, P, on which a magnetometer, M, he magnetometer, M, is supported on three feet ing; two of these feet slide in a V groove, cut of hardwood let into the top of the platform, P, allows the magnetometer to be moved nearer to r from the coil, but prevents it being so turned to change the zero reading of the instrument.

up the instrument for use, place it with the plane l in the magnetic meridian by turning the instru- til the index of the magnetometer points to zero ale when the semi-circular magnet is removed, and by turning the screws shown at the front of the until the bubble of the circular level attached to etometer stands in the centre of the level. The y of the instrument is changed by changing the of the magnetometer on the platform. When of the magnetometer is placed at any division ale marked on the platform, the number stamped division indicates the deflection, in divisions of etometer scale, produced by one volt difference ntial between the ends of the coil, the y of the magnetic field in which the magneto- eedles are placed being supposed unity. In avoid as much as possible errors due to changes gnetic field produced by local influences, a per- magnet of semi-circular shape is supplied with each t for the purpose of producing a field at the eter needle much more intense than that of the This magnet is placed on the magnetometer in tion shown in Fig. 9, and its field brought into parallelism with that of the earth by turning the screw at the point of the magnet until the magnetometer index points to zero. The absolute intensity of the magnetic field at the needle due to this magnet alone is carefully determined and, with the date of the determination, marked on the magnet before the instrument is sent out. The total intensity of field is obtained by adding the horizontal component of the intensity of the earth's field to the number marked on the magnet. To avoid accidental demagnetisation of the magnet, it must be kept at a distance from all other magnets. A fall or violent shock of any kind may also alter the magnetisation of the magnet, and must therefore be avoided.

It is desirable that the field which the magnet gives at the needles should be determined from time to time. This may be done for the potential instrument by means of a standard cell, and for the current instrument by electrolysis.

In order to facilitate the use of the instrument, a pair of flexible electrodes, about four yards long, are supplied with it. These electrodes are shown attached to the instrument in the figure. The spring clips attached to the ends of the electrodes allow the instrument to be readily put in contact with two points of a circuit. To prevent a current passing through the coil when no reading is being taken, a key is placed in the circuit of the coil. This key should on no account be permanently short-circuited, because the coil becomes heated when a continuous current is allowed to flow through it, and is consequently increased in resistance. The indications of the instrument are thus made too small.

(To be continued.)

INSTITUTION OF ELECTRICAL ENGINEERS, Mar. 10.

On the Manufacture of Lamps and other Apparatus for 200-Volt Circuits.

BY G. BINSWANGER BYNG, MEMBER.

DISCUSSION.

(Continued from p. 271.)

The **President** said before the discussion on Mr. Byng's paper commenced, there was a matter he would like to speak on. A testimonial was being organised in Belgium for Mr. Zénobe Gramme, who, as they all knew, had done so much in the cause of electrical engineering. He did not think it right that they should take no part in honouring Mr. Gramme, and a circular was being prepared asking the members for subscriptions. A medal had been struck in commemoration of the event, and donors of 10s. would be presented with a bronze medal, and those giving 25s. would have a silver medal.

[We are requested to state that members wishing to obtain tickets for the banquet (price £1) should apply to M. Roosen, 64, Rue Vondel, Brussels, before March 21. Subscriptions should be forwarded to Mr. W. G. McMillan, secretary of the Institution, as soon as possible, so that the first list, to be published on March 24 may be as large as possible.]

The discussion was then resumed.

Mr. C. H. Stearn said it was just two years since a discussion took place in that hall upon high-voltage lamps. He then read one or two extracts from his remarks on March 12, 1896, on high-voltage lamps. He thought then that the double-filament lamps were the most convenient, owing to the great length of filament required and the difficulty in making this sufficiently rigid singly. He was sure, however, that the single filament would eventually come in when a means of increasing the rigidity of the carbon was found. Two years ago he had mentioned two alternatives, of which one was a filament of high specific resistance. This had come in for a time, and he thought it the best for the transitional period, but a better arrangement would without doubt be devised. The proper policy in this case was to act quickly. If the adoption of the 200-volt lamp seemed to meet the requirements—viz., endurance, durability, and no increase of price—the sooner it came in the better. In 1887 the carbon filaments obtainable were very rough, and treating them was first tried to obtain greater durability in transit, as when the lamps were received, as a rule more than half the filaments were broken. Since then Mr. Swan had given them the process of squirting cellulose into a zinc solution at high pressure, and carbon filaments prepared in this way were much better than any others. The untreated carbon had, however, one advantage

over the treated: the untreated carbon did not vary in thickness, but once they began the treating process they got variations in each individual filament. It seemed to him that at first it was desirable to start with a success, as every 200-volt lamp that cracked or broke would be brought up as showing how bad they were, whereas if they had been 100-volt lamps no notice would have been taken. The piece of wire 14in. long he showed them bent like an ordinary filament, and was a very cumbrous thing, but when bent back many times upon itself it was rigid, and went into just as small a compass. The fears of the public had now been allayed, and they would settle in favour of a long-life lamp. He was surprised to hear that one in twelve short-circuited. Was it not a case of Tommy and his cats, when he came down from 1,000 cats in the garden to two. He did not agree with the author as to the cause of the short-circuits. A great many were due, in his opinion, to the filaments getting entangled when in transit, or to a tiny crack in the glass allowing a little air to get in, or to bad capping and careless exhaustion. As to the distance apart of the lead wires, he would remind them of the Newcastle experiment, in which they brought the wires out at the side of the bulb. They then found that the same distance might safely be used for 100-volt lamps as for 50 volt, and he thought the same would do for the 200 volt. He had never experienced any difficulty with occluded gases. As to increase of candle-power when running, that lay entirely in the hands of the maker. It did increase somewhat if run at a very high efficiency, but he had tried it at 3½ watts, and it increased so slowly that it did not make the lamp less long-lived. A continual slight increase of candle-power for about 300 hours gave a good lamp. To vary the voltage to reduce the price of the lamps would not do, as if in Westminster they had 200 volts and in Edinburgh 220 volts, then Westminster would have the successes and Edinburgh the failures. Accuracy in calculation rather than cheapness was to be sought after by the makers. Mr. Byng proposed to make 230 volts the highest voltage, but why should they throw away the extra 20 volts allowed by the Board of Trade? There was no reason why 500-volt incandescent lamps should not be used for street-lighting. Other things being equal, he thought the treated 200-volt lamps would be successful. With regard to the life of lamps on alternating circuits being rather longer than on direct-current circuits if the lamps were not properly exhausted this would be so. By using boron in proper proportions the resistance might be made the same from zero to very high voltages, and the boron did not separate out even at one watt per candle.

Mr. R. E. B. Crompton said he had to congratulate Mr. Byng on his paper. He had had the lighting of Harrow to undertake some years ago, and his experience of 200-volt lamps there was very satisfactory. He had tried Mr. Stearn's device and found it give satisfaction. He had been deputed by the committee who drew up the Institution wiring rules to ascertain the length of break required for high-voltage switches and fuses. After a large series of experiments with varying lengths of break, he had found that no simple table could be prepared. With the cut-out they wanted a larger cap, and he did think it was right to say that the explosion was not due to the expansion of hot air in the fuse box. He thought that plaster of Paris was an excellent thing to use for fuse covers. He would not say anything about arc lamps, except that he did not agree with the author on this subject.

Mr. James Swinburne said that one of his assistants said the other day that at the end of every chemistry book there ought to be the words: "N.B.—Chemistry may be quite different now." The question of high or low volt lamps had been going on since 1885. In his opinion the unflashed filament was the best, but some animal fibres, such as silk, when carbonised, had nearly the same resistance whether cold or hot. The question of the effect of treating a carbon filament was raised at the now historical lamp lawsuit. He had then expressed what was considered to be a most unorthodox opinion, that the treatment did not increase the light-giving power of the carbon filament in fact, temperature and efficiency were most intimately connected, and their ratio was independent of the treatment by flashing.

Mr. C. H. Wordingham said that in Manchester they had always had available a 200-volt supply. He had had no complaints from the consumers. Engineers had overlooked the fact that arc lamps had to be used on the same circuit as incandescent. They should not be forced to use 230 volts or 250 volts. At the Municipal Association's meeting in 1896 he had showed broken samples of defective fittings. After extended trials, he found it a safe test to prescribe that a switch must be capable of breaking 50 per cent. excess current at 50 per cent. excess voltage, and that fuses must be able to break and short-circuit at 50 per cent. excess voltage. Thus a five ampere switch for 200 volts must break 7½ amperes at 300 volts without damage. It was said that only 200 volts ought to be used. A cut-out must break 200 volts to be of any use. He had tried Mr. Byng's fuses, and found them the best he had ever seen.

Mr. W. R. Rawlings said he viewed the matter from a contractor's point of view. He was not actually a consumer himself, but he was a contractor. He had been ill since the 200-volt lamps had come in. He had some customers who had changed from 100-volt to 200-volt lamps, and he was almost frightened to go to these people. He had also some customers who had only tried 200-volt lamps, and these were as nice about it as they could well be. He supplied society customers entirely, and up to the present time it was his opinion that the lamps were not a great success.

Mr. Leon Gaster said he had tested a number of lamps, and found the efficiency very variable. Much depended on the composition of the filaments.

Mr. A. A. C. Swinton said that in the future he thought there *would come a time when* they would not have to depend on filaments at all. Why should they not do it with the cathode rays? Great heat could be got from cathode rays. The great difficulty about this lamp would be that 20 000 volts would be required, and this was rather too much for the Board of Trade.

Mr. H. W. Miller said that in Kensington he had had experience of 600 consumers, half of whom had had their lamps changed from 100 to 200 volts. Complaints had been received from those that the lamps did not give as good a light as the 100-volt. With regard to combination filaments, he did not agree with the author. He had had experience with such filaments taking only 2½ watts per candle, which showed that they might come largely into use in the future. As to the action of the fuses he thought that when a fuse burnt, if there were no ventilation hole, the cover would be blown off by the hot air. Copper fuses were never run at a dull red heat. It was impossible to use such a soft metal as tin for fuses. Mr. Stearn was right in saying that flashed carbon was the ideal, and also that unflashed carbon had worked best so far. They ought to thank Messrs. Wynne, Powell, and Evans for having brought the celluloid-zinc process to a successful issue, and to-day there was not a lamp in America which was not made by this method. Lord Kelvin had said that more light (one-third more) could be got from the lamps by changing the polarity.

Mr. W. Geipel said the whole question resolved itself upon the ability to keep up a constant pressure. It had been said that central station engineers had brought up this question, but he thought it was the makers of the lamps who wished it settled.

Prof. S. P. Thompson said it was rather unfortunate that the consumer did not come in somewhere. He would prefer 100-volt to 200-volt lamps himself, and 50-volt to either. They wanted for the 200-volt circuit a better flexible wire than was now used. He had experimented in his laboratory on some arc lamp carbons. He took an ordinary carbon and one of Mr. Gaster's treated carbons and slit them down the centre. He then tied half of one on to half of the other and put them in an arc lamp. He then by means of photography found that Mr. Gaster's treated carbon gave 25 per cent. more light than the other one. Mr. Byng despaired of ever obtaining more light by using the rarer earths, and Sir W. Crookes and he (the speaker) tried experiments and could not then find a substance which did not volatilise straight away.

Mr. Grimshaw said he would like to remark upon the short-circuiting of 12 per cent. of lamps. His firm had supplied 40,000 such lamps, and only about 2 per cent. had short-circuited. The 200-volt lamps made greater progress than did the [illegible] lamps at first. They were just what was wanted for scattered areas.

Mr. J. W. Swan said he agreed with Mr. Byng that it was the customers' verdict on which all depended, and if it was decided on the question of price it would be in favour of the 200-volt. The best 200-volt lamps now on the market were quite equal to the 100-volt lamps at present in use. He did not agree that untreated carbon was as good as treated. The cost would be lowered by the larger supply which could be given. The reduction was sure to come in the long run. Mr. Mordey would perhaps be surprised to find that untreated carbon showed no sign of porosity. In the fuses and switches for high voltages every safeguard should be taken, and this was an opportunity for the younger members.

Mr. Binswanger Byng, in replying, said he would reply under three headings—viz., lamps, fittings, and arcs. He felt greatly honoured by having two such veterans as Messrs. Swan and Stearn to reply to. It was now 20 years since Mr. Swan had first laid down his gas-engine to try experiments, and Mr. Stearn was also one of the earliest pioneers in this business. He said, with him, that he was not afraid to make 200-volt lamps. Though Mr. Stearn seemed to criticise adversely, he really only added other details to his remarks. As he criticised adversely as to whether lampmakers should make their lamps of varying efficiency, it was only because he (Mr. Stearn) had found it so in his own experience. They were certain they could make 200-volt lamps as efficient as 100-volt. They were now making them at 3½ watts. He thanked Mr. Wordingham, but he would stick to his guns and say his explanation of the fuse action was the correct one. With regard to arc lamps, Mr. Mordey had said that the watts consumed in an arc lamp were proportional to the light given by it. He thought this must be wrong. There were two phenomena in the arc lamp, the electrolytic action and the flame. The crater gave all the light and the flame none, only heat being obtained from it. All extra power went into the flame and increased the heat.

Mr. C. J. Robertson has sent us a communication which he intended to read at the meeting: With regard to incandescent lamps, he thought it necessary to point out that the author had not run down all high-voltage lamps but had only pointed out some of the peculiarities of high-voltage lamps with unflashed carbon. He had shown that for such lamps flashed carbon would give them the ideals sought for in a good lamp, stating that "such lamps compare favourably with those of lower voltage." The Robertson Lamp Company made several types of high-voltage flashed carbon lamps, but in some cases it was necessary to use larger bulbs than those in general use. For instance, the 220 and 250 volt lamps required bulbs about ¼in. to ⅜in. larger in diameter, and they would like to [illegible] that this small increase in the size of the bulb would be accepted to engineers and contractors although they were quite prepared to supply 220 and 250 volt flashed filaments in the usual bulbs. Now that engineers and others had passed over the responsibility to the lampmakers of providing high-voltage lamps as good as those of low-voltage, success would only be obtained by an interchange of experience. For instance, smaller bulbs were possible if unflashed carbon with its concomitant disadvantages were used. On the other hand, to obtain the advantages of flashed

without any accompanying disadvantage, assent to of larger bulbs was sometimes necessary. It was now that 999 lamps out of every 1,000 manufactured had ts derived from a solution of cellulose zinc chloride ose introduction and practical working they had to and were under great obligation to, Messrs. Wynne, and Evans), and that each of these filaments had approxi- the same specific resistance in the finished lamp. When ints, vacua, etc., of such lamps were equal, then it was that present-day unflashed lamps should be very similar haracteristics and behaviour of their filaments. He had ost of the high-voltage lamps now on the market and found was so, and that such unflashed lamps had the peculiarities out in the author's paper. In deference to the wishes of asumers for a small-sized bulb, his company had made such He did not advocate that flashed lamps were a panacea for s there were certain styles of flashing which would produce which was no better than a well-baked unflashed one. Also d carbons, if baked in an electrical furnace, occupied the posi- sing between a properly flashed and an ordinary unflashed rbon. Mr. Mordey thought that specific resistance should with specific gravity. With carbon at present used s, lowness of specific resistance generally accompanied l density (or specific gravity). The carbon needles f retort carbon as found inside gas retorts, suggested by dey for use in lamps, had been tried, but the quality of bon was not so good as well-flashed filaments, and it was, in a very unmanageable form. He would have liked to experience of others on the relative advantages of burning alternating and continuous currents, a subject referred Mordey. His later experience since writing the letter *lectrical Review*, and to which Mr. Mordey had referred, ened his previous opinion, stated therein, that an alter- arrent of the same percentage variation as a continuous one o increase the life and retention of candle-power of lamps. g on this subject, he could recollect 11 or 12 years ago rd Kelvin drew attention (as a result of experiments made) that, with continuous current, lamps would last f the polarity of the circuit was constantly changed. een stations where such were still in existence, but they now used, as the object for which they were originally had doubtless been forgotten. This was really corrobo- his own experience with alternating currents, as con- currents of very rapidly-changing polarity were alter- urrents. There seemed to be some additional proof as to en wear of the filament subjected to a continuous current, experience of the manufacture of the original "Crypto" . This was formed by raising a very fine platinum wire descence in a hydro-carbon gas. By this means carbon t round the wire, and as continuous currents were used for pose, it was found that there was always a far greater of deposit on the negative than the positive end, and for son the polarity of the current had to be continually in order to obtain an approximately even building up of ent. A close inspection of the filaments which had run ating and continuous current showed that there were dis- ysical changes going on which explained the advantages by running lamps on alternating current. Mr. Shool- d remarked that he had not found much trouble by 220-volt lamps in a horizontal position—at least, with aped filaments. His experience with these and all similar wavy-filament lamps which were now on the market that such wavy filaments when used for horizontal burning t quite successful unless supported, or unless they had d carbons, with their unavoidable peculiarities, as ted by the author—points, however, upon which Mr. d did not touch. Flashed wavy filaments at present on ket seemed to be no better for horizontal burning than der types of high voltage lamps, for in spite of being eir filaments soon sagged on to the bulb. It was periences which had led to his company designing w type of flashed high-voltage lamps with curl , each curl being supported. Numerous and lengthy oved that such lamps were giving every satisfaction, e quite equal to 100-volt lamps. This type also had itional advantage that high-voltage lamps with low ower were possible, such as 200 or 230-volt 8-c.p. p. at 4 and 4½ watts. Some of the previous speakers o have taken exception to the last two lines on p. 2 of ract, but the author had only remarked that 'I have eral engineers say that they expect one in twelve to go in ." This was not, however, the experience of the Robertson , and doubtless referred to some early experience with ign type of lamp, as their experience showed that care- le and exhausted high-voltage lamps were no worse in ct than 100-volt lamps. With reference to Mr. Stearn's he was glad to hear that he agreed with the author that high-voltage lamp was one with a flashed carbon, and shed carbons were only a transitional stage of develop- The Robertson Company's new high-voltage lamps, had passed out of this transitional stage into the ideal ; is to say, they had well flashed carbons. Mr. Stearn d virtues in his present untreated carbon filaments, which, ay, were very ancient, and pointed out that previous were soft, porous, cokey, etc. This might be misleading r. Stearn referred to either filaments of the dark ages, ratory, or else to the parchmentised cotton filament of had had so much experience. The present "Stearn" fila- he had every reason to believe, one of the 999 class to which reviously referred (squirted cellulose in zinc chloride). This filament was one with which he had had 10 years' continuous manufacturing experience, and it had, when properly made, even 10 years ago, the same virtues that it had to-day. Mr. Stearn was therefore somewhat tardy in extolling its virtues. It was used by the Brush Company for their lamps in 1886 or even earlier, and was used by their old factory to this day. About 1887 this filament was in general use by the larger Continental makers, and was also used by them to day. Right along from 1884 to the present time similar filaments had been continuously made from modifications of cellulose, as used by Weston and passed on to Khotinsky and Siemens, and also he believed to the Allgemeine Company, of Berlin, etc. There was also the equally glass-like filament of Woodhouse and Rawson of several years ago. In comparison with the above long experience gained with this class of filament, Mr. Stearn would appear to be a comparatively recent convert, and the Edison and Swan Company had, he believed, been only recently converted to partially adopt it about 18 months ago or thereabouts. In addition to the above ancient history of glass like, non-cokey filaments, and which were considered the best to-day, they had the extraordinary fact that, in spite of the long manufacturing experience obtained with this filament since 1884, yet none of these firms left such filaments as they were, but they generally flashed or treated them ; and many valuable papers had been read in the past as the result of experience made on the comparative advantages of flashing this same filament. The final fact which would prove to everyone that the virtues of flashing or treating were real, and were more than met the eye, was that even those firms who now used unflashed carbon for their 200-volt lamps still continued to make all their 100-volt lamps with flashed carbon. He would point out with reference to Mr. Stearn's remarks on efficiencies, in which he referred to the author's remarks at the bottom of p. 3 of the abstract, that there was a printer's error in the position of the comma, which should come after the word "efficiencies," and not after "voltages." The author's sentence, instead of reading "and the present practice of varying efficiencies with voltages," etc., should read, "and the present practice of varying efficiencies (with voltages running, in the case of low-voltage lamps, from 95 to 120 ; and in the case of high-voltage lamps from 200 to 230"). With this correction, Mr. Stearn's remarks show that he was in practical agreement with the author upon the variations of manufacture, and the convenience afforded of supplying efficiencies at any required voltage, and that this was conducive to cheaper manufacture. He quite agreed with Mr. Stearn as to the importance of a perfect vacuum necessary to produce the perfect lamp. This interference in producing a good vacuum by the gases emanating from mounts and platinum wires was, of course, a very old subject with lampmakers, and the necessity of getting rid of these gases was distinctly pointed out by Swan and Edison's old patents for heating and incandescing lamps while undergoing exhaustion. In the author's paper this was not touched on, as it was so well known, but he pointed out that some consideration should be given to the varying amount of occluded gases in unflashed as compared with flashed filaments. As also pointed out by Mr. Stearn, the accidental cracks were undoubtedly the greatest cause of deterioration of vacuum and premature breakage in high-voltage lamps. It was for this very reason that after having had experience of manufacturing several millions of lamps with the form of seal now used by nearly all the Continental manufacturers, the Robertson Company had given up this seal (sometimes called the German seal) for the pinch seal, which they considered superior in this respect. He might point out that this form of seal was now used by all the English manufacturers.

MOTOR DUST-VANS.

The following is the report to the Vestry of the parish of Chelsea by their surveyor, Mr. T. W. E. Higgens, A.M.I.C.E., on the purchase of motor dust-vans :

Preliminary.—On Nov. 23 the Vestry passed the following resolution : "That the surveyor be instructed to investigate and report upon the question of providing 12 dust motor-cars for the home district and three for Kensal Town, and bring up an estimate of the cost of the same, with full detail particulars, from not less than six makers." In accordance with the above resolution I have, therefore, to submit my report.

Importance of the Subject.—The question of providing mechanically-propelled vehicles for the public service is one which should have the most careful consideration of every local authority, more particularly in large towns where congestion of traffic in narrow roadways and nuisance caused by horse droppings along the main lines of thoroughfare are felt to be sources of danger and discomfort to all who use the streets.

Sanitary Considerations.—I am strongly of opinion that, should the cost of working motor vehicles even approximate to that of horse drawn ones, every local authority responsible for cleansing the streets should encourage their use, both on sanitary and economical grounds. More particularly should this be the case in populous London districts. A whole army of men and boys are there engaged in merely picking up horse droppings, and the public are so accustomed to the sight that the enormous expense entailed by it is hardly ever realised. But if motor vans and carts were substituted for only the horse-drawn vehicles now used for the purposes of the vestries and district boards within the metropolitan area, an appreciable saving in the matter of street cleansing would ensue.

Economy in Road Repairs.—Some account should also be taken of the very heavy wear and tear to the road surface by the existing systems of traction, which would to a great extent be obviated if mechanically-propelled vehicles were in use. What has been termed the "three-hundredweight hammers of ironshod horses' feet" probably wear out every road twice as quickly as the iron-shod wheels of the vehicle which they draw, and, in addition, as I have just mentioned, the horse is in itself the cause of a great portion of the offensive matter lying in the streets of towns. Before, however, proceeding farther with the consideration of the subject, there are one or two preliminary matters which require attention. I propose to deal with them in the following order: (*a*) Horse-power and traction; (*b*) primary considerations regarding road vehicles; (*c*) motive power in use for road traction.

(*a*) *Horse-Power and Traction.*—In order to compare the work done by steam or other engines with that done by a horse, the term "horse-power" was coined to denote what was considered to be the average power exerted by a horse. One horse-power is said to equal 33,000 foot-pounds per minute; and was arrived at by calculating that a horse could raise 150lb. at the rate of 220ft. per minute during a day of eight hours. This calculation is now considered too great, but it is always adopted as the "horse-power." The question of horse-power for traction purposes is one which should be thoroughly understood in calculating the power required for motor-cars. Sir David Salomons calculates that to travel 12 miles an hour up and down hill and on the level, on good and moderately good roads, requires about 10 h.p. per ton, and if only half the speed were required only 5 h.p. would be sufficient. In Chelsea, where the roads are practically level, the horse-power required would be considerably less. The term, however, is one which greatly misleads many people unacquainted with the usual method of calculating energy. They are apt to conclude that as two horses will draw a certain load, a 2-h.p. motor should draw the same. But, of course, this is not so. A horse varies his tractive power with the nature of the load and the state of the road surface. At starting a heavy load he puts forth the utmost of his power, but when he has once started on a smooth road the tractive power exerted is very slight. On a good level road for a short journey, in starting heavy wagon loads, big horses often exert as much energy as an engine of 8 i.h.p. Some experiments were recently made on the average pull required by an iron-tyred phaeton on various roads, when it was found that the tractive force per ton varied as follows:

Asphalte	22lb. per ton on clean roads,	23lb. on wet and dirty roads.
Wood (new)	22lb.-29lb. ,, ,,	30lb. ,,
Wood	38lb. ,, ,,	—
Macadam (good)..	52lb. ,, ,,	50lb. ,,
Macadam	60lb. ,, ,,	51lb. 54lb ,,

It will be thus seen that Chelsea, with its paved main road, is a district suitable for mechanically-propelled vehicles.

(*b*) *Primary Considerations regarding Road Vehicles.*—The first consideration as regards motor-vans is that they should be constructed to comply with the Locomotives on Highways Act of 1896, and with the regulations of the Local Government Board made in pursuance of the powers of that Act. To comply with the requirements of the Act the motor-vans must be constructed: (1) to weigh less than three tons when unladen, without taking into consideration the weight of water, fuel, or accumulators; (2) to emit no smoke or visible vapour; (3) to measure less than 6ft. 6in. in width between their extreme projecting points; (4) to have flat tyres to each wheel, and if the weight exceeds one ton the width of the tyre is not to be less than 3in., and if two tons not less than 4in.; (5) to be capable of travelling either forwards or backwards; (6) to have two independent brakes. The machinery of a motor-van should be easily accessible, the parts should not be complicated, the apparatus for steering, starting, and reversing as simple as possible; and, above all, the motor should be perfectly reliable. It is also most necessary for a motor dust-van to be able to tip easily and turn in a very small space; one man ought to be sufficient to drive and guide it; and it should be able to carry sufficient water, oil, fuel, or accumulators to enable it to complete a day's work.

(*c*) *Motor Power in Use for Road Traction.*—Mechanically propelled vehicles on ordinary roads are driven by means of (*a*) oil engines, (*b*) electric motors, or (*c*) steam-engines.

(*a*) *Oil-Engines.*—I place these first as considerable attention has been called to their use since the races from Paris to Bordeaux and Marseilles, as the first eight vehicles in the former race were petroleum-driven cars. It is, I think, generally known that engines of this type are worked by means of an explosive mixture which is ignited by a flame, an incandescent tube, or an electric spark. The second arrangement is that most commonly adopted for motor-cars. The oil-gas motor has an advantage over the steam engine, as it requires no boiler; but, on the other hand, it has its disadvantage. These engines work at a nearly constant speed, and in consequence, any alteration in the speed of the vehicle driven by them has to be contrived by means of gearing. Another drawback to their use is that the motor is kept constantly at work when the vehicle is standing still in the streets.

(*b*) *Electric Motors.*—Electric motors for vehicles have the advantage of being noiseless, free from smell or smoke, and are quite safe. They are, however, very weighty, and the accumulators require recharging after a comparatively short run. In fact, electric traction on ordinary roads seems in this country to be a matter of accumulators, and the efficiency of accumulators is a subject upon which opinions differ very greatly. Edison is credited with the kindly remark that the natural capacity of man for lying comes out in reference to accumulators; at any rate, reliab as to the weight of accumulators per horse-power at vari of speed on any particular vehicle would be most valuable present time, however, I am of opinion that electric tr more suitable for the brougham, cab, and carriage ab rather than for the heavy van used for business purposes. that no estimate for an electrically-driven dust-van has rea

(*c*) *Steam-Engines.*—In considering steam-driven motor must bear in mind that the steam-engine is an old and servant, it is the product of much thought and care and experiments. A steam-engine can be started and revers and its speed can be regulated without difficulty. Mod engines are made with very small boilers, are very reli improved appliances are now provided to condense the ste out any perceptible vapour. I am of opinion that for heavy purposes steam-engines will become very popular.

Conditions to be Observed in Submitting Estimates.—In obtain the necessary estimates I wrote to 11 firms askin were prepared to submit estimates to the Vestry for mo vans. These vans I specified were each to contain six cu of refuse which would not weigh more than four tons, to be worked in accordance with the Locomotives on H Act of 1896, and would be required to tip the refuse shoot. From the replies I received it seems evident that of the size I specified is rather beyond the capacity of the electric motor or oil-engine. There do not at present se any firms making electrically-driven cars of the size we The makers of electric motor-cars seem to be directing th tion more to light passenger vehicles than to heavy business purposes. The Daimler Motor Company and t Horseless Carriage Company, of Coventry, both make motors, write that at present they are unable to quo large and heavy a type of car as would be required for the we have in view. Messrs. Roots and Venables, of We Bridge-road, will build a dust-van driven by an oil-motor geared to run at any speed not exceeding six miles an h capable of carrying a load of 1½ tons, for £375. The eng be driven by ordinary paraffin, and the cost of fuel woul than 3d. per hour. This van is, I think, too light for required. If a van of larger capacity is used the time travelling backwards and forwards to the wharf to ti reduced by one half. Five firms have submitted estim specifications for steam motor-vans—viz.: the Lancashi Motor Company, of Leyland; Messrs. T. Coulthard an Preston; Messrs. Toward and Co., of Newcastle-on-T Liquid Fuel Engineering Company, of East Cowes; th Carriage Wagon Company, of Chiswick.

The prices of their motor-vans and the description of m to be used are as follows:

The Lancashire Steam Motor Company.—The Lancashi Motor Company, of Leyland, will build a steam-motor for £320. The tip van to carry six cubic yards of dust, th of dust not to exceed four tons. The body of the van to of ash supported with ironwork. The underframe to be steel filled up with oak. The engine and boiler to be plac side the driver's seat within a covered shelter for the driv engine to be a compound steam-engine of about 14½ h.p. a speed of four miles an hour; and the boiler to be com patent copper conical tubes, and to work at 200lb. to th inch. The firing is done by a patent automatic apparatus, which keeps the working pressure steady; it independent of the driver's attention after he has once lig burner. The consumption of oil does not exceed two ga hour when in full work. The commonest paraffin oil is us Lancashire Steam Motor Company are the makers of ste vehicles and lawn mowers.

Messrs. Coulthard and Co.—Messrs. T. Coulthard an Preston, will build a steam-motor dust-van for £340; vans are ordered at the same time there will be a red 5 per cent. The tip-van is to carry six cubic yards of weight of dust not to exceed four tons. The effective ho of the engine is to be under ordinary conditions 9 h.p., high-pressure steam is used in both cylinders 18 h.p. distribution valve will be used which will admit of t being regulated between "no load" and "full load," operation being performed with one lever. The engin protected from dust and can easily be cleaned. The bo the water-tube type, oil fired; all the tubes are stra accessible. The tip-van is to be built by the Gloucester Company, and is to be provided with their patent tipp The engine and boiler will be placed alongside the driv and the driver will be protected by a covered shelter. sumption of oil—ordinary lamp oil—will be less than 1 during the day's work. Messrs. Coulthard and Co. have use at Preston which is used for carrying coal and heavy

Messrs. Toward and Co.—Messrs. Toward and Co., castle-on-Tyne, will build one steam-motor dust-van The engine and boiler would be placed under and alon driver's seat within a covered shelter. The engine wo compound steam-engine, fired with coal or coke, having mediate shaft geared for five and three miles per hour. wheels would be of steel with iron tyres. The tip van tain about six cubic yards, the weight of dust not to ex tons. The approximate cost of working, according to the would probably be: driver, 20s. to 25s. per week; coke 5s. to 6s. per week; waste stores, 3s. to 4s. per week; to 35s. Messrs. Toward and Co. have built a steam-drive van which is now in use in the North.

id Fuel Company.—The Liquid Fuel Engineering Company, t Cowes, Isle of Wight, will build a steam-motor dust-van 5, but if the order is given for three vans at the same time ce to be £475. The tip-van is to carry six cubic yards of from three to five tons of rubbish. It is to be built of e seasoned wood, the frames to be of best channel iron. igine and boiler to be placed in front of the van. The to be a compound steam-engine, and the vehicle is to have of from five to six miles an hour, the boiler to be of the ube pattern, ordinary paraffin oil to be burnt, and the firing natically regulated by means of the steam pressure in the The van is fitted with a steam ejector whereby dustbins e steamed out. The Liquid Fuel Engineering Company makers of the steam-motor road train which runs between ster and Fairford.

Carriage and Wagon Company.—The Steam Carriage and Company, Limited, of Chiswick, will build a steam-motor n for £668. The tip-van is to contain six cubic yards of d will carry a load of three tons up an incline of 1 in 20 on y macadam roads. The main framing is to be of steel, as the wheels. The engine and boiler will be placed along driver's seat, and will be protected by a covered shelter. iler will be of the Thorneycroft water-tube type, with arrangements for the control of steam and silent blowing alve, the engine (a compound reversing one) being enclosed ustproof and oiltight casing. The Steam Carriage and Company are the makers of the two motor dust-vans now t Chiswick, which collect an average of 20 cubic yards of er day with a consumption of 2cwt. of steam coal.

al Consideration of the Estimates.—The prices of these vary considerably, and an inspection of the plans and ations submitted does not show sufficient reason for such a ifference, but the two lowest estimates are very close. A £320 or £340 is not much to pay for a motor-van of this y, and if a thoroughly reliable motor can be obtained at ice I think the Vestry would be wise in purchasing one on erstanding that if it worked to their satisfaction for six they would obtain more motor-vans from the same maker. stry's resolution suggested 12 for the home district and r Kensal Town, but I consider that at present 10 for the istrict and two for Kensal Town would be all that would be d, as each motor-van would do the work of two ordinary rts, probably more; but how much more could only be ined by actual trial of a motor-van.

—The cost of a motor-van compared with two dust-carts rses would be:

	£	s.	d.
van—capital expenditure	320	0	0
Annual Expenditure.			
's wages, 35s. per week	1	15	0
ustmen, 25s. per week	2	10	0
water, etc.	2	0	0
Per week	£6	5	0
for 52 weeks = per annum	325	0	0
cent. for depreciation, etc., say	32	10	0
	£357	10	0
Two Dust-Vans and Horses—Capital Expenditure.			
orses at £70	140	0	0
ust-vans at £50	100	0	0
	£240	0	0
Annual Expenditure.			
s' wages, two at 28s. per week	2	16	0
ustmen, at 25s. per week	2	10	0
, etc., two horses at 16s. per week	1	12	0
Per week	£6	18	0
for 52 weeks = per annum	358	16	0
iation at 5 per cent.	12	0	0
	£370	16	0

above shows that though the capital expenditure would be £80 more for a motor-van than two horse-driven ones, yet nnual expenditure on the former is sufficiently low to more repay the interest on the extra money borrowed to pay expenditure on the motor-van.

s v. Horses.—The annual expenditure on the motor-van probably be about £12 or £13 less than for the horse-driven vans, and if 12 were obtained the saving would be about that is if each motor only did the work of two dust-vans. I wever, it would do more. Besides, there is always the valuable horse dying. In looking through the annual an adjoining parish I find that out of a stud of 112 horses, r were killed during the year. One worth £80 only e month, another worth £74 three months, and the others ee, four, four and a-quarter, and six years respectively. can be repaired and its interior renewed; a horse, how to the knackers or to the Zoological Gardens to feed the any portion of his vital machinery goes wrong.

ndations.—In conclusion, I consider that the offer of hire Steam Motor Company for a motor dust-van to cost £320, and that of Messrs. Coulthard and Co. to cost £340, deserve the careful consideration of the Vestry, but I cannot go so far as to actually recommend either of the two firms until I have seen their vehicles at work so as to satisfy myself that their arrangements for burning liquid fuel are quite satisfactory.

COMPANIES' MEETINGS AND REPORTS.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING COMPANY, LIMITED.

The fourth ordinary general meeting of this Company was held last Monday at Winchester House, E.C., Lord Rathmore presiding.

The **Chairman** said it was with great satisfaction he was able to present them with such an excellent report. The report for the year stated that the net revenue, with the balance from the last account, was £21,400, out of which an interim dividend on the preference shares for the half-year ending June 30 last at the rate of 6 per cent. per annum had been paid, and the directors now recommended a dividend at the same rate for the half-year just ended, this leaving a balance of £10,080 to carry forward. Their chief source of prosperity were the London stations, and in these they had invested most of their capital. Most of the Company's interests in the Bournemouth Electric Company had been disposed of, but they had thought it best to retain some interest in it, and had secured an allotment of ordinary shares at par. As regarded their provincial companies, things had been very satisfactory. The gross profits on the Dover station last year amounted to £1,128, as against a loss the previous year, and it had now got past the stage of misfortunes which attended most stations when first started. The equivalent of 8-c.p. lamps connected till Dec. 31 was 10,137, being an increase of 2,619 for the year. The cost of production had been reduced very much. Power plant had been laid down during the year. They had always asked the shareholders to regard the Richmond station as a good thing, and they had no reason to say otherwise of it now. There was a great improvement in the Company's accounts, which allowed of a dividend of 3 per cent. being paid on the share capital. The equivalent of 9 512 in 8-c.p. lamps were connected to the mains on Dec. 31 last, this being an increase of 2 387 during the year. The plant and mains were to be extended during the present year. Turning to the London stations, they had adopted a broad policy in dealing with the supply of electricity in London. They had built two large generating stations, one on the north, the other on the south side of the river, each capable of supplying an area much greater than the surrounding district. They had at present the largest area of any electric lighting company in London. He ventured to suggest to small vestries who might be thinking of starting electric light to ponder whether it would not be better to get their wants supplied from a large established company—their own, for instance—which had all the plant, etc., and greater technical knowledge. They had erected a fine station by the Regent's Canal, thus saving a great deal of expense in carriage of coal, etc. Their difficulties in St. Luke's and Wandsworth had now been overcome. The building at St. Luke's was finished, and was capable of supplying 80,000 8-c.p. lamps connected. They had good grounds for expecting the demand in this district to increase. In East Holborn current was now being supplied. At West Holborn and St. Giles-in-the-Fields they had secured the consent of the local authorities to their applications. So far he had been speaking of electric lighting alone, but they had also in those districts a large demand for electric current for motive power. Special mains had been laid for this in the principal thoroughfares, and the batteries would start that very day. The Wandsworth station was a fine building, situated just where the Wandle joined the Thames. It was completed, and the plant now installed there could supply more than 40,000 8-c.p. lamps connected, while there was space in the building for machinery to supply three times that number. From that area an encouraging demand had already sprung up, and in Camberwell there was already a considerable demand for motive power as well as for electric lighting. He hoped he had satisfied them that the policy they had adopted bade fair to be justified by experience on both sides of the river. It was a policy which involved, no doubt, heavy expenditure at first and some delay in obtaining a substantial revenue in return, but they had done with large capital expenditure for years to come. They had paid no dividend yet on their ordinary shares. When, however, they allotted 10,000 ordinary £10 shares last December, their market value was £15, and they were allotted at par to their ordinary shareholders in the proportion of one share for three already held, and this was equal to a dividend of about 5 per cent. for the last three years. He thought he might say that their present position was very satisfactory, and that they had before them the probability of a large and lucrative business.

Mr. J. B Braithwaite, jun., in seconding the motion, expressed his belief that the future of the Company as regarded motive power would be equal in importance to its future in connection with electric lighting.

The report was then adopted, and the final dividend on the preference shares declared.

Mr Sparks, one of the shareholders, then proposed a resolution that the fees of the directors should be raised from £1 000, on a scale of £500 a year, dating from the start of the Company (1893), on a like basis with the City of London Electric Lighting Company, whose directors were now receiving about £3,000 a year.

Mr. Richard Brush proposed an amendment, "That the salaries of the directors be raised to £2,000 for the year 1898 only, and that at the next meeting the matter be again considered."

Lord Rathmore, the chairman, said the matter was, of course, one for the shareholders, but he might explain that the Company was originally intended to be founded on the same terms as the City of London Electric Lighting Company, and when he and his co-directors were asked to join the Board they did so on that understanding. In drawing up the articles of association, however, the persons responsible omitted the increase clause, and the omission was not discovered until it was too late to alter it.

Mr. Sparks: That's it; the directors have now lost between them £1,500, and stand to lose another £1,500 in 1898 unless my resolution is passed.

Lord Rathmore: We were obliged to accept what we could get—the £1,000 only.

Mr. Sparks: But the Company have inadvertently gained £1,500, and the directors are thus, through no fault of their own, having to do our work, which they do very admirably, on a junior clerk's wages—£100 a year each. My motto is, "Pay the directors a good fee." As the Bible says, a labourer is worthy of his hire, and surely our directors are the same. I should like to hear the amendment withdrawn.

Mr. Brush: I am told by the shareholders not to. I cannot now in fairness to them.

A **Voice:** Well, vote against it.

Lord Rathmore then put the amendment, and the show of hands counted 14. Against the amendment the chairman began to count the hands, when cries of "A tie" were shouted.

Lord Rathmore, however, said the number was only 13, and the amendment was carried by one vote.

Amid considerable excitement, **Lord Rathmore** thanked the shareholders, but **Mr. Sparks** remarked that it meant that they would lose £2,000 on a single vote.

HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY.

The tenth ordinary general meeting of the House-to-House Electric Light Supply Company, Limited, was held on the 11th inst. at Winchester House, Old Broad-street, E.C., Mr. H. R. Beeton (the chairman) presiding.

The **Chairman**, in moving the adoption of the report and accounts (published in a previous issue), said: The extension in the demand for electricity has continued undiminished, and a further reduction in the cost of production has been effected; so that our increased revenue has again been earned without any appreciable addition to our expenditure, and the increase of profit is larger than in any previous year in the Company's history. In regard to the future, the applications so far received from new consumers during the current year exceed those received at the corresponding date last year, and although the cost of production cannot be indefinitely reduced, there is no reason to believe that finality has been reached in this particular. Referring to the free wiring, Mr. Beeton said: Alone among the electric lighting companies in the Metropolis to-day, we are prepared to give householders a limited installation, not only free of all initial expense, but free from any additional charge for electricity. We believe that when consumers realise that they can enjoy the electric light without incurring any capital expenditure, and especially leasehold consumers, whose expenditure would not benefit their own property, many will be disposed to adopt the electric light in preference to gas, and as we can make a larger profit on the same number of lights in the form of many small installations than in the form of fewer large installations, it will pay us to expend the capital necessary to extend our business in this way.

The report and accounts having been adopted,

The **Chairman** moved: "That the following dividends be now declared out of the net profits of the undertaking for the 12 months ended Dec. 31, 1897—namely, the remainder of a dividend of 7 per cent. on the preference shares, and on the ordinary shares a dividend of 4 per cent. for the year."

This was seconded by **Mr. W. R. Davies**, and carried.

Mr. W. Page (managing director) proposed the re-election of Mr. Beeton and Mr. Germaine as directors of the Company. He remarked that the chairman was their oldest director, having been with them almost from the beginning. Both Mr. Beeton and Mr. Germaine had been with the Company through all the uphill work, and had served for many years without fees.

Mr. W. F. Losse seconded the motion, which was carried unanimously.

On the proposition of **Mr. Frost**, seconded by **Mr. Lawry**, Messrs. Miall, Wilkins, Randall, and Co. were re-elected auditors.

A vote of thanks to the chairman terminated the meeting.

BRITISH INSULATED WIRE COMPANY.

The report for the eight months ended Dec. 31 shows a profit of £33,281. After deducting administrative expenses, interest on debentures, the dividend on the preference shares, and writing off depreciation and a portion of the preliminary and reconstruction expenses, there remains £17,754, from which the directors recommend a dividend at the rate of 15 per cent. per annum on the ordinary shares for the eight months, leaving £1,629, of which the directors have decided to transfer to patents and goodwill account £1,500, carrying forward £129.

The first ordinary general meeting of the shareholders of this Company, whose works are at Prescot, Lancashire, was held this
week at the Exchange Station Hotel, Liverpool. Mr. W
Brigg, chairman of the board of directors, preside
were also present Mr. E. K. Muspratt, Mr. S. Z. de
Mr. J. B. Atherton, and Mr. J. E. Pearson, directors;
Leslie, solicitor; Mr. Edward Tracey, secretary; and a co
number of shareholders.

The **Chairman**, in moving the adoption of the r
accounts, expressed the pleasure of the directors a
the shareholders under such happy circumstances.
already found it necessary to enlarge their working
and further buildings were in progress, in order to enab
keep pace with the orders in hand. Fortunately, their a
at Prescot was large enough for the extensions req
already a competent authority had informed him that
the most complete and best laid-out works in the count
the new company took over the business they had £200
of orders on hand. The figure now stood at £300,00
sonally he felt confident that ere long they would requir
issue of capital in order to keep pace with the demands
He was satisfied that they could employ a very much lar
profitably. He, therefore, felt entitled to congratulate
holders, both as to what they had already done and un
lent prospect before them.

Mr. Berry seconded the motion, which, after a brief
was unanimously adopted, and a dividend was declared
mended.

On the motion of **Mr. Muspratt**, the retiring directo
W. M. Brigg and Ferranti, were unanimously re-ele
Messrs. Chalmers, Wade, and Co. were reappointed aud

A hearty vote of thanks to the chairman and directors
the proceedings.

LIVERPOOL AND DISTRICT LIGHTING COMP

The annual meeting of the Liverpool and District
Company took place last week at the offices of the C
Hackin's-hey, Mr. Hill Holme, chairman of directors,
We are indebted to the *Liverpool Journal of Comme*
following report:

The **Chairman** said they were now supplying ele
their customers from two stations. That at Waterloo
plete so far as it went, for they had got engines and b
plete there, and were supplying a considerable amou
tricity there. They supplied, or had orders for, 635 l
their station was equipped with the very latest imp
in electrical engineering. It was capable of extensio
they could supply 3,600 lights, and double this by exte
building. At Gateacre they had not been so fortunate.
finished building, but owing to the engineering strike
unable to get permanent engines, and had, therefore,
a portable engine. There was a large demand f
lighting in the neighbourhood, and they were su
had orders for 454 lights, so that they had a tota
lights ordered or supplied. Of course, as they had
only just started work, they could not be expected
dividend. Their initial expenses were large, but when
supplying 2,000 lights—1,000 from each station—which
would be in the immediate future, they would be a
expenses and put a little on one side to pay a div
course the cost of supplying a small number of lights wa
much greater than supplying a large number, and as the
their business the cost of production would be relativel
They had endeavoured to do as much contract work a
but competition was so keen that their profit had n
large as they could have wished. They were determin
high-class business, and no jerry work. They would se
Garston District Council had decided to undertake to su
selves with electric light, but they might finally see t
their ways, and ask the Company to again take over
He was sorry to say that Sir William Forwood had r
position of director, as he was leaving the neighbou
they had filled the vacancy by the election of Mr
Beaver, a member of the Waterloo District Council,
already done them some service. With the call made
shareholders, they had plenty of money to meet all their
and they must regulate their expenses according to th
of the Company being able to supply more customers
lighting had become very popular, and generally the p
the Company were good. He was sorry there was n
this year, but they hoped that next winter they would
or 3,000 lights supplied by their present machinery, and
would be in a position to pay a dividend. He moved th
of the report.

Mr. Von Sobbe seconded.

The **Chairman**, replying to questions by the shareh
they charged a rate of 8d. per unit in Waterloo. In ti
lights increased, they would be able to reduce the pric
more money. They had considered the question of pu
wires free, but they could not do this. They did t
cheaply as possible, however.

The resolution was carried.

On the motion of the **Chairman**, seconded by **Mr. V**
Mr. H. Cunningham was re-elected a director.

The **Chairman** moved, **Mr. Naylor** seconded, and it w
that Mr. Holbrook Gaskell be re-elected a director.

Mr. W. L. Jackson was re-elected auditor, on the mo
M'Allister, seconded by **Mr. Barry**.

It was resolved that the next annual meeting be held
1899.

. Wynne moved a vote of thanks to the chairman.
Morris E. Jones seconded.
Chairman, in response, said there was little doubt that ...ng they would be in a very satisfactory position.
...concluded the proceedings.

GATESHEAD TRAMWAYS COMPANY.

...sixteenth annual meeting of the shareholders of the ...ad and District Tramways Company was held this week ...depôt, Sunderland-road, Gateshead, Mr. C. R. Greene, ...n, presiding.

...annual report stated that an agreement had been entered ...ween the Company and the British Electric Traction ...y, Limited, which was unanimously accepted at the ...inary meeting held on Dec. 9 last. The scheme was ...consideration by the Gateshead Corporation and the Urban District Council, whose consents were necessary ...e arrangement came to could be carried into effect. Under ...ns of the agreement made with the British Electric Company, Limited, a director of that company must be ...n additional director of this Company, and the directors ...l that Mr. Emile Garcke, managing director of the British Traction Company, Limited, should be so elected.

...port, and a dividend of 2 per cent., free of income tax, ...ied, and the re-election of Mr. H. Carrick and the appoint- Mr. E. Garcke as a director were agreed to.

...NGHAM ELECTRIC SUPPLY COMPANY, LIMITED

...annual meeting of the Birmingham Electric Supply ...y, Limited, was held at Birmingham on the 10th inst., ...ry Buckley presiding.

...hairman, in moving the adoption of the report (published ...st issue) gave figures showing the large increase of busi- ...r by year, not only amongst manufacturers, but also in ...ential suburbs. They had been approached by the Cor- ...to dispose of the business, but the matter was still under ...ideration of the Council Committee. Whatever was the ...e shareholders would be consulted. In consequence of ...al outlay, the directors thought it advisable to increase ...al from £200,000 to £300,000 by the creation of 20,000 ...l shares of £5 each.

...port was adopted, and a special resolution with regard ...creased capital was carried.

...IEFFIELD TRAMWAYS COMPANY, LIMITED.

...eral meeting of the Sheffield Tramways Company, ...was held on the 10th inst. at the offices, 23, Queen ...street.

...E. Illingworth, who presided, stated when the liquida- ...menced they had a balance in hand of £297. 16s.; since ...ir receipts, including £27,904 paid them by the Sheffield ...ion for their effects, amounted to a total of £47,395, ...expenditure for the same time, including £5 13s. 3d. per ...paid to the shareholders, exactly balanced that sum. ...s, however, a small sum of £118 in excess, arising from ...that some of their securities realised more than had been ...ed, and this they proposed should be handed over to Mr. ...eir secretary, in addition to the sum specially voted to ...e last meeting.

...reholder, in thanking the liquidators, said the Company ...d the town well and met a public want for several years, ...y little return in the way of dividend, and now they were ...on to forfeit about one-half of their original capital. Such ...gs were not calculated to encourage private enterprise in ...tion for the future.

DOVER ELECTRICITY SUPPLY COMPANY.

...nual meeting of the Dover Electricity Supply Company ...at the station, Park-street, last week.

...illiam Crundall (Mayor of Dover), who presided, in ...the adoption of the report, said the accounts for 1897 ...gross profit of between £1,100 and £1,200, or to be more ...1,127. 17s. 5d. No dividend was proposed, the profit ...pplied towards the payment of the fixed charges, ...es, and interest upon loans. The units sold in 1896 ...d to 154,210, and the units in 1897 amounted to 243,111, ...rease of 58 per cent. in units sold in 1897 as against 1896. ...port was adopted.

...e motion of Mr. Van Tromp, seconded by Sir W. ..., Messrs. C. W. Bagshawe and R. P. Sellons were ...l directors.

...motion of Mr. Edwin seconded by Mr. Beeton, Mr. R. ...was re-elected auditor.

...motion of Mr. Edwin, seconded by Mr. Van Tromp, ...thanks was passed to the chairman for presiding.

...SOR ELECTRICAL INSTALLATION COMPANY, LIMITED.

...rs: M. Drury Lavin, Esq., chairman; H. L. Prior, Esq., ...hairman; Tonman Mosley, Esq.; Edward Riley, Esq.; ...ipley, Esq., managing director; A. A. Somerville, Esq.; Rev. R. H. Whitcombe. Consulting engineer: Mr. A. H. Preece. Engineer-in-charge: Mr. A. E. Farrow.

Report of the directors to the shareholders for the year 1897:

The number of lamps installed on Dec. 31, 1897, was equivalent to 4,985 of 8 c.p.; since that date 395 have been added. In the course of the year a new engine, twice the size of the original ones, has been added, and the storage cell capacity has also been doubled. Extension of mains have been made in St. Leonard's-road, Osborne-road, and King's-road. The net profit for the year is £1,256. 16s. 7½d., as shown on the net revenue account, and out of this sum the directors recommend that a dividend of 4 per cent., free of income tax, be declared on the paid-up capital of the Company, the dividend on the new shares being calculated from the dates of allotment and call. This will absorb £652. 7s. 4d., leaving a balance of £604. 9s. 3½d. to carry forward. The directors have now been in office for two years without any remuneration whatever, and in view of the very satisfactory progress of the Company they will, at the general meeting, ask the shareholders for a vote on account of their past services. Mr. A. W. H. Good resigned his position of secretary of the Company in the early part of the year, and your directors did not consider it necessary to appoint another permanent secretary, as Mr. A. W. Shipley, in addition to being a director of the Company, kindly accepted the position of managing director, and the Board consider themselves very fortunate in securing his valuable services. It is proposed to issue the remaining capital, £5,000, during the current year. The directors recommend that the shares be issued at a premium of 2s. 6d. per share, and any shareholders desiring an allotment should apply at the Company's offices for a form of application. The allotment will be *pro rata* to existing holdings, but any shareholder not applying within one month of the date of this report will be deemed to have renounced his right to an allotment. Current is now being supplied at 7d. per unit, but the directors hope to reduce the price to 6½d. when 8,000 lamps or their equivalent are installed. This reduction in Windsor is equal to 3d. per 1,000ft. of gas. The retiring directors selected by ballot are Mr. Tonman Mosley and the Rev. R. H. Whitcombe, who, being eligible, offer themselves for re-election.

REVENUE ACCOUNT, YEAR ENDED DEC. 31, 1897.

Dr.		£ s. d.
Generation of Electricity.		
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£463 4 2	
Oil, waste, water, and engine-room stores	83 9 11	
Wages and gratuities at generating station	182 14 9	
Repairs and maintenance as follows: buildings, £28. 19s.; engines and boilers, £14. 15s.	4,314 0	
		773 2 10
Distribution of Electricity.		
Wages and gratuities to linesmen, fitters, labourers	3 14 9	
Repairs, maintenance, and renewals of meters, switches, fuses, and other apparatus on consumers' premises	1 3 7	
		4 18 4
Rents, Rates, and Taxes.		
Rents payable	35 8 4	
Rates and taxes	27 6 0	
		62 14 4
Management Expenses.		
Directors' remuneration	—	
Proportion of salaries of managing engineers, secretary, accountant, clerks, and messengers as certified by the chairman	177 5 3	
Stationery and printing	26 18 11	
General establishment charges	30 10 4	
		234 14 6
Law and parliamentary charges		7 0 9
Special Charges.		
Insurance, etc	30 12 9	
Fees to auditors of Company	15 13 0	
Cost of temporary plant	62 11 8	
		108 17 5
Total expenditure		1,191 8 2
Balance carried to net revenue		541 17 9
		£1,733 5 11
Cr.		£ s. d.
Sale of current per motor (52,095 units) at 7d. per B.T.U., less discount and bad debts		1,435 5 10
Sale of current under contracts		117 13 5
		1,552 19 3
Rental of meters and other apparatus on consumers' premises		33 11 10
Rents receivable		52 9 8
Transfer fees		0 18 6
Pupil's premium		33 6 8
Amount refunded by contractors against cost of temporary plant		60 0 0
		£1,733 5 11

General Balance Sheet, Dec. 31, 1897.

Dr. Liabilities	£	s.	d.
Capital account—amount received	19,969	15	0
Sundry tradesmen and others due on construction of plant and machinery, fuel, stores, etc., to Dec. 31, 1897	5,864	17	11
Sundry creditors on open accounts	142	6	10
Forfeited shares	1	7	6
Net revenue account—balance at credit thereof	1,256	16	7
	£27,235	3	10
Cr. Assets.			
Capital account—amount expended for works	20,468	18	10
Stores on hand at Dec. 31, 1867: coal, £4. 13s. 9d.; oils, waste, etc., £47. 12s. 9d.; general, £874. 2s. 10d.	926	9	4
Sundry debtors on account of contracts in course of completion	378	12	2
Preliminary expenses	418	15	2
Sundry debtors for current supplied to Dec 31, 1897	924	10	0
Other debtors	2,128	5	3
Cash at bankers and in hand	1,989	13	1
	£27 235	3	10

SHEFFIELD ELECTRIC LIGHT AND POWER COMPANY, LIMITED.

The report of the directors of the Sheffield Electric Light and Power Company, Limited, for the past year states that the net profit, including a balance of £99 brought forward, is £11,492, which it is proposed should be appropriated as follows: interest on debentures, £1,125; in payment of a dividend of 12½ per cent., free of income tax, £9,464; and carry forward £903. The last issue of shares at £2 premium, which was wholly taken up, realised a premium of £3,792 This was applied as follows: to costs of increasing capital, £200; to depreciation fund, £1,903, making that £6,643; and to reserve, £1,689, bringing that fund up to £2 970. On Jan. 1, 1897, the price of current was reduced from 6d. to 5d. per unit, and an increased demand followed. The amount derived from the sale of the current was £14,319, as against £11,258 in 1896. During the past year £19,980 had been expended upon machinery, mains, and other appliances, being £1,600 more than in the preceding year. The directors in July last notified their inability to accept new customers for attachment before Christmas on account of the strike, but new machinery had now been laid down. At the annual meeting the shareholders will be asked to approve of an agreement for the sale of their undertaking to the Corporation. The capital expenditure is fixed at £124,472, and the Corporation agree to pay £220 Sheffield 2½ per cent. redeemable stock, or £213. 8s. in cash for each £100 of the capital property expended by the Company. The sale takes place as from Dec. 31. The shareholders are to receive a dividend of 10 per cent. per annum upon their paid-up capital until the completion of the sale, and the directors advise the shareholders to accept these terms.

OXFORD ELECTRIC COMPANY, LIMITED.

Directors: Sir Henry C. Mance, C.I.E., M.I.C.E. (chairman); James W. Barclay; Alderman Robert Buckell, J.P.; L. A. Selby Bigge, M.A.; John Irving Courtenay, M.A. Chief engineer: P. J. Rea. Secretary: Henry Eeles.

Report of the directors (with abstract of accounts) to be submitted to the shareholders at the seventh ordinary general meeting to be held at the Randolph Hotel, Oxford, to-day (Friday), at 3.30 p m.:

The revenue account shows a profit for the year of £3,996. 17s. 5d., to which has to be added £13. 17s. 6d. (the difference between the receipts from share premiums and the expenses attending the redemption of the old debentures) and £537. 7s. 6d., the amount brought forward from last year's account, making a total of £4,548. 2s. 5d. After deducting £202. 15s. 2d. on account of the expenses attending issue of debenture capital, and providing £1,499. 1s. 10d. for debenture and loan interest, the available balance is £2,846. 5s. 5d., which the directors propose to appropriate as follows: £500 to a fund to provide for future renewals of machinery and plant, and £2,327. 8s. in payment of a dividend at the rate of 5 per cent. per annum upon the capital (the new shares issued in March ranking for dividend, as provided by the prospectus, from the average date of payment of the instalments thereon), leaving a balance of £18. 17s. 5d. to be carried forward to next year's account. The £25,000 of 5 per cent. debentures outstanding at the date of last accounts have been redeemed at a bonus of 5 per cent., and replaced by an issue of £35,000 debenture stock at 4 per cent. interest. The premiums received on a further issue of 2,000 shares made in March last exceeded the bonus paid on the redemption of the debentures by £13. 17s. 6d., which has been carried to the revenue account. The expenses attending the issue of the new debentures, including the sum of £79. 10s., which previously stood to the debit of capital account, amount to £608. 5s. 6d., whereof £202. 15s. 2d. has been debited to the revenue of the year, and the balance carried forward, to be liquidated out of the revenue of the next two years. The gross receipts have been to some extent affected by a reduction in the price of current to consumers as from Jan. 1, 1897, but the directors confidently expect that this liberal policy will yield advantageous results in the near future. Since the last report 2,630 8-c.p. lamps, or the equivalent, have been connected with the mains, bringing the total on Dec. 3[1] up to the equivalent of 21,364 8-c.p. lamps. The plant a[t the] generating station has been increased during the year [by a] 500-h.p. engine and a boiler of 200 h.p. capacity. A new [trans]former station has also been equipped in Ship-street, an[d] additional transformers connected to the system. A line o[f] iron pipes has been laid from the works at Osney to a c[entral] position in the city, to provide for extensions of the high-te[nsion] feeding system, and to enable the supply to be controlled [m]ore from the works. The cost of these additions to plant and [exten]sions has been provided by the proceeds of the 2,000 shares [issued] during the year. The directors who retire by rotation a[re Mr.] J. W. Barclay and Mr. Alderman Buckell, who offer them[selves] for re-election. The auditor, Mr. W. S. Carver, offers hims[elf for] re-election.

Revenue Account, Year ended Dec. 31, 1897.

Dr.	£	s.	d.	£
Generation of Electricity.				
Coal	£905	3	8	
Oil, waste, water, and engine-room stores	100	14	10	
Wages at generation station	694	10	5	
Proportion of engineer's salary	176	5	8	
				1,876
Maintenance Charges.				
Buildings	61	11	6	
Engines and boilers	291	18	3	
Dynamos and transformers	240	18	10	
Machinery and tools	36	16	3	
Meters and switches	24	10	6	
Accumulators	128	10	8	
Electrical instruments	13	14	0	
Works installation	18	11	7	
				816
Distribution of Electricity.				
Wages at distributing station	£196	11	0	
Maintenance of mains	54	11	2	
				251
Rent, Rates, and Taxes.				
Rent	161	17	10	
Rates and taxes	188	7	1	
				350
Management Expenses.				
Directors' fees	415	0	0	
Salaries	426	3	8	
Insurance	47	13	2	
Legal expenses	70	0	3	
Audit fees	31	10	0	
Printing and stationery	91	6	4	
General establishment charges	128	16	7	
Advertisements	40	18	11	
Carriage and cartage	33	3	7	
				1,284
Balance, being profit carried to net revenue account.				3,996
				£8,576

Cr.	£
Sales by meter	7,911
Less discount allowances, etc.	212
	7,69[illegible]
Street-lighting	45[illegible]
Rentals of meters	130
Pupil and transfer fees	22[illegible]
Profits on installations, services, and sundry supplies	4[illegible]
Rents receivable	2[illegible]
	£8,576

Dr. General Balance-Sheet, Dec. 31, 1897.	£
Capital account—amount as received	85,0[illegible]
Sundry creditors	2,52[illegible]
Sundry creditors for debenture interest	64[illegible]
Balance of net revenue account brought down	2,84[illegible]
	£91,01[illegible]
Cr.	**£**
Capital account—amount as expended	84,54[illegible]
Sundry debtors	4,45[illegible]
Expenses attending on issue of debenture capital, £608. 5s. 6d.; less one-third paid out of profits for 1897, £202. 15s. 2d.	40[illegible]
Cash at bankers	61[illegible]
Cash in hand	[illegible]
Stock, coal, and other stores on hand	99[illegible]
	£91,01[illegible]

Statement of Electricity Generated, Sold, etc., Year [ended] Dec. 31 1897.

Quantity generated in B.T. units		[illegible]
Quantity sold	Public lamps	42,833
	By contract	2,000
	Private consumers by meter	298,734
Total quantity accounted for		[illegible]
Quantity lost in distribution, transformation, etc.		[illegible]
Number of public lamps		[illegible]

Total maximum supply demanded, 3,110 amperes at 100 [volts]

TRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

n.—Tenders will be called shortly for electric installa-
at and power. Particulars may be obtained from the
he town.

gh.—Tenders are invited for the additions and exten-
electric lighting at the City Chambers. For particulars
sing columns. Tenders by March 22.

The Corporation invite tenders for the electric wiring
d-street yard and premises, full particulars of which
nother column. Tenders by April 12.

ıond (France).—Tenders are invited for lighting the
ctricity or otherwise. Particulars are to be obtained
tenders addressed to, Municipal Authorities at above
rtment Loire) by March 31.

ad.—The Vestry invite tenders for the supply,
nd erection at their central station, Lithos-road,
ad, of various plant, full particulars of which appear
column. Tenders by March 31.

—The Secretary of State for India in Council announces
me allowed for the receipt of tenders by the Chief
for Irrigation, Madras, for the utilisation of water
ne Periyar Lake has been extended from Oct. 31, 1897,
898.

(Belgium).—Tenders are invited for electric installa-
olic and private lighting and for power transmission
, to commence from Feb. 1, 1899. Particulars are to
from, and tenders addressed to, Municipal Authorities
Belgium, by April 1.

ria (Egypt).—Tenders are invited for indiarubber tubes,
Post and Telegraph Department. Specifications may
from, and samples inspected at, the Gabbary Stores,
are to be addressed to the President of the Council of
tion, Cairo, by March 28.

(Denmark).—For complete establishment of electric
orks, etc. Specifications are to be obtained from
Udvalg for Electricitätsvaerket, Sugförer Edv. Lau.
r (£3. 3s.) to be returned on receipt of bona fide tender,
addressed the same at Kolding by March 24.

(Spain).—Tenders are required for the sole right of
ing by electricity for 20 years. The deposit required
as (350 provisional). Particulars are to be obtained
nders addressed to, the Local Government Administra-
ment, either at Madrid or Zafra. Tenders by March 29.

—Tenders are invited for the supply of the lightest
m of motor (to be complete with tank, tender, or other
), capable of developing energy of 9 h.p. on brake test,
revolution of 500 per minute. Dimensions and total
the machine to be sent to Mr. B. Morley Fletcher,
, 7, Victoria-street, Westminster.

—The Electric Lighting Committee are prepared to
n responsible firms full detailed offers for carrying out
ons of the Ipswich Electric Lighting Order, 1897, includ-
pon which the undertaking could be acquired by the
at certain dates if so desired. Offers, endorsed
to be sent to the Chairman of the Electric Lighting
, Town Hall, Ipswich, by March 25.

rt.—Tenders are invited by the Town Council for the
buildings for an electric lighting station on the site of
llgate gasworks, Stockport. Quantities, etc , obtained
ngineer, Mr. S. Meunier, Millgate Works, Stockport.
contractors will be required to deposit the sum of £2,
be returned on the receipt of a bona fide tender.
be sent in by 12 noon on March 24.

—Competitive plans and estimates are invited for
a new generating station. All information may be
rom the Electrical Engineer, Walness-road, Salford, on
th inst. Sealed plans and estimates, endorsed "New
ddressed to the Chairman of the Electric Light Com-
be delivered at the office of Mr. Saml. Brown, town
n Hall, Salford, by 9 a.m. on 25th inst.

—The Corporation invite tenders for the electric wiring
natic asylum and premises at Rowditch, Derby. Speci-
etc., may be obtained from the Engineer and Manager
ctric Lighting Works, Sowter's-road, Derby, on payment
which will be returned on receipt of a bona fide tender.
marked "Asylum Lighting," and addressed to Mr. H. F.
own clerk, are to be sent in by 24th inst.

mouth.—Tenders are required for motor vehicles for the
of house refuse, street scavenging, and conveyance of
erials. Specification, etc., accompanied by drawings,
vered at the office of Mr. F. W. Lacey, M.I.C.E.,
eer and surveyor, Municipal Offices, Bournemouth,
rked "Tender for Motor Vans," by April 4. Out-
n and form of tender can be obtained on applica-
ough Engineer's Office.

The Corporation invite tenders for the supply of
rs (alternating-current) for the 12 months ending
0. Specification, with form of tender, may be
na fide meter manufacturers or their authorised
lication to Mr. John H. Rider, borough electrical
-street, Plymouth. Sealed tenders, endorsed
eters," must be delivered to Mr. J. H. Ellis, town
ll, not later than March 23.

Devizes (Wilts).—Tenders are invited for two 40-kw. continuous-current belt-driven dynamos and for two high-pressure horizontal compound engines of 70 b.h.p. each for driving electric light machinery. Specifications and particulars may be obtained from Messrs. Massey and Allpress, 25, Queen Anne's-gate, Westminster, on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders to be sent to Mr. Joseph T. Jackson, clerk to the Visiting Committee, Wilts County Asylum, Devizes, by March 21.

Darwen.—Tenders are invited by the Corporation for (A) quick-revolution steam-engines and dynamos; (B) steam and exhaust pipes, etc.; (C) accumulators; (D) switchboards, balancing apparatus, etc.; (E) underground mains, etc.; (F) arc lamps, pillars, etc. Conditions, etc., may be obtained at the offices of the Borough and Electrical Engineers, on payment of £2 per specification, or £5 for the entire set of specifications, which sum will be returned on receipt of a bona fide tender. Tenders by noon on March 28.

London, S.W.—The Secretary of State for War is prepared to receive offers, in writing, accompanied by competitive designs and specifications, for the supply of portable electric search-light apparatus. General particulars as to requirements can be obtained on application, either by letter or personally, to A. Major, director of army contracts, War Office, Pall-mall, S.W. The offers and designs must be delivered at the War Office, Pall-mall, London, S.W., by April 27, addressed to the Director of Army Contracts, and marked on the outside "Designs for Search-Light Apparatus".

Leyton.—The Council invite tenders for the supply and erection of (No. 1) two dynamos, one continuous-current balancing transformer; (2) two gas-engines and connections; (4) switchboards. Specifications to be obtained from Mr. H. Collings Bishop, the electrical engineer, Cathall-road, Leytonstone, on and after March 21, on payment of £2. 2s. for each copy, which sum will be refunded upon the receipt of a bona fide tender. Tenders, accompanied by a £10 Bank of England note to be enclosed with the tender and to be forfeited if the tender is withdrawn before the contract is signed, must be received at the Town Hall, Leyton, Essex, by April 4.

Victoria (Australia).—Tenders are invited by the Council of the city of Hawthorn for the supply and erection, or for the supply only, of: (Section A) buildings only; (B) boilers, water-heater, pumps; (C) engines, dynamos, switchboard, mains, sub-mains, transformers, meters, arc lamps, insulators, testing instruments; (D) supply of poles and their erection; running of the plant for three years. Specifications and forms of tender can be obtained at the office of the Agent-General for Victoria, Lieut.-General Sir Andrew Clarke, G.C.C.M., Victoria Office 15, Victoria-street, Westminster, London, S.W., on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Tender for Electric Lighting," and addressed to the Mayor of Hawthorn, Victoria, Australia, on June 24, at 5 p.m.

Blackpool.—Tenders are invited by the Corporation for the supply and erection of the following plant at the Corporation electricity works—viz.: Contract No. 1—(Section A) one tubular boiler with superheater; (B) superheaters for five existing Lancashire boilers; (C) surface condensers, pumps, pipes, and storage tanks; (D) two 55-light rectifiers; (E) 10 15-kw. boosters. Contract No. 2—(Section A) high and low tension lead-covered cables; (B) 10 50-kw. transformers. Contract No. 3—(Section A) 20 arc lamp pillars; (B) 100 arc lamps. Tenderers are at liberty to tender for any section, but not for part of a section. Specifications, general conditions, forms of tender, etc., may be obtained from Mr. Robt. C. Quin, borough electrical and tramway engineer, Blackpool, on prepayment as to Contract No. 1 (Sections A to D, which are bound up together) of the sum of £5. 5s., and as to Contract No. 1 (Section E), Contracts No. 2 and 3 (Sections A and B) of the sum of £2. 2s. for each section, which respective sums will be returned on receipt of a bona fide tender on the prescribed form and within the prescribed time. Duplicate copies of Contract No. 1 (Sections A to D) and Contract No. 2 (Section A) will be charged £1. 1s. each, which will not be returned. The Corporation require the erection and completion of above plant within four months from the date of order. Tenders, endorsed "Electricity Works Extension (Contract No. —, Section —)," should be addressed and delivered to Mr. T. Loftos, town clerk, Town Hall, Blackpool, before 10 a.m on March 22.

RESULTS OF TENDERS.

Carlisle.—The Corporation have accepted the tender of J. Laing, Denton-street, at £7,668. 8s. 1d., for the erection of a central electric lighting station, consisting of engine-house, boiler-house, office, stores, chimney, etc., in James-street.

Waterloo (Liverpool).—The District Council have accepted the tender of the Liverpool District Lighting Company, at £61. 18s., for the erection of four electric arc lamps at the junction of Great George's-road with Crosby-road.

Parochial Engineers.—On Thursday, the 10th inst., the Association of Parochial Engineers and Engineers-in-Charge held their annual dinner in the large hall at Frascati's. There were about 160 present, the chair being taken by Mr. Edward White, L.C.C., M.A.B., and vice-chairman of the St. Marylebone Guardians. Among those present were Sir J. R. Somers Vine, C.M.G., Clifford Smith, Esq., A.M.I.C.E., A. Saxon Snell, Esq., F.R.I B.A., etc. This institution has grown very rapidly during recent years, and the gathering was in all respects a distinct success.

BUSINESS NOTES.

Blackpool.—An electric tramway is to be laid over the face of Ingleborough.

Wallingford.—The Guardians have abandoned the idea of using electric light to illuminate the workhouse.

Buckingham Palace.—A sum of £11,000 is to be expended in furnishing Buckingham Palace with the electric light.

Darfield.—At a special meeting of the District Council it was decided to apply for a provisional electric lighting order.

Mansfield.—A petition has been deposited in the House of Lords by the Town Council in connection with the General Power Distribution Company.

Change of Address.—We are informed that Mr. Robert Hammond is to-day moving into new offices at 64, Victoria-street, Westminster, S.W.

Southport.—At the next Council meeting a resolution is to be moved to advance the salary of the electrical engineer, Mr. C. D. Taite, by £70 per annum.

New Catalogue.—We have received a new catalogue of standard electric lighting accessories from Mr. A. P. Lundberg. It is well arranged and most useful for reference.

Grimsby.—It is understood that Prof. Kennedy agrees with the Electric Lighting Committee in their selection of the East End Closes as the most suitable site for the depôt.

Halifax.—Major Cardew has held an enquiry on behalf of the Board of Trade respecting an application by the Corporation to borrow £20,000 for electric tramway purposes.

Motor Development Corporation, Limited.—We understand that the sale of the Wellington patent ignition tubes for gas engines manufactured by this company is steadily increasing.

London Parks.—We hear that there is a promise of improved lighting of the footpaths in St. James's Park the Green Park, and Hyde Park. A vote of £1,000 is to be taken for this purpose.

Yorkshire House-to-House Electric Supply Company.—We understand that this Company have declined an offer made by the Leeds City Council for the purchase of its undertaking by the Council.

Leeds and Bradford Light Railway.—The Corporations of Leeds and Bradford are to hold a conference with reference to the light railway which it is sought to construct between the two cities.

Yarmouth.—The Town Council have resolved to engage the services of an expert engineer to assist the committee in the enquiry they proposed to make into the recent breakdown at the electricity works.

Southend.—Fifty-nine applications were received for the appointment of a resident electrical engineer, and Mr. J. B. Mitchell, electrical engineer and manager to the Corporation of Dewsbury, has been appointed.

Salford.—At a meeting of the Council last week the Chairman of the Electric Light Committee said that the price they were selling electricity at was practically 4d. per unit, instead of 1s., as had been stated in the local Press.

Watford.—We hear that the project for the inauguration of a motor-'bus service between Callow Land and Bushey is being pushed forward with all possible haste, and that the running of motor-'buses will shortly be commenced.

Christchurch.—It appears that the Town Council view the tramway question as one of great possible utility, and have expressed their satisfaction that the British Electric Traction Company are still continuing their efforts.

Personal.—Mr. H. E. M. Kensit has resigned his position as assistant engineer at the Corporation electricity works, Blackpool, in order to join the staff of the Westinghouse Electric Company, Limited, of 32, Victoria-street, S W.

Sheffield.—At the last meeting of the Parliamentary Committee a proposal was submitted by the electric light company's engineer to reduce the price of the current for electric lighting from 5d. to 4d., and the suggestion met with the unanimous approval of the committee.

Lindsey.—The Bill of the General Power Distributing Company for constructing works and for supplying electricity within a radius of 26 miles of Warsop Church, Nottinghamshire, was considered by the Council at its last meeting, and a proposal not to oppose the scheme was carried.

Wimbledon.—The next Council in committee will deal with the following resolution: "That plans and an estimate be prepared for a sludge and dust destructor as described in the report made by the chairman and surveyor in reference to their visit to Leyton, and as recommended by Mr. Preece."

Buxton.—At a special meeting of the Urban District Council it was resolved that Prof. Kennedy be asked to prepare the necessary plans and specifications for lighting the town by electricity, and that tenders be obtained for the laying down of an installation by the Council under its provisional order.

Personal.—Mr. W. McWhirter, M.I.E.E. of Trinity-street, Aberdeen, has received an appointment in India to carry out a new system of electrical train signalling. During his absence his electrical engineering business in Glasgow will be carried on by his son, Mr. Anthony C. McWhirter, A.I.E.E.

Smoking Concert.—A successful electrical smoking concert, promoted by Messrs. A. W. Jones and W. J. Ellis on behalf of the
drawing-office staff and their associates connected
Electric Construction Works at Bushbury, was held on
last at the Swan and Peacock Hotel, Wolverhampton.

Pritchetts and Gold.—We have been asked to no
future all correspondence in connection with the man
storage batteries of this firm will be conducted from th
Feltham, Middlesex to which address all communication
to that portion of their business should be forwarded.

New Offices.—We are informed that Mr. S. Harris
Ellesmere Mill, Newtown, and 697, Ormskirk-road, P
Wigan, Lancs.) has taken new showrooms, offices, and
73, Wallgate, Wigan. Mr. Harrison has been appoint
agent for the North of England for the Crescent arc lam
Hard incandescent lamps.

Leicester.—A special committee has been appointed t
and report as to the advisability of purchasing the tr
the borough either by agreement or compulsorily, and as t
(if purchased) the Corporation themselves should work
ways or lease them to other persons, and as to the most
method of traction to be adopted.

Walsall.—The Electric Lighting Committee's repor
further increase in the number of consumers, and also
paying interest on loans and providing sinking fund, th
deficiency of £531. 17s. 7d. on the past year's busines
with the previous year's loss, the total deficiency on t
taking up to Dec. 31 last £977. 1s. 5d.

Bradford.—The Mayor of Bradford (Mr. T. Speight),
Dixon, Mr. T. H Shaw, and Mr. A. Gibbings, the elect
neer to the Corporation, left Bradford on the 11th in
Continent, in order to inspect central electrical sta
which power is supplied both for lighting and tract
deputation will visit Brussels, Hamburg, Cologne, L
Dresden.

Stafford.—The electricity engineer having reported th
tion of Mr. J. S. Highfield, on his appointment as elect
neer at St. Helens, the Gas and Electricity Committe
that they had appointed Mr. J. H. Clothier (the present
to the post of electrical engineer. The Town Council
the appointment. Regret was expressed at the resi
Mr. Highfield.

Maidenhead.—At the last meeting of the Town C
Electric Lighting Committee asked the Council for a
employ a consulting engineer to prepare a scheme and
fee not exceeding 75 guineas. An opinion was expe
provision should be made in the next estimate for th
ture if sanctioned. Finally, it was resolved to refer
back to committee for amendment.

Hackney.—The vexed question of the transfer of t
lighting provisional order came up before the wh
Committee on Wednesday last. Two amendments were
one in favour of adjourning the matter for a month,
favour of the Vestry doing the work themselves. It
impossible to finish the heated discussion, and finally a
to adjourn for a fortnight was passed by the casting
chairman.

Chester.—The Town Council intend to lay arc
distributing mains for the supply of public and privat
in Lower Bridge-street, Castle-street, Castle esplanade,
road, and Nicholas-street at an estimated cost of £95
posal to increase the salary of Mr. F. J. Beckett, city
and registrar of Corporation stock, on condition tha
up outside practice and devotes the whole of his time to
of the office, including those in connection with the el
undertaking, has been postponed for six months.

St. George-the-Martyr, Southwark.—The Board of T
written saying they did not "see their way" to gr
Vestry a provisional order, as two companies had al
to lay down electric plant in the parish and were do
the last meeting of the Vestry, Mr. Redman said they
submit to this snub. One company had only show
because the Vestry had moved. The Electric Lighting
must meet and send a strong protest against the Boa
favouring a monopolist company. This was agreed to.

Bournemouth.—At the last meeting of the Town
Town Clerk reported the receipt of a letter from
Electric Traction Company stating that they were s
that they might lay such a scheme for electric tramw
the Corporation as might be satisfactory to all concern
the directors would take steps with a view to such a sc
formulated and hoped to arrange a conference on th
an early date. The Town Clerk formally reported the
the Light Railway Commissioners against both th
schemes

Aberdeen.—Prof. Kennedy, in his notes to the C
the joint report of Messrs. Sinett and Blackman, agre
engineers that the proposed extensions will add to th
the undertaking, and that high tension continuous cur
with rotary transformers should be used. If the
should decide to introduce electric traction, he sees no
both systems should not be supplied from one central
a dust destructor were to be erected in the future, it
placed near that station, so that steam from it could
the engines there.

Brighton.—An electricity main is to be laid in Dor
and the lamps in that street lighted by electricity inst
The *Sussex Daily News* says it is understood that t
Committee of the Brighton Town Council came to th

s on Monday to reduce the price of electricity from 1½d. per ter the first hour to 1d. Though the change will not, it is d, come into operation for another three months, the step will create immense satisfaction among the 2,000 present ers, and will without doubt lead to vastly increased s in the future.

n.—It is expected that the Clontarf section of the city tram system will be opened to the public next week. It l that on the Haddington-road section of the line connect- gstown electric tramway with Nelson's Pillar the route that followed by the Sandymount trams, through D'Olier- Brunswick-street, Westland-row, Merrion-square, and Mount-street. The line connecting Ballsbridge with Rath- now laid down nearly in its total length, and it is expected system will be complete in the summer, both from the d Rathmines to Dalkey.

s-super-Mare.—At the last meeting of the Council a s read from Messrs. Foote and Milne, Prince's-mansions, ria-street, S W., suggesting that the Council should heir provisional order, and that they would undertake to the obligations of the said order, and to commence ixed date; that the Council should have the option to the undertaking upon payment of such a sum as will otal of 10 per cent. per annum upon the capital of the g, after bringing into account the profits which, from e, may have been earned.

—A special meeting of the Board of Works for the trict was held on Monday last, the 14th inst., to tice given by Mr. J. Stephens to move: "(1) That the of the Board of Feb 21 last, adopting the following ation of the Electric Lighting Committee—viz., 'That proceed at once to act upon its provisional order, and electricity within the compulsory area at the earliest moment; and the Electric Lighting Committee be o take the necessary steps to carry this resolution into ting its action from time to time for the approval of "—be rescinded.

pton.—The Northampton Electric Light and Power n their letter to the town clerk, state that representa- een received from some of their most influential share- erse to the sale of the undertaking. This being so, the not feel in a position to name a price at which the might be advised to sell, but they will give their best n to any offer emanating from the Town Council. They ; if the Corporation entertain a scheme for the destruc- se, and any question arises as to the disposal of the ated, they would be willing to enter into negotiations the use of such steam.

rade.—The report of H.B.M.'s Consul at Naples. Mr. e, dwells greatly upon the extreme Custom House xporters to that country have to cope with. Dealing ctric lighting of Naples, he states that German lamps inferior, both in colour of the globes, finish, and light- ower, to those manufactured in England are in use. , in answer to enquiries received by him, mentions s of fittings is mainly in the hands of the following ly, Messrs. Lacarrière and Co., Strada Bisignano; per l'Illuminazione, Galleria Umberto; and Messrs. trada Pace—all of Naples.

l.—At the last meeting of the Urban District Council s read from Mr. F. Hastings Medhurst, consulting gineer to the Fleetwood and District Electric Light Syndicate, which has purchased the provisional order lighting from the Urban Council. The letter was in e from the clerk of the Council enquiring the cause commencing the installation, and stated that the only was now preventing the issue of their prospectus was of obtaining a suitable site on reasonable terms. It to relegate the matter of offering the town's yard to to the chairmen of committees.

m.—At the meeting of the Town Council on the 14th ectric Lighting Sub-Committee recommended that, in avourable report made by Mr. Robert Hammond, the lectricity should be undertaken by the Corpora- ub-committee further recommended that the Corpo- ld not oppose the insertion of a clause in their rder that they should take over that portion of the of the Midland Electric Light and Power Company, ich would be of use to the Corporation for the purpose rtaking. The committtee's report was adopted, and for the purchase of the mill property from the ntess of Aylesford was sealed.

.—An adjourned meeting of the Urban District held last week for the purpose of receiving details the laying on of the electric light to Shoreham, which outhern Cross Engineering and Shipyard Company ratuitously lay before the Council. Messrs. R. E and M. H. Churchill-Shann, of the company rticulars, attended to explain. Plans and a detailed re laid on the table. The cost of the entire installa- imated at £6,000. That would provide 56 1,000-c.p. street-lighting and 1 500 16-c.p. incandescent lamps nsumers. An expenditure totalling £1,255 was given, revenue of £1,625—an estimated profit of £370. will be discussed in committee and laid before the

enquiry was held on the 11th inst. at the Guildhall A. G. Durnford, R.E., Local Government Board inspector, into the Corporation's application to borrow, amongst other sums, £20,000 for electric lighting. The Town Clerk stated that the first area proposed to be lighted comprised only four streets—namely, Coney-street, Spurriergate, High Ousegate, and Parliament-street—but it was subsequently decided to extend the area to other streets in the centre of the city. These streets were Low Ousegate, Clifford-street, Market-street, Frasegate, Davygate, St. Helen's-square, Stonegate, Lendal, Museum-street, and St. Leonard's. Prof. Kennedy explained the system of lighting proposed to be adopted, stating that the lighting station was to be constructed on Foss Islands, a piece of land belonging to the Corporation, situate at the side of the River Foss. This concluded the enquiry with regard to the electric light.

Tipton.—At the last meeting of the District Council, held in reference to the proposals of the Midland Electric Corporation, it was stated that the Council had lodged an objection against the granting an order to the Electric Corporation, and the latter had applied to the Board of Trade to dispense with the consent of the Council. After discussion, it was proposed that the Council withdraw their opposition to the corporation supplying power to the district, provided they will supply electricity for lighting in bulk to the Council at 2d. per unit, this to include the supply of mains. It was agreed to make this offer to the corporation, and to reply to the Board of Trade that the Council could not answer their communication until present negotiations are completed. It was understood that the offer of the Council was to have no reference to public lighting, in reference to which the quotation of the corporation, at 1·6d. per unit, was considered satisfactory.

Crompton and Co., Limited.—The directors have addressed to the shareholders a circular stating that, in consequence of certain differences of opinion between themselves and Mr. J. F. Albright as to the management of the Company's business, Mr. Albright is relinquishing his position as a managing director, and has also informed the Board that as soon as may be convenient to the Company he is desirous of resigning his position as director. The directors regret that this course should have become necessary. To provide for the future management of the Company the directors have appointed Mr. F. R. Reeves, the Company's secretary, to the post of general manager, Mr. R. E. Crompton continuing to superintend the technical part of the Company's business. The directors are pleased to be able to inform the shareholders that arrangements have been made by which Mr. Albright undertakes for 12 months to give the Company all advice and information reasonably in his power.

Barrow.—Seventy applications for the post of resident electrical engineer have been received by the committee. The sub-committee having considered the applications and reduced the number to 23, it has been resolved that such 23 applications be forwarded to Mr. Manville, and that he select a few from which to make the appointment. The following recommendation of Messrs. Kincaid, Waller, and Manville, has been adopted—viz., that the Brush Company be allowed to substitute cells of the Tudor type for those included in their contract, and that the extra £112 on the capital price be provided for as an extra in the contract, the rate of maintenance mentioned in the contract to be reduced from £55. 8s. to £44 per annum, the cells to be maintained for this amount to 100 per cent. of their original capacity in place of 70 per cent., and the period for which the contractors are to gratuitously maintain the battery to be 12 months instead of six months as stipulated for in the order. The borough engineer has been authorised to engage Mr. Varley as clerk of works.

Islington.—At an ordinary meeting of the Vestry to be held to-day a report from the Electric Lighting Committee will be presented, stating that as the Vestry has resolved to lay electric lighting mains along a considerable portion of St. James's-road for the purpose of lighting Liverpool-road, and as the traffic during the night time in St. James's-road is considerable, the committee is of opinion that it would be advisable to continue the mains and erect lamps throughout this thoroughfare, and therefore recommends that conduits and mains be laid on one side of the road, and that 13 arc lamps be erected therein at an estimated cost of £1,260. Also that as the Vestry has resolved to lay electric lighting mains in Camden-road, and that the tramway from Camden-road runs along the Parkhurst-road to Holloway-road, the committee is of opinion it would be advantageous to extend the arc lighting through Parkhurst-road, thus completing the line of lighting direct to Holloway-road, and therefore recommends that conduits and mains be laid both for public and private supply on both sides of the road, and that 13 arc lamps be erected, the total estimated cost of the work being £2,200, and that the necessary fund in each case be raised by loan as heretofore.

St. Marylebone.—At a meeting of the Vestry held on the 10th inst., a report was received from the Electric Lighting Committee, recommending (a) that no action be taken at present with regard to the proposal that two additional electric lights be placed at each side of Oxford-circus in Oxford-street; (b) with respect to the Vestry's application for a provisional order for power to construct and maintain electric lines and works and to supply electricity within the parish of St. Marylebone, that the Board of Trade be informed that the Vestry undertake to proceed with the execution of the works as soon as possible after the grant of the necessary powers, and, further, that the Vestry agree to the omission from the order of the clause empowering them to transfer their powers to any other body or person. At yesterday's meeting the Works Committee recommended, as regarded a notice from the Metropolitan Electric Supply Company of their intention to lay low-tension armoured mains directly in the ground from their Rathbone-place station along Rathbone-place, Oxford-street, Upper Rathbone-place, Newman-passage, and Newman-street,

crossing Oxford-street at Rathbone-place and Newman-street—that the Vestry should formally signify their objection thereto.

Beckenham.—The following report of the Electric Lighting Committee was adopted by the Urban District Council on Monday last. The sub-committee's report on the inspection of works at Oldham, etc., was presented. The reference from the Council, directing the committee to consider the advisability of enquiring as to the probable applications for light throughout the district was submitted. The committee are of opinion that it would be inadvisable to take action in this direction at present. The committee recommend (*a*) that the scheme to be adopted should be a combined scheme for the generation of electricity and the destruction of house refuse; (*b*) that an engineer be associated (at a fixed remuneration of 50 guineas) with Mr. Angell, in the preparation of plans to accompany an application to the Local Government Board for sanction to a loan; such fee to cover, if necessary, his evidence up to and including the Local Government Board's enquiry; (*c*) that no steps other than the preparation of plans, and the application for sanction to a loan, be taken until after the election of the new council; (*d*) that the selection of the engineer be left to the surveyor.

Eastern Telegraph Company.—The Bill promoted by the Eastern Telegraph Company, which has originated in the House of Lords, will pass as an unopposed measure through that House, no petitions having been lodged against it within the time allowed by the standing orders. Under this Bill the Company are empowered to convert their £700,000 6 per cent. preference shares into 3½ per cent. preference stock by the issue of £18. 10s. of the new stock for every £10 fully-paid preference share. To effect this conversion it is proposed to create £2,000,000 preference stock, and the balance not required for the conversion is to be issued "as and when the directors think fit, and applied to any purposes of the Company to which capital is properly applicable." The Bill also proposes to empower the directors, with the sanction of the members, to create "new additional preference stock or shares," provided that the total amount of the preference capital issued shall never exceed one-half of the ordinary capital created and issued. Power is also given to the Company to create debenture to an amount not exceeding one-third of the total amount of ordinary and preference capital. It may be mentioned that the ordinary capital of this Company already created is £4,000,000, and the debenture stock already issued is £1,521,868.—*Financial Times*

Westminster.—At the meeting of the Vestry on 17th inst., the Parliamentary Bills and General Purposes Committee stated that they had considered a letter from the St. James's and Pall Mall Electric Light Company, stating that on and after Jan. 12 the charge for the supply of electricity will be further reduced, and in future the rate will be as follows: for the first 4,000 units of annual consumption, 6d. per unit; for all further consumption during the year, 4d. per unit; the supply for motors, heating, and other similar purposes will be made by separate meters at 3d. per unit; and now report that the time has arrived when it is possible under the company's provisional order for the Vestry to make representations to the Board of Trade that the prices or method of charge stated in the schedule of the order should be altered; and that they have considered in connection therewith a statement prepared by the vestry clerk, showing the capital, dividends, receipts from the supply of current, net profits charges, etc., of the company for the seven years ended Dec. 31, 1897; and recommend that in the first instance a communication be addressed to the St. James's and Pall Mall Electric Light Company, calling attention to the profits made by the company, the amounts charged to depreciation, and other particulars relating to the undertaking, and urging the company to at once make a further reduction in the prices charged for the supply of electricity, particularly to smaller consumers, beyond that notified in their communication of Jan. 12.

Hendon.—At the Hampstead Vestry Hall, Mr. Fitzgerald and Colonel Boughey, Light Railway Commissioners, resumed on Saturday last the enquiry, opened the day before at Hendon, into the scheme of the Hendon and Finchley Districts Light Railways Company. Evidence in support of the scheme was given by Sir Douglas Fox and Mr. Wragg, the engineers, Mr. J. T. Firbank, M.P., and Mr. W. M. Murphy, the promoters, Mr. Hearne, chairman of the Hendon District Council, and others. Mr. Lewis Coward, for the Hampstead Vestry, objected to the serious damage to property that the scheme would cause. Evidence having been given in support of this, Mr. Ernest Moon submitted, on behalf of the London County Council, that it was contrary to public policy that a scheme of this kind should be permitted in London. The line was a tramway, and so seriously did the London County Council regard this attempt to come into their area, without the protection given by the Tramways Act, and to override the public right to purchase the line which they had already so expensively exercised, that they would be compelled, if this scheme were passed, to consider the introduction of fresh legislation to limit the scope of the Light Railways Act. Mr. Dix, on behalf of the Middlesex County Council, and Mr. Colam, representing a committee of Hampstead residents, took objection on similar grounds, and after a great deal of evidence against the scheme had been given, the sitting was adjourned.

Lewisham.—Mr. Trenchard had given notice that he would move at the next meeting of the Board of Works: "In view of the memorial of the ratepayers to the Board and inasmuch as the conversion of the Board into a trading or manufacturing corporation in competition with private enterprise we consider to be unwise and unfair, and as the Great Western Electric Light and *Power Company, Limited*, have offered to purchase the Willoughby
dust destructor and destroy the refuse at cost price, not
1s. 6d. per ton, which on 20,000 tons would amount to
the ratepayers of at least £1,400 per annum, and a
company have also undertaken to supply electricity for
lamps at a price which will reduce the cost by about 16
per annum, and further agree to supply within 12 m
High-street, Lewisham, Sydenham-road, Perry-vale,
parts of the district as specified in the draft order,
private consumers only 3d. per unit after the first
Islington Vestry charging 7d. per hour), this Board
rescind the resolutions of the Board of Nov. 24, 1897, a
1898, authorising an application to the Board of T
provisional order, and the resolution of the Board of
1898 declining the offer of the Great Western Electric
Power Company, Limited, and, further, to withdraw
application by the Board, and to grant consent to the
order of the said company on the terms of their prop
as the resolution was one to rescind, and would therefo
tate a special meeting, the notice was not received.

Wednesbury.—A special meeting of the Town Counc
last week to consider the electric lighting question, whe
tion representing the Midland Electric Corporation
Distribution, Limited, were present. The Mayor said
were being made by the Midland Electric Corporation
provisional order to supply electricity in the town, b
out that certain objections had been made to their prop
Town Clerk intimated that their objections were to the
the Board of Trade should not grant a provisional o
Midland Corporation for Wednesbury without their co
that numerous objections were to be raised to the propo
taking; and, further, that the Corporation of Wednesb
if required, obtain from the Board of Trade a provision
the electric lighting of the borough. The Town Clerk
the Board of Trade had asked for the observations of t
upon the proposals of the Midland Corporation. Fina
resolved: "That each member of the Council be supp
copy of the application of the Midland Corporation, als
the objections which had been served to the Board of
that a special meeting of the Council in committee be
Monday evening next." The representative of the Mi
poration explained that they would supply electrici
maximum rates of 3d. per unit for the first hour's use p
825d. for each subsequent hour's use. At Monday's
was decided that the Council should apply for a provis
for themselves. The decision will be reported to a futu

House of Lords Committee.—On the motion of Lo
in the House of Lords on the 15th inst., the following
appointed to represent their lordships on the Joint Co
both Houses to consider the subject of electrical energy
stations and supply): Lord Cross (Privy Seal), Lord Sp
Knutsford, and Lord Monkswell. The motion refer
passed on the 10th inst., as follows: "That it is desi
Select Committee be appointed to join with a commi
House of Commons to consider and report: (1) whethe
standing the provisions of Section 12 (1) of the Electri
Act, 1882, powers should be given in any cases for acq
compulsorily for generating stations, and, if so, under
ditions as respects liability for nuisance, notice to
owners, and otherwise; (2) whether compulsory powers
land for generating stations, if proper to be given in any
be given where the proposed site is not within the area
(3) whether, in the case of a generating station, however a
being situate within the area of supply, power should b
the breaking-up of streets between the generating stat
boundary of the area of supply; (4) whether powers
given in any case for the supply of electrical energy a
including districts of numerous local authorities, invo
of exceptional dimensions and high voltage, and if s
may properly be given whether any and what conditi
be imposed—(*a*) with respect to system and plant and
struction and location of generating stations in view of
of purchase conferred upon local authorities by Sectio
of the Electric Lighting Act, 1888, (*b*) with respect t
tions of the promoters to other undertakers and to l
rities within parts of the area; (5) under what conditi
ought powers to be conferred upon promoters seeking
electrical energy to other undertakers, and not
consumers."

Whitehaven.—At the last meeting of the Town
Water and Lighting Committee's minutes showed that
a letter was read from the Local Government Board
entertain the application of the Council for sanction
£7,500 for electric lighting, as the Council had not pow
out lighting outside the area prescribed by their elect
order of 1891, and that thereupon the Town Clerk re
ing out that £6,000 of the £7,500 was required for w
the old area, and asking the Local Government Board t
the application as far as that part was concerned. A
on Feb. 23 a further letter was read from the Local
Board, asking for more details with regard to the ap
borrow £7,500; and it was resolved that the chairma
chairman, and Alderman Dees be a sub-committee to
the town clerk as to the advisability of obtaining an
would include the new area, and report to this com
reply to a question anent the breakdown in the public
Sunday, the 20th ult., the Town Clerk read the report m
Brodie to the committee, and the report made by Mr.
Mr. Brodie on the subject. From these it appeared tha
where the conductors for the Lowther-street section

...ere there was a joint which proved to have been badly ...and which was alleged to have been made by Messrs. ...'s men. The consequence was that the insulation was ...ed, and at last the current leaped from one cable to the other, ...the shortest cut back to the dynamos instead of traversing ...ther street section conductors, as it ought to have done. ...ghts of that section all went out, and the momentary auto...ffect of this sudden alteration in the demand made upon ...amos was to bring them to a standstill, so that the lights ...whole town went out, with the exception of the two arc lights ...street, which are connected with the private supply. The ...of the lights were out for about two minutes, when they ...stored, except in the Lowther street section. Lowther...ection remained in darkness until with the utmost expedi...street could be opened where the defect was located, and ...ary connection could be made which enabled the lamps ...ighted within a couple of hours. Mr. Brodie utilised the ...to point out to the committee how useful their arc lamps ...private supply cables were in such an emergency, and to ...that it would probably be found desirable for the com...to extend this system of arc lamps on private cables to all ...streets.

...mpton.—At the Council meeting on Monday last, the ...letter from the Board of Trade regarding the Midland Power Distribution and Lighting Provisional Order was ..."With reference to your letter of Jan. 11, notifying the ...of the Corporation to the application for the above...d order, I am directed to forward you enclosed copy of a ...quest by the promoters that the consent of the Corpora...the application may be dispensed with." The copy ...was of a detailed character, and stated the applicants ...the Board of Trade to dispense with the consents of the ...s of Wolverhampton and Walsall, and the Urban ...uncil of Tipton, being local authorities having jurisdic... the proposed area of supply who have not consented ...t of the order under the title of the Midland Corpora...ower Distribution, Limited, Provisional Order, and the ...such requests were given. One of them was that the ...uncil of Tipton had not obtained, nor was it making ...tion for license or provisional order under the Electric Act. The applicants submitted the Corporations of ...pton, Walsall, and Tipton Council were not entitled ...their consent unreasonably, and that in this case they ...so. The objects of the company were not only to ...district named with cheap electrical energy, especially ...power and manufacturing purposes, such as the ...mines and driving machinery, but also for lighting. ...ny stated they would be able to supply the power ...an Wolverhampton and Walsall, and a comparative ...as appended showing the prices charged in 15 towns ...be local authorities owned and worked the electric ...ders. The communication stated: "That starting a ...taking for the supply of electricity for motive power ...cturing purposes is not within the sphere of operations ...ld be under municipal management, and that risks ...evitable in a new enterprise of this kind, and which a ...ay be justified in incurring, are unsuitable for a ...r local authority to embark upon, having regard to the ...must borrow money on the ratepayers' account to enable ..." and "that the prices—viz., 6d. and 3d. per Board of ...—to which the applicants were limited, were con...wer than the price—viz., 6d. per Board of Trade unit—...y the fourth schedule of the Wolverhampton and ...rporation Electric Lighting Orders, 1896. Another ...rade would be encouraged, but if one or two important ...the area were excluded from the order it would ...ffect the entire scheme. A motion to the effect that ...tion assent to the promotion of the provisional order, Electric Lighting Acts, 1882 and 1888, by the Midland ...rporation for Power Distribution, in respect of an area ...in the counties of Stafford and Worcester, on condition ...mpany insert in such order, or the confirming Act, an ...not to supply electricity within the borough of ...pton, except with the consent of the Council, and ...such conditions as the Council may impose, was

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PROVISIONAL PATENTS, 1898.

MARCH 7.

...ved apparatus for regulating the pressure on ...tric mains, chiefly in connection with storage ...teries. John Somerville Highfield, 6, Ingestre-road, ...ford.

...vements in electric high and low tension fuse ...s for blasting purposes. William Albert Malson ...Sidney Richardson Malson, Bank-buildings, George-...st, Sheffield.

...vements in and connected with dynamo-electric ...chinery. Montague Tabor Pickstone, Roland Sydney ...heim, and Arthur Charlesworth Peebles, Tay Works, ...ington, Edinburgh. (Complete specification.)

...proved holder for carbon and other brushes for ...tric motors, dynamos, and the like. Adam Latimer ...strong, 18, Buckingham-street, Strand, London.

...vements in switches for electric glow lamps. ... Berthold-Kistritz, 46, Lincoln's-inn-fields, London.

5571. **Improvement in or connected with the application of electricity to marine propulsion.** William Thomas Carter, John Alexander Dawson, and Thomas Gray, Norfolk House, Norfolk-street, London.

5596. **Improvements in electric arc lamps.** Sigmund Bergmann, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

MARCH 8.

5624. **Improvements in and in relation to electrical alarms.** George Tithe Moore, 9, Westland-row, Dublin.

5644. **Improvements in electric lamps for photographic and similar purposes.** William Cottier Cubbin and Greville Ewing Johnston, 212, Kensington, Liverpool.

5663. **Improvements in metallic conductors for protecting electric wires and cables.** Peter Charles Middleton and Frederick Huggins, 7, Staple-inn, London.

5672. **An improved electrical safety lamp for miners.** Henry Harris Lake, 45, Southampton-buildings, London. (Otto Siedentopf, Germany.) (Complete specification.)

5680. **Improvements in telephone speaking-tube and like receivers.** Hannemann Adolphus Catmore, 7, Quality-court, Chancery-lane, London.

5686. **Improvements in and relating to dynamo-electric machines and electromotors.** Sidney George Brown, 45, Southampton-buildings, Chancery-lane, London.

5693. **Innovation in electric lighters (pyrophore).** Wilhelm von Zabern, 10, Silver-street, London.

5703. **Improvements in electrodes for secondary batteries or accumulators.** Henri Pieper fils, 47, Lincoln's-inn-fields, London.

5704. **Improvements in electrodes for secondary batteries or accumulators.** Henri Pieper fils, 47, Lincoln's-inn-fields, London.

5705. **Improvements in the manufacture and production of electrodes for secondary batteries.** Henri Pieper fils, 47, Lincoln's-inn fields, London.

MARCH 9.

5729. **Improved apparatus for the electric ignition in internal combustion engines.** Robert Andrew Miles, Greylands, Gosford green, Coventry.

5750. **An improved form of automatic transformer switch.** J. E. M. Stewart, Holford, Middle-road, Bournemouth.

5786. **Improvements in a method of and means for making connection between an underground conductor and a vehicle motor.** Harry Louis Butler, 22, Glasshouse-street, Regent-street, London.

5783. **Improvements in electric tram and railway systems.** William Charles Cloete Hawtayne, 55, Chancery-lane, London.

5806. **Improvements in the manufacture of metal bases for incandescence lamps.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (La Compagnie Générale des Lampes a Incandescence, France.) (Complete specification.)

5810. **Process for making an electrical conductor and an insulating body of tar asphalte and the like materials.** William Phillips Thompson, 6, Lord-street, Liverpool. (Albert Lessing, Germany.)

5823. **Improvements in and in connection with underground conduit electric railways.** Edward Heyl-Dia, 37, Chancery-lane, London.

5830. **Improvements in and in connection with incandescent electric lamps.** Edward Heyl-Dia, 37, Chancery-lane, London.

MARCH 10.

5863. **Improvements in incandescent electric lights and in processes therefor.** William Lawrence Voelcker, 171, Queen Victoria-street, London. (Complete specification.)

5912. **Improvements in electrical galvanic batteries.** Giambattista Laura, 65, Chancery-lane, London. (Complete specification.)

5934. **Improvements in conduits for electric conductors.** John James Bate, 6, Lord-street, Liverpool. (Complete specification.)

5950. **Improvements in or connected with the application of electromotors to propulsion.** William Thomas Carter, John Alexander Dawson, and Thomas Gray, Norfolk House, Norfolk-street, London.

MARCH 11.

5959. **Improvements in guards for flames or fragile objects, such as incandescence electric lamps, glass globes, etc.** Harry Neville Moody and Albert Lewis Davis, 68, Victoria-street, Westminster, London.

6014. **The springless contacts bayonet-holder for electric incandescent lamps.** Lewis Bertgues, 16, Tudor-street, Fleet-street, London.

6022. **Improvements in primary voltaic or galvanic batteries.** Pierre Lafargue and Edouard Drouet, 7, Staple-inn, London.

6024. **Improvements in and relating to conduits for electric cables.** William Sykes, 18, New Bridge-street, Blackfriars, London.

6026. **An electric drill.** Richard Joseph Crowley and Charles Hughes Preston, 34, Walbrook, London.

6025. Improvements in and relating to draw and junction boxes for electric mains. William Sykes, 18, New Bridge-street, Blackfriars, London.

6028. Improvements in the method of and apparatus for the electro-deposition of metals. James Holloway, 24, Southampton-buildings, Chancery-lane, London.

6032. Improvements in electrical or electromagnetic therapeutic apparatus. O. Waratka and E. Sachs, 40, Chancery-lane, London. (Complete specification.)

6044. Improvements in secondary batteries. Alexis Werner, 53, Chancery-lane, London.

6058. Apparatus for transmitting motion to a distance by means of electrical energy. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Atkien Gesellschaft, Germany.)

MARCH 12.

6108. Movement mechanism for electric apparatuses. Philipp Richter and Theodor Weil, 8, Rue des Princes, Brussels.

6109. Improved electric arc lamps. Philipp Richter and Theodor Weil, 8, Rue des Princes, Brussels.

6110. Improvements in blades for electric current collectors. Philipp Richter and Theodor Weil, 8, Rue des Princes, Brussels.

6135. Improvements in electric incandescence lamps. Walther Nernst, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

6145. Process for hardening and rendering tenacious the active mass of electric accumulators. Roderich von Barby, 1 and 4, Mitre-court-chambers, Fleet-street, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1897.

907. Device to be used as an indicator signal or relay in connection with telephone switchboards and other analogous apparatus. Rabidge.

5171. Conductors for electric railways and the like. Wood.

6197. Electric apparatus for governing engines. Snow and Cooper.

7212. Rheostatic apparatus particularly applicable to the starting of electromotors. Dixon.

7646. Electrical motor-generators. Siemens Bros. and Co., Limited, and Leake.

8041. Apparatus for transmitting motion to a distance by means of electrical energy. Siemens Bros. and Co., Limited. (Siemens and Halske.)

8674. Electric switches. Brockies.

9166. Method of and apparatus for erecting overhead electric conductors for railways and tramways. Werther and Schäffer.

9586. Current-collecting apparatus for electric tramways. Little and Ireland.

10651. Holders for incandescent electric lamps. Masson. (Date applied for under International Convention, Sept. 24, 1896.)

15933. Portable electric lamps. Mills.

20591. Electric tramway and electric transmission of power systems. Little.

21110. Arc lamps with double globes. Wheatley. (Allgemeine Elektricitäts-Gesellschaft.)

23260. Automatic magnetic circuit breakers. Scott. (Date applied for under International Convention, March 17, 1897.)

26659. Automatic cut-out or short-circuiting device for electric arc lamps. Holsten and the Elektrische Bogenlampenfabrik Naeck and Holsten Gesellschaft mit Beschkrankter Haftung.

27888. Electric furnaces. Bradley.

28882. Electric switches for electric valve-controlling apparatus. Barker. (Schoeffel.)

29590. Dynamo-electric machines and motors. The British Thomson-Houston Company, Limited. (Priest.)

29710. Electric accumulators. Browne and Kamperdyk.

30211. Insulating conduits for electric conductors. Thompson. (Jungbluth.)

30626. Method of and means for regulating the phase relation between current and electromotive force in alternating-current systems of electricity distribution. The British Thomson-Houston Company, Limited. (Steinmetz and Rice.)

30628. Induction watt-hour meters. British Thomson-Houston Company, Limited. (Thomson and Pratt.)

1898.

1017. Method of and apparatus for signalling or advertising by electricity. Ginisty.

1379. Electrical insulation conduits and method of and apparatus for making same. Justice. (The Lithosite Manufacturing Company.)

1391. Electromagnetic brakes for cars. Peckham.

1416. Telegraphic transmitters. Price, Phillips, and Weiny.

TRAFFIC RECEIPTS.

Dover Tramways.—The traffic receipts for the wee[k] March 12 were £100. 5s. 9d. The total receipts for [...] 1898 are £1,048. 11s. 6d. The mileage open at present is [...]

Bristol Tramways.—The traffic returns for the wee[k] March 11 were £2,259. 13s. 2d., compared with £2,125 [...] for the corresponding period of last year, being an in[crease of] £133. 15s. 8d.

Birmingham Tramways.—The traffic receipts for th[e week] ending March 12 were £3,278. 16s. 7d., as compar[ed with] £3,307. 2s. 6d. in the corresponding week in 1897, [a] decrease of £28. 5s. 11d.

Liverpool Overhead Railway.—The traffic receipts [of the] railway for the week ended March 13 amounted to £[...] compared with £1,280 in the corresponding week of the [...] year, being an increase of £50.

City and South London Railway.—The returns for [the week] ended March 13 were £1,077, compared with £1,031 for th[e corre]sponding period of last year, being an increase of £46. T[he] receipts for the half-year amount to £11,796, compar[ed with] £11,806 for the corresponding period last year, being a [...] of £10.

South Staffordshire Tramways.—The traffic returns [for the] week ending March 11 were £533. 18s. 5d., as compar[ed with] £565. 9s. 7d. in the corresponding week of the previo[us year.] The aggregate receipts for the year are £5,789 10s. [...] against £5,696. 5s. 11d. in the corresponding period [of the] previous year.

Dublin S.D. Tramways.—The traffic receipts for th[e week] ending March 11 were £381. 4s. 1d., as compar[ed with] £392. 11s. 0d. in the corresponding week in the previo[us year,] being a decrease of £11. 6s. 11d. The number of pa[ssengers] carried was 65,867 in 1898 and 63,023 in 1897. The a[ggregate] returns up to date are £3,975. 13s. 5d., as compa[red with] £4,305. 18s. 6d. last year, being a decrease of £330. 5s. [...] mileage open is the same as last year—viz., 8 miles.

COMPANIES' STOCK AND SHARE LIST

Name.	Paid.
Birmingham Electric Supply Company	5
Brush Company, Ordinary	2
—— Non. Cum., 6 per cent. Pref.	2
—— 4½ per cent. Debenture Stock	100
—— 4½ per cent. 2nd Debenture Stock	100
Callender's Cable Company, Debentures	100
—— Ordinary	5
Central London Railway, Ordinary	10
——	6
—— Pref. Half-Shares	1
—— " "	5
Charing Cross and Strand	5
—— 4½ per cent. Cum. Pref.	5
Chelsea Electricity Company	5
—— 4½ per cent. Debentures	100
City of London, Ordinary	10
—— Prov. Cert. 80,001-90,000	10
—— " 90,001-100,000	2
—— 6 per cent. Cumulative Pref.	10
—— 5 per cent. Debenture Stock	100
City and South London Railway, Consolidated Ordinary	100
—— 4 per cent. Debenture Stock	100
—— 5 per cent. Pref. Shares	10
—— " " " '96	10
County of London and Brush Provincial Co., Ordinary	10
—— 6 per cent. Cum. Pref.	10
Crompton and Co., 7 per cent. Cum. Pref. Shares	5
—— 5 per cent. Debentures	—
Edison and Swan United Ordinary	3
—— 5 per cent. Debentures	5
—— 4 per cent. Deb. Stock, Red.	100
Electric Construction, Limited	2
—— 7 per cent. Cumulative Pref.	2
Elmore's Copper Depositing	1
Elmore's Wire Company	3
W. T. Henley's Telegraph Works, Ordinary	10
—— 7 per cent. Preference	10
—— 4½ per cent. Debentures	100
House-to-House Company, Ordinary	5
—— 7 per cent. Preference	5
India Rubber and Gutta Percha Works	10
—— 4½ per cent. Debentures	100
Kensington and Knightsbridge Ordinary	5
—— 6 per cent. Pref.	5
London Electric Supply, Ordinary	5
Metropolitan Electric Supply, Limited, Ord. No. 101-50,000	10
—— " " " 50,001-82,500	10
—— 4½ per cent. First Mortgage Debenture Stock	100
National Telephone, Ordinary	5
—— 6 per cent. Cum. First Pref.	10
—— 6 per cent. Cum. Second Pref.	10
—— 5 per cent. Non. Cum. Third Pref.	5
—— 3½ per cent. Deb. Stock, Red.	100
Notting Hill Company	10
Oriental, Limited, £1 shares	1
—— £5 Shares	5
—— £4½ shares	4½
Oriental Telephone and Electric Company	4
Royal Electrical Company of Montreal	—
—— 4½ per cent. First Shares Mortgage Debentures	100
South London Electric Supply, Ordinary	2
St. James's and Pall Mall, Limited, Ordinary	5
—— 7 per cent. Pref.	5
—— 4 per cent. Deb. Stock, Red.	100
Telegraph Construction and Maintenance	12
—— 5 per cent. Bonds	100
Waterloo and City Railway, Ordinary	100
Westminster Electric Supply, Ordinary	5
Yorkshire House-to-House	5

NOTES.

and Steel Institute.—The annual meeting is eld at the Institution of Civil Engineers, Great treet, London, on Thursday and Friday, May 5 The autumn meeting is announced to be held at m under the auspices of the Swedish Association asters on Friday and Saturday, Aug. 26 and 27.

al London Railway.—This company have Sir Henry Oakley, late general manager of the orthern Railway Company, as their chairman. the matter of great congratulation at the special of the company, and Mr. Henry Tennant, the chairman, both proposed the change and at the e pointed out its advantages.

ric Lighting of Trains in India.—The -Bikanir Railway are setting an example in this The managers' reserved carriage was fitted up e ago with Stone's system of electric lighting, s worked satisfactorily. Urged by this success ey are going to use the system on a whole train, mo and accumulators being placed in the brake van.

ric Railway Schemes for London.—The d opposition to the Bill promoted by the Charing ston, and Hampstead Railway Company has been n, and hence the Bill has been passed on to the d Bill Committee. As regards the City and Railway Bill, amendments having been made to objections of the local authorities, the Bill, as is to be reported for third reading.

rtesian Lighting and Power Plant.—Mr. son describes in the columns of our New York a power artesian well he is the happy owner of. s power for grinding feed, sawing wood, ripping tc., and after that has power enough to operate a amo supplying 35 lamps. A grain elevator has added, and this is driven by an electric motor. eter of the well pipe is 4½in., and it is 525ft. deep.

sion on the "Maine."—Mr. C. Rettie, of , writes to combat the idea that this explosion o electricity from the lighting mains, as has been some of the daily papers. He points out that in ps no lights of any kind are allowed to be fixed agazine, nor are the wires of any kind conveying f electricity—whether it be for the electric light, wer, electric signalling, gun and torpedo firing— be run inside the magazines. The magazines d from an outside source by what is known as s, about 2ft. by 1ft., and consists of a watertight a glass front, about 12in. square and 1in. thick, y dust-tight and watertight. The electric or any p is inserted in this box from the outside, and the ires for supplying same are also run outside, so uld be impossible for the explosion on the United iser "Maine" to have been caused by any of the stems on board. There is only way to get into ines, and that is from the upper deck, and to get hts you have to go down a separate hatch.

l Heat from Incandescent Lamps.—Dr. dley, writing to the *Lancet* with respect to the a on the heat of incandescent lamps which we o last week, says: "In further illustration of the ould call attention to an apparatus for cooking purposes where the heat is produced by broad-candescent lamps with a reflector of special con- A thermometer placed midway between two ps 12in. apart quickly registers 350deg. F. The re can be regulated by a rheostat or by adjust- the reflectors. Such an apparatus adapts itself admirably to medical uses and where dry heat at a very high temperature is required, and the writer never uses any other method of obtaining it. By means of such an arrangement heat may be localised upon any particular limb or organ, or applied to the whole surface of the body. It is easy to show that in order to obtain the most intense heat rays the heat-producing source ought to be of a luminous character, and by far the best means of securing high temperatures with luminosity is the electric light. Here heat is produced without combustion and the many disadvantages that accompany the latter."

Aurora Borealis.—Last week a most brilliant aurora borealis was witnessed from Kelso. We understand from the *Kelso Mail*, that shortly after sundown a halo of pale light, closely resembling that of the electric light, was observed to spring up on the northern horizon. It gradually formed itself into a well-defined arch, showing distinctly amid the surrounding darkness of the moonless but starlit sky. The area of luminosity seemed to wax and wane both in extent and intensity, but tending always to increase, till the whole horizon from east to west was bathed in light almost equal to that afforded by a full moon. From the centre of illumination there shot out straight shafts of light pointing towards the zenith, moving now in one direction and now in another, like the beams from so many distant search-lights; and all the time great waves of light rolled up from the north, flashing out and disappearing in all directions till one half of the visible heavens, from east to west by north, and right overhead, was filled by the beautiful shimmering radiance. The similarity of this display to the rays of an arc lamp reminds us that one night in 1888 we called out a crowd of friends in Newcastle to see a brilliant display of northern lights, which after investigation proved to be due to some arc lamps newly erected in the exhibition held that year.

The Metropolitan Railway and Electric Traction.—The Bill now before Parliament to grant the above company power to run their trains by electricity is opposed by the Great Western Railway Company. The object of the opposition appears to lie in the fact that the Great Western Railway Company run certain trains on the Metropolitan Railway. A question was then raised as to the *locus standi* of the opposing company on the grounds that all that was proposed was that the Metropolitan Company might—not everywhere on their system, but over certain lines—use electricity for working their own carriages. The Metropolitan Company desired to improve their system for the convenience and comfort of the public, and they sought powers, in order to render the ventilation of the railway more satisfactory, to use electricity. The system to be adopted was not decided upon, the company asking for three years in which to make enquiries and test the various systems of locomotion, the Board of Trade having a voice in the final selection of a method. In order to get rid of bad ventilation they sought to run their own trains by electricity, having no desire to interfere with Great Western trains at all. After argument before the Court of Referees of the House of Commons the *locus standi* of the Great Western Railway was allowed.

The Cable to Iceland.—This question is to be discussed at the next National Sea Fisheries Convention. The chief industry of Iceland and the Faröe Islands is the fishing, and hence the connection between the convention and the cable. As mentioned in a previous note, the Danish Government have promised an annual subsidy of £5,000 for 20 years towards the cost of working the cable. The Great Northern Telegraph Company of Copenhagen, who are the promoters of the present scheme, hope to be able to obtain from Great Britain a £3,000 subsidy

for 20 years. In return for this it is proposed to wire the meteorological reports free of charge, and to transmit Government telegrams over the cable at one-half the ordinary rates. The capital required is estimated at £100,000, and the expenses as follows: £4,000 for working of three stations (Shetland, Faröe, and Iceland); £3,200 maintenance, at £4 per nautical mile per annum; and £6,000 interest on capital at 4 per cent. and sinking fund over 28 years. The commerce of the Faröe Islands and Iceland is as yet not large enough to justify the expectation of a telegraphic traffic producing a sum anything like sufficient to cover the expenses of the undertaking, and the traffic revenue is expected to cover only one-half of the daily working expenses.

The James Forrest Lecture.—This year's subject of the above lecture was "The Relation of Geology to Engineering," and in the able hands of Prof. Boyd Dawkins yielded one of the best John Forrest lectures yet delivered. The author pointed out that geology and engineering were so intimately interwoven that sometimes it was impossible to separate them. The structure of the earth ought to form an essential part of the education of a civil engineer. The success or failure of an undertaking depended largely upon physical conditions falling within the province of geology, and the works of the engineer should be based on the faith of the geologist. The lecturer then considered some of the important questions which had been answered by the combined results of the two sciences. Beginning with the movements of water in the sand, sandstone, and the chalk, he went on to discuss the conditions under which the solid rocks of the British Isles have been more or less covered by superficial *débris*, sand, gravel, and clay, and to show how geological theories connected with the Pleistocene age and the glacial period might have an important bearing on engineering works—for example, on the construction of watertight reservoirs. Lastly, he drew attention to the value of geology, as directing the mining engineer where and where not to search for the minerals he desired to win. The most striking illustration of geological theory working out into practical results was presented by the history of the discovery of the south-eastern coalfield.

Trial of Motor Vehicles.—The Self-Propelled Traffic Association calls our attention to the forthcoming trials of motor vehicles for heavy traffic, which will be held in Liverpool during the last week of May. This competition has for its object the attainment of a self-propelled road vehicle capable of economically taking the place of horse haulage in the transport of heavy loads of goods over considerable distances. Beginning on May 24, trial runs of from 30 to 40 miles will be made in the neighbourhood of Liverpool with a minimum load of two tons of goods. A large number of points bearing on the cost, control, working, and construction of the vehicles will be taken into account in making the awards. The judges appointed are: Sir David Salomons, Bart.; Mr. Boverton Redwood, F.R.S.E.; Prof. H. S. Hele-Shaw, LL.D., M.I.C.E.; Mr. John A. Brodie, M.I.C.E.; Mr. Everard R. Calthrop; Mr. S. B. Cottrall, M.I.C.E.; and Mr. Henry H. West, M.I.C.E.; whilst Mr. E. Shrapnell Smith, hon. local secretary, has charge of all the work of organisation. Several types of French vehicles are likely to take part as competitors, and the Automobile Club de France—a body that has done much to encourage this industry on the Continent—has accepted the invitation of the Self-Propelled Traffic Association to attend the trials and to appoint official delegates. Home support, however, is not to be lacking, for it is expected that nearly all the Government departments will *be officially represented*. Further information may be obtained from the secretary of the association, W. Barr, whose office is at 30, Moorgate-street,

Telectroscopy.—The *Telegraph* is still co the value of the discovery of Herr Szczepanik gives the following from its Vienna corresp among other headlines says, "Further det telectroscope." We fail to find the details, our readers can do so: "The inventor of the te Herr Szczepanik, will introduce his discovery i of the next few days to a select circle of sc and journalists. In contradicting certain rem Press, according to which the telectroscop described by experts as a discovery which at no practical utility, Herr Szczepanik declared the telectroscope possesses far greater practical and possibilities of usefulness than is supp apparatus, says Herr Szczepanik, not only c pictures from a long distance, but will make system of telegraphy as it now exists superflu as well as portraying real proceedings in th pictures, the telectroscope will also show copi scripts and prints at the remotest distances in a time, and fix at one stroke photographic facsin same on a sensitive plate or sensitive paper. mission will extend, as regards distance, as far telephone. Respecting this telegraphy of the f Szczepanik declares that it is possible, for e place a copy of a newspaper in the apparatus been prepared by him and is now ready fo within a few seconds, at such a distance, sa Vienna to Berlin, a photographic facsimile of this would be yielded."

Space Telegraphy.—On the 16th inst. Lodge gave a lecture before the Engineering Liverpool, on "Telegraphy by Electric Wa Space." Prof. Lodge commenced by saying system of telegraphy which had excited so mu lately was based on the emission of electric w by electric oscillations. These electric oscillatio known to science ever since 1853. They were s Joseph Henry, of Washington, in 1840, and by H 1847, but in 1853 Lord Kelvin found out th unknown fact at that time that electricity be matter, in that it possessed inertia, or that it be it possessed inertia. He would not say it did pos because he imagined that would be the sam saying it was a form of matter. He did not kn was not, but they saw it stated sometimes that it of energy. Prof. Lodge then detailed the progr by which these electric oscillations had been inve Clerk Maxwell, Fitzgerald, Hertz, and others, an ceeded to illustrate his previous remarks by ex He afterwards said he did not know if wir graph would be of much use. Everyone could message sent unless it was sent in a particular could only be received by a corresponding rec had an entirely new method which he had ho which would send messages big distances. It did upon waves at all, but upon magnetism, which pendent of obstacles, and that was a great advan thought it would be used over great distance signalling ships while still at sea. But it would ta paper to explain that.

London Telephone Service.—The meetin sentatives of the various public bodies of Londo at the Guildhall last week to discuss the telephon at length. Mr. A. C. Morton was appointed cha stated that 36 boards and vestries out of the Metropolis had responded to the Corporation's

the conference, while 25 had resolved to apply to the easury to institute an enquiry into the question of the lephone service in London. After a lengthy letter m Mr. J. Staats Forbes (the chairman of the Telephone mpany) had been read, the meeting proceeded to speech-king. The following resolutions were eventually passed: 1) That, in the opinion of this conference of delegates, presenting the Corporation of London, and the vestries d local boards in the Metropolis, the present telephone rvice of London is both inefficient, inadequate, and costly;) that, in the opinion of this conference, an enquiry should held by the Treasury as to the adequacy, cost, and ciency of the London telephone service, and all matters ating thereto, agreeably to the request of the local horities of London; (3) that, inasmuch as the National lephone Company is not possessed of statutory powers placing mains, pipes, or wires under the streets of the tropolis, it is undesirable they should have permission until interests of the public are duly secured by statute, as the case of tramways and electric lighting undertakings, ject always to the consent of the local authority." anks to the Corporation of the City of London for ng the conference were then given, and it was resolved end copies of the resolutions to the Treasury, the Cor-ation of London, the London County Council, the tries and local boards of the Metropolis, and to every poration and local board in the United Kingdom.

hambers of Commerce.—At the meeting of the ciated Chambers of Commerce last week, a resolution passed to the effect "that in the opinion of the ciation the compulsory adoption within some limited ied of the metric system of weights and measures lised by the Act of last session be advocated by every ible means, with a view of inducing her Majesty's rnment to afford facilities for the amendment of the in this respect, and that a copy of this resolution be to the President of the Board of Trade and to the Lord of the Treasury." The comment was made the manufacturers would not move in the matter out compulsion. We are not sure that the Govern-t will find it convenient to teach the manufacturers is best for them against their wills. The other s of the meeting included a resolution in favour halfpenny local post, which was not passed, a resolu-in favour of a parcels post with the United States of ica, and, finally, Mr. Dixon, of Hull, attacked the hone question. He proposed, "That, in the opinion is association, the utility to the mercantile community trunk telephone cables between mercantile centres ry materially decreased owing to the great delay in ing a turn, and the executive are respectfully requested gain press upon the Telegraph Department of the rnment the necessity of promptly increasing or oving the main cable connection." He said that ess men admitted that the telephone was worth a deal more at certain hours of the day, and if an rovement could be made in the service during those s, and the annoying delays which occurred obviated, ess men would be willing to pay even an increased for the service. The proposition was carried.

ectricity in Coal-Pits.—The *Colliery Guardian* has some interesting extracts from a report drawn by Mr. Leproux, of France, on the use of electricity the Belgian and Westphalian coal mines. In the s of a recent tour through Belgium and Westphalia, Leproux had the opportunity of studying the state of ection in the districts containing fiery mines of these ountries; and the following is the result at which he s from the safety standpoint, quite independently of any economical consideration: Neither in Belgium nor in Westphalia do there exist any power-transmission installations any portion whatever of which is in contact with an air current decidedly impregnated with firedamp. In fact, the only dangers that have had to be guarded against are those of fire and also shock through personal contact; and the restrictions laid down in this respect do not differ from those that have been found necessary for surface installations connected with industrial establishments. As to the danger of exploding gaseous or dusty mixtures, if any attention has been bestowed upon it, this may be said to be only for appearance sake, at any rate, up to the presen time. The measures taken are—in Belgium a careful encasing by special conductors of the parts capable of giving out sparks, and in Westphalia the adoption of polyphase-current motors without brushes, and the use, also, of strongly-armoured cables. In both countries the Government has been led to require for such installations that previous permission be applied for and obtained, but subject, at any rate ostensibly, to the appointed regulations, which are far more stringent in Belgium than in Germany. "I consider," concludes M. Leproux, "that this difference is largely due to the dangers of firedamp being far better known, more studied, and especially mere dreaded in the former than in the latter country, and that therefore the efforts already made in other countries, especially England, are more closely watched."

Resistance and Temperature. — The relation between the electrical resistance of a pure metal and its temperature is so simple that it has been often taken advantage of commercially. Thus pyrometers for measuring high temperatures have been successfully designed, when the measured resistance gives the temperature in any given place. The latest device on this principle must be credited to Mr. H. L. Callendar, M.A., F.R.S., professor of physics at the McGill University, Montreal. This gentleman has designed an electrical method of measuring the temperature of a metal surface on which steam is condensing. The condenser used in his case is a very thin platinum tube, ½in. in diameter and 16in. long. The thickness of the tube is only six-thousandths of an inch, and the greatest difference of temperature between its inner and outer surfaces at the maximum rate of condensation observed in the experiments could not have been greater than ½deg. C. The mean temperature of the metal itself is determined in each case by measuring the electrical resistance of that portion of the tube on which the steam was condensing. The author concludes that in a steam-engine cylinder in which the condensation temperature varies between 290deg. F. and 330deg. F., the rate of condensation would be equal to 0·74 thermal units per square foot per degree per second. Comparing the three different methods of experiment, which all lead to a similar result, it may be regarded as highly probable that the old view of an infinite rate of condensation requires revision, and that the value of the rate of condensation of steam on a metal surface as determined by the author is at least a first approximation to the truth. The question at issue is one of fundamental importance in the theory of the steam-engine, and the author shows that, if the law of condensation proposed be admitted, a number of interesting practical deductions can be made, and problems may be solved, which have not hitherto been regarded as amenable to other than empirical treatment.

Calcium Carbide and Acetylene.—Mr. Henry Fowler's paper on the above subject was read before the Institution of Civil Engineers on the 15th inst., and further discussed last Tuesday. The author pointed out that acetylene was first isolated by E. Davy in 1837 from potassium

carbide, a by-product of Sir H. Davy's method of manufacturing potassium. In the middle of the century Berthelot investigated its properties, and Wöhler produced it from calcium carbide. During the past few years it had assumed commercial importance owing to the development of the electric furnace, in which calcium carbide could be readily produced from lime and carbon. The carbide formed was a hard, dense substance of reddish colour, unacted upon by most of the ordinary reagents. It was, however, rapidly decomposed by water into acetylene and lime, giving 5·9 cubic feet of acetylene, at a temperature of 60deg F. and a pressure of 30in. of mercury per 1lb. of carbide. As the power required theoretically to produce 1lb. of calcium carbide in an electric furnace was more than two horse-power hours, its manufacture was at present restricted to localities where power was cheap, as, for instance, where water power was available. Acetylene was a colourless gas with an intensely penetrating odour, and was slightly soluble in water, and extremely so in some other fluids. It was enthodermic giving 407 calories per cubic foot, whereas theoretically its value was 336·5 calories. As an illuminant it gave the most brilliant light of all gases, five cubic feet per hour under suitable conditions giving 240 c.p. For small consumptions, however, this value could not be approached, and after a short time the burners become clogged with soot. Nearly all proportions of air and acetylene were explosive, and the gas itself when compressed was liable to explode at a comparatively low temperature. The author estimated that with calcium carbide at £16 per ton, it could compete with coal gas at 2s. 6d. per 1,000 cubic feet, when flat flames were used for the latter and a light of not less than 30 candles was required.

Ozone.—The manufacture of ozone by the silent discharge of electricity is not new, and yet we think that the recent paper by W. T. Evans read before the Chemical Society is the first practical treatise on the subject. He shows in it that after the maximum amount of ozone has been formed the continuation of the discharge produces nitric peroxide, which destroys the ozone. Other writers, and perhaps especially those who attack the problem commercially, have been given to general statements rather than to exact facts. Thus we know of at least three apparatus at present, all of which are "the best on the market," and all of which also produce "the maximum amount of ozone for a given electrical input." Still, there is room for all in the application of ozone to commercial problems, as these new applications required individuality in detail. Thus, the Electric Ozone Syndicate, who wish us to say that their ozone generators of aluminium are now ready for issue, enumerate the following applications: thickening and drying oils, seasoning linoleum, bleaching waxes, manufacturing disinfectants, bleaching fats, sterilising foul casks, seasoning wood, making spent oil, vinegar making, producing fine chemicals, bleaching palm oil, bleaching tissues, maturing wines and spirits, drying varnished goods, ventilating unhealthy works, sterilising impure water, and deodorising fish oils. This list is longer than previous ones we have seen, and it cannot be expected that ozone can be applied in the best possible way in all of them at the first trial. Perhaps an ndication of this is seen in the syndicate's circular, which, after giving the output as 100 grm. of ozone per horse-power hour, goes on to say, "If you are desirous of applying ozone in your works, please let us know for what purpose you want it, what is the approximate quantity of ozone you require per hour, and we shall write you to say on what terms you can have an installation which will answer your requirements." This is just what manufacturers will not do. They require to be told wha[t] want, and what to do with it afterwards.

Diffused Light.—Prof. William Hallock has co[mmuni]cated to the *Progressive Age* an article on the art of [illumi]nation. In it he dwells particularly on the valu[e] plain white surface as a reflector of light, as he sa[ys] people realise that a "dead white" surface reflects 80 per cent. of the light which falls upon it. T[he] white wall or ceiling absorbs much less light than d[o] transmissive diffusion apparatus, such as ground-glass, etc., which often absorb 40 to 60 per cent. of th[e] impinging upon them. A desire for diffused illumi[nation] for bringing out the architectural effects of t[he] Columbia University library, led to the following for this purpose. A white opaque sphere, 7ft. in di[ameter] was suspended from the middle of the dome, 85ft the floor, by ¾in. steel rope, the latter being invisible from below. To all appearances the sphe[re] in the air. This globe is a framework of wood with veneering and coated with a white matt wash, its general appearance being that of a glass surface. This is illuminated to an intrinsic b[ri]of from 75 to 300 foot candles by rays from Colt projection lanterns placed in eight equ corners of the four upper balconies. These lig boxed in, so that only the projecting lens is Each of them throws a disc of light 6ft. diameter upon the sphere. The eight discs ove that the whole sphere seems to glow with a pale light. The effect is beautiful in the extreme. The seems translucent, and the light seems to come certain depth within, and to bathe the whole glo a warm light. As the globe floats below the ceili difficult to locate it; whether it is near by or a the clear blue sky miles away is left to the imag This is not intended as a light by which to read, th all having reading lamps, but it is possible to re considerable ease on the floor of the reading-room light of the sphere alone. A crude test gives the mate candle-power as about 500, but the light is and so agreeable that it gives one the impression of power. The eight lamps take about 150 ampe whole lighting of the main reading-room takin 300 amperes, while the central room of the Congr Library at Washington (about 10 per cent. larger) nearly 900 amperes. The author does not state, h that in the one case some arc lamps were used an incandescent lamps in the others.

The Difficulties of a Modern Ma[gnetic] Observatory.—Mr. R. F. Stupart, the dire[ctor of] the Toronto Magnetic Observatory, communicates [to the] *Canadian Engineer* an interesting article on the of the observatory and the difficulties arising fr progress of electrical engineering. The buildi erected in 1853, and great care was bestowed ensure the absence of all magnetic bodies in the c tion. For the next 23 years everything went w the observations obtained made the Toronto Obse famous in the history of terrestrial magnetism. I the building of the school of science caused some ve changes in the zero values, but these could be correc Then followed, a few years later, electric light circuits produced a change in the force instruments whene current was turned off or on. This difficulty was overcome by the light company courteously agre arrange their wires in the vicinity of the observa such a manner that currents should counteract each The next difficulty occurred when the addition wa to the school of science, tons of iron being used

struction of that building in an all too close proximity the magnetic instruments, and much time and labour been required to determine the precise effect of this mine" on the various instruments. It was not, however, until the autumn of 1892 when the trolley cars to run that the directors began to suspect that or later the magnetic observatory would have to be ved to another site. The interference at first was but grew with the increasing traffic of the line until in the vertical forces amounted to as much as of a dyne. The disturbances naturally were most ble. It is noticeable that, although several changes red in the vertical force, it at times having been less the current on and at other times greater, the ntal force showed a steady decrease on all occasions the turning on of the current, which during the past two has been ·000200 to ·000500. No appreciable deflec of the declinometer magnet can be noted, the only being a continuous vibration which has rendered the very ragged and difficult to read with accuracy. A of the traces during the times that the various electric were put in operation shows that with the currents arily used there is little effect at three-quarters of a and hence it was decided to move the observatory to at least two miles distant from any probable trolley route.

he Nernst Incandescent Lamps.—Dr. H. Lun butes to the *Electrical World* a most interesting little on the probable advances in electric incandescent . The author considers that as long as carbon nts are used for incandescent lights the efficiency of ghting system will probably not be much increased. eason for this is that carbon has almost exactly the ties of the "black substances," as Kirchhoff denotes . An absolutely black body absorbs radiant energy wave-lengths, the visible rays that we call light, as the heat rays of longer wave-length, and the ultra- or so called chemical rays. By Kirchhoff's law a raised to incandescence emits all the rays it is able to . If an incandescent filament of carbon is used for rce of light, the invisible heat rays and the ultra- rays are emitted with the rays of light which are d; on this account the efficiency of the incandescent is certain to be rather small. In the experiments of Nernst no attempt was made to use the carbon nt, which has qualities similar to a metallic conductor tricity. He uses the so-called conductors of second such as chalk, magnesia, and kaolin, materials that, cold, have an extremely high resistance to the nt, so high, indeed, that they might be called tors, this resistance falling greatly at high tempera . These materials are notable for the large proportion ble light rays in their radiation. As Prof. Nernst in a letter, these materials have a higher emission of as they are not in the sense of Kirchhoff absolutely k substances." If these materials are raised to a ntly high temperature, no matter by what means, fficiency of production of light is remarkably high. Nernst applies as the means to bring the bodies to a temperature the electrical current, conducting it by staffs of magnesia, chalk, or other materials, the of which he keeps secret, after having prepared to conduct the current by warming them. The obtained surpasses all expectations. With an of 27 watts (0·23 ampere at 118 volts) of alternating Prof. Nernst obtained, employing a hollow staff of ia (length 7mm., thickness 1·5mm.), a lighting y of 27 c.p., or per watt 0·96 c.p. It is necessary k with alternating currents to avoid electrolytic action on the material employed. The importance of this invention, if it can be practically employed—Prof. Nernst, a true scientific man, advises not to be too hopeful—can be seen at once. The cost of incandescent lighting would be reduced to about one-third of the present rate. There is still the difficulty, however, that the filament, in order to be adapted to practical work, has first to be raised to a very high temperature. Prof. Nernst has not so far given any explanation in what way—and it is highly important that it should be a practical and easy way—this warming will be effected. It is to be hoped that this as well may be done by the electrical current.

Glasgow Telephones.—The refusal of the Postmaster-General to grant the Glasgow Corporation a license to establish a municipal telephone exchange did not come as a great surprise to most people. The following extracts from Sheriff Jameson's report on his public enquiry are of interest in this respect. Thus, in his findings, the sheriff declares that in his own opinion the service is not at present efficient. This inefficiency is due mainly, either directly or indirectly, to the want of a metallic circuit, but a very considerable proportion of the enormous number of complaints which were proved to have been made were not referable to that cause alone, and might have been remedied by more thorough supervision in the central and junction switchrooms. The rates charged are not unreasonable, except where they come to be applied to some of the outlying districts. The service is adequate, and the number of call offices sufficient. It appears to Sheriff Jameson that the evidence led by the Glasgow Corporation against the Telephone Company being allowed to lay wires under the street is self-condemned. So far as the inconvenience to the public is concerned it would be no less if the work was done by the Corporation than if it was done by the company, and the objections to the latter seemed to him to be purely of a sentimental and fanciful kind. Sheriff Jameson says the continued inefficiency of the telephone service is for the most part due to the refusal of the Corporation to allow the National Company to construct a metallic circuit underground. In reply to the question—Is it expedient to grant Glasgow Corporation a license? he sums up as follows: "A telephone service in this country did not exist for the benefit of all classes of citizens, but for that of a limited number. It was, therefore, not an object to which the 'common good' of a burgh ought to be applied. Whether the foregoing proposition were correct or not, it was his opinion that the Corporation of Glasgow were not at present entitled to apply the burgh funds or funds raised on the security of the 'common good' to the establishment and maintenance of a telephone service outside of the burgh boundaries. On general grounds of public convenience, it was inexpedient to have two telephone systems or two telephone authorities within the same area, because the establishment of a second telephone system might render the acquisition of the telephones in Glasgow by the Government at the end of 1911 more difficult and expensive; and because the Corporation had not produced satisfactory evidence that they could successfully finance and work the proposed system without the risk of putting a new and more serious burden on the ratepayers of Glasgow. In his opinion, the reasonable solution of the matter would be that the Corporation should grant to the National Telephone Company the same facilities for laying a metallic circuit system underground as the large English municipalities. Unless this was done, the telephone service in Glasgow would continue to be inefficient. A deputation from the Glasgow Corporation is trying to induce the Postmaster-General to reconsider his decision.

LORD KELVIN'S PATENTS.*

Potential Galvanometer.

(*Continued from page 339.*)

To determine the difference of potentials between two points of a circuit, an electrode is clipped on at each of the points and then the key is depressed and the deflection noted. If the deflection is too great the magnetometer must be pushed to a division further from the coil, if too small, to a division nearer the coil. The number of divisions in the deflection is then to be multiplied by the number on the magnet, plus the proper number—say, for example, ·17 for the earth's force—and divided by the number at the division of the scale on the platform exactly under the front of the magetometer. The result is the required difference of potential in volts. That is to say, the coefficient for volts corresponding to any division on the platform scale is obtained by dividing the intensity of the magnetic field by the number at that division. When the difference of potential to be measured exceeds 200 volts, the readings of deflection must be taken as quickly as possible on account of the rapid heating of the coil. The rise of temperature for any short time, T, may be taken as $v = \frac{E^2 T}{R J K}$, where E is the difference of potential and R the resistance in absolute measure, T the time in seconds, J Joule's mechanical equivalent of heat, and K the thermal capacity of the coil.

For example, let $E = 200$ volts;

$$R = 5{,}000 \text{ ohms};$$
$$T = 30 \text{ seconds};$$
$$J = 4{\cdot}2 \times 10^7;$$
$$K = 400.$$

Thus $v = \frac{200^2 \times 10^{16} \times 30}{5 \times 10^{12} \times 4{\cdot}2 \times 10^7 \times 400} = 0^\circ{\cdot}17$ C. rise of temperature. The temperature of the coil at which the numbers on the platform scale are correct is stamped on the instrument. The following table gives the coefficients by which the deflections must be multiplied when the temperature of the coil differs by any number of degrees less than 20 from the temperature at which the instrument is correct. The first column gives the difference between the actual temperature and that at which the instrument is correct, in degrees centigrade; the second column gives the corresponding coefficient for copper coils when the difference is positive; the third column gives the coefficient when the difference is negative; the fourth and fifth columns give the corresponding coefficients for German-silver coils:

1°	1·004	·996		
2	1·008	·992		
3	1·012	·988		
4	1·016	·984		
5	1·020	·980	1·002	·998
6	1·023	·977		
7	1·027	·973		
8	1·031	·969		
9	1·035	·965		
10	1·039	·961	1·004	·996
11	1·043	·957		
12	1·047	·953		
13	1·051	·949		
14	1·055	·945		
15	1·059	·941	1·007	·993
16	1·062	·938		
17	1·066	·934		
18	1·070	·930		
19	1·074	·926		
20	1·078	·922	1·009	·991

Current Galvanometer.—This instrument is similar in form to the potential galvanometer with the exception that the coil is made up of a few turns of thick copper strip, and has a resistance of only about $\frac{1}{1000}$ of an ohm. Any current the intensity of which is less than 100 amperes may be safely measured by this instrument. The number at any division of the scale on the platform indicates the deflection which an ampere of current produces when the magnetometer is set with its front edge at that division and the intensity of the magnetic field is unity. The mode of setting up this instrument for use is precisely
as that described above for the potential galvano
To find the number of amperes correspond
deflection—*Rule*: Multiply the number of di
the deflection by the number on the magnet plu
zontal intensity of the earth's field, and divi
number at the division on the platform scale exa
the front of the magnetometer.

Terminal pieces of the form shown in the f
attached to the coil, and to the electrodes sup
the instrument. When the electrodes are bein
from the coil or from the leads, the two sides of
terminal piece should come into contact with
before they are out of contact with the plates of
terminal pieces. When this is attended to the
not interrupted, and hence sparks are avoided.
terminal piece, shown in the figure with two s
attached, is also supplied, for the purpose of all
galvanometer to be easily introduced or remove
circuit. This terminal piece is made to form p
circuit the current through which is to be meas
adopting this arrangement the galvanometer can
removed from one circuit to another.

Adjustable Magneto-static Current M

The magneto-static current meter (Fig. 10
essentially of a small steel magnet or system o

Fig. 10.—The Magneto-Static Current Meter.

suspended in the centre of a uniform field of fo
two coils, each having one or more turns of cop
or wire, and also under the directive influenc
systems of powerful steel magnets. The suspend
of magnets is attached to one end of a vertical sh
down centrally through an opening in the sole-p
instrument from an indicating needle, which is
by a jewelled cap resting upon an iridium po
two systems of directive magnets are circular in
each ring is composed of two semi-circular magn
in a brass cylindrical frame with their simi
together. Each system is securely fixed to a circ
frame, which fits on to the cylindrical case of t
ment in such a manner that the systems are
being turned round, together or separately, as
below.

The instrument has a "tangent scale," which
in its position before the instrument is sent out,
needle indicates equal differences of readings
differences of current. The scale consists of
divisions, and for most purposes it is convenient
field magnets in such a position that the needle p
and to use the scale from that point upwards to
Sometimes, however, it may be found convenient
currents, whose direction is being occasionally
without being at the trouble of reversing the ele
the contact clip; in that case the zero should be
division 50 at the middle of the scale, and readi
on each side of it. It must be remembered
the point taken as zero is changed, the constant,

* Abstract of paper read by Dr. Magnus Maclean to the *Philosophical Society of Glasgow*, Feb. 23.

lications of the instrument have to be multiplied to e current in amperes, is changed in proportion to sine of the angle between the zero point and the of the scale; and as this angle is 60deg. the constant is zero at 50 on the scale is exactly double the t with the zero at 0 on the scale. The instrument ided with a "lifter," which serves to raise the off the iridium point when it is being moved about ce to place. This lifter is in the form of a ring below the needle, and may be raised or lowered by the handle attached to an eccentric passing through of the instrument on a level with the scale. It es as a checker, by bringing it lightly into contact pointer, so as to stop its vibrations.

ro grades of this instrument which are found most nt are: The milliampere-meter, which has an range of from ·3 to 300 milliamperes, and is djusted to read two milliamperes per division; and ere-meter, which has an effective range of from 0 amperes, and is usually adjusted to read one er division; in both grades with the zero at 0 on

If desired, instruments can be supplied having ants adjusted to any value. The very wide range te measurement given by these instruments makes aluable for laboratory use.

strument has an advantage, important for some purposes, of being available as an accurate direct-urrent meter, through a continuous range of from times its smallest current, which may be anything a milliampere to four amperes, according to the f turns in the coils supplied with the instrument. however, available as an alternate-current instru- it must be remembered that the magnetism of the ting magnet does not remain absolutely constant. d quality of steel, a proper preliminary ageing of et (by heating it several times in boiling water ng it again, and subjecting it to somewhat varied ge) brings it to a condition in which its magnetism to remain exceedingly nearly constant month th and year after year. Still, it should never upon as absolutely constant, and for accurate y work it is therefore necessary to have some retesting the instrument at any time. This is aily done with the utmost accuracy if one of the nstruments, to be described below, is available lard. Another advantage which the instrument at, when a standard instrument is available, its is capable of being varied to any desired value one-tenth of that which it has with its directive in their strongest position. Thus if the constant three amperes per division of the scale, with the oles of the magnets coinciding, it may be adjusted value down to 0·3 ampere per division. Instru- this class are made to suit all ranges from 0 0001 eres per division.

ery convenient use of the instrument is to act p counter for indicating the number of incan- amps in use in an installation. For this purpose to standardise it by putting on a known number and adjusting as described below until the desired s obtained on the scale. Of course, this numbering is not possible to any great accuracy, because the mselves are not all rigorously equal in the amount t which each takes, but the lamp counter serves rtant practical purpose of showing at any time er of lamps in use nearly enough for practical

In private houses this is very useful as a check me lamp or lamps being left accidentally alight t, or safe-room, or box-room, or other place where f its being alight might escape observation for eeks together. To count larger numbers of incan- amps up to 1,000 or more, the instrument is made ller rings of more massive conductor, and the same ate accuracy is attained as with the 100-lamp

lliampere-meter, on account of the low resistance pper coil—about 40 ohms—may conveniently be voltmeter. To adapt it for this purpose, a copper wound anti-inductively with two platinoid resist- supplied. The first of these, together with the resistance of the instrument, makes up 100 ohms, and the second alone is 900 ohms. Thus, taking the constant of the instrument at two milliamperes per division, by joining the smaller in series with the instrument, the reading on the scale will be one-fifth of a volt per division; with both resistances in series with the instrument, the reading will be two volts per division.

(To be continued.)

THE NEW WORKS OF MAVOR AND COULSON, LIMITED.

We received an invitation for last Friday to pay a visit of inspection to the new electrically-driven works of Messrs. Mavor and Coulson, Limited, which this well-known firm have recently erected at Bridgeton Cross, some 1½ miles from the Glasgow Royal Exchange.

The history of this firm has been one of progress from the very beginning, and although it cannot be called by any means an old-established firm, as the term is understood as a rule, still an electrical firm established 14 years

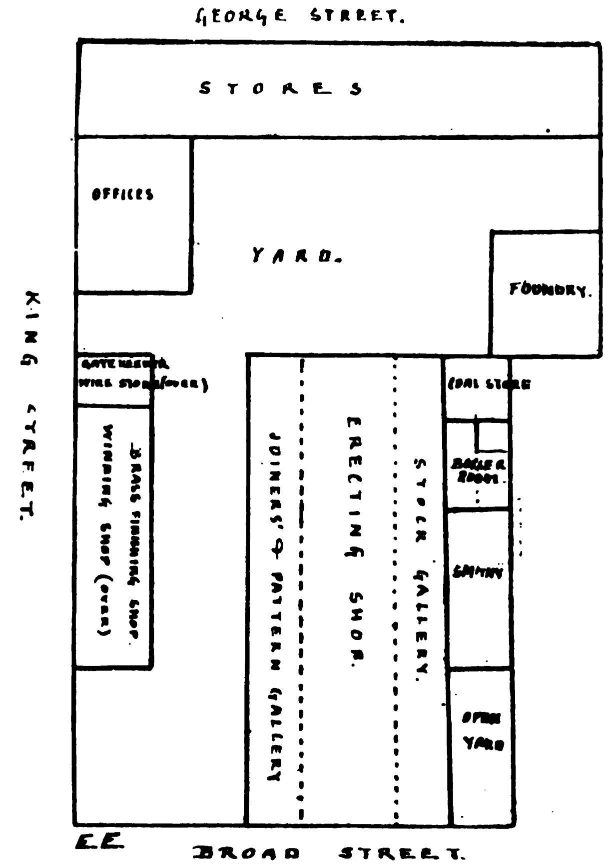


FIG. 1.—Plan of Works.

ago had very few rivals, indeed, in the business, so that as far as this particular class of work is concerned, a firm of 14 years' standing might almost claim the title of "old established." Further, the fact that it is now in a position to readily turn out electrical machinery of the heaviest type speaks volumes for the energy displayed by the gentlemen at the head of affairs.

In 1892 Messrs. Mavor and Coulson took works at Orr-street, Bridgeton, where they started the manufacture of dynamos, and it was here that Mr. W. B. Sayers, when with them as manager, worked out his well-known method of armature winding. At the beginning of last year it was found quite impossible to cope with their business at the Orr-street works. They therefore determined to erect works that should be in every way worthy of the reputation that they had gained, and enable them to stand a chance of securing their share of the extensive central-station and transmission of power jobs now under consideration. Seeing that the firm's manufacturing business carried on in their premises in Orr-street, together with the machine tools there, were only held on lease, at the expiry

of this lease last year they were therefore in a singularly favourable position to undertake the design and equipment of a new factory for their specialities in electrical machinery and accessories, for which, during the firm's tenancy of their Orr-street works, patterns were developed and standardised, and methods of production systematised.

About this time the business was converted into a limited liability company, with the three partners of the old firm as managing directors, and they were fortunate in securing an extensive range of buildings near their old works in Bridgeton. In the general arrangement of the works and selection of machinery the directors have had the advantage of an intimate knowledge of the most recent American and Continental practice, and of their own special requirements. The result has been the building and equipping of a factory which is the only one of its kind in Scotland, and in facilities for the rapid, economical, and accurate production of high-class electrical machinery is not surpassed by the best and most recent factories in the kingdom.

the space swept by the crane is erected a g be used on the one side by the pattern-ma carpentry department, and on the other by the finished stock. The design is to ultimately galleries for light machine tools, and accommodate the two departments mentioned. The large cen floored with granolithic, and the two side bays galleries are floored with double pine plankin joists. The machinery in A Department is 10 electric motors. None of the shafting is dr from the steam-engine, with the exception of length on the testing engine. The advantages the use of electric motors in this departmen summarised as follows:

The machinery is arranged solely with ref facility and speed in carrying out the man operations, and there is no restriction as to posit from the necessity of accommodation to the drivin ments. The electric motors will run in any d

FIG. 2.—General View of the Main Machine Shop.

The general arrangement is shown on the plan, Fig. 1. The original offices were very spacious, and faced on to King-street, and these have again been retained as the present offices. The works also front on to George-street on the north and Broad-street on the south, covering an area of nearly two acres arranged in a compact square block. The erection of a large and well-appointed erecting and fitting shop, with smithy, brass foundry, and moulding shop, was immediately commenced. The main machine shop stands conveniently in the centre of the various other auxiliary departments, and consists of a brick building of ornate elevation where it abuts on to Broad-street. This machine shop, or A Department, illustrated in Fig. 2, is 160ft. long by 75ft wide, and is covered by a single-span steel roof, glazed all over and supported by 14in. brick walls, and cast-iron columns carrying the crane girders, which are spaced at 40ft. centres. The lofty roof gives a spacious and airy workshop, while its steel and glass structure and the side windows in the walls provide exceptionally good and uniform lighting. On either side of

position, and may be fixed to floor, walls, c ceiling. The sub-division of the driving power of motors greatly reduces the quantities and shafting, bearings, pulleys, and belting. There of power due to running such apparatus while mitting useful work. While the machines are bein or when, from various reasons they are not operation, their whole driving mechanism is at r are no long belts, bevel wheels, or spur gear, attendant noise, vibration, and wear and tear. Th use of light short shafting leads to a great re wear and tear. The absence of noise is of advantage, as it not only makes the conditions more comfortable for the workman, but greatly supervision and management.

A special feature in this department is the ex of milling machines and other special appliances saving. While special appliances do not in dispense with the necessity for skill on the p workman, they permit of the use of a class of l

ailable than that of a fully-trained and equipped tradesman. The machines and tools are arranged iew to the utmost accuracy in the work without sity for individual measurements by the operator, ines themselves being provided with measuring n which dimensions can be read off with ease and down to $\frac{1}{2000}$in. The use of such machinery tes a separate department, with special appliances ng new tools and keeping the working tools in This is provided in the toolroom in the north-west the main shop, where a staff of skilled men are y employed in these operations. The antiquated f keeping a machine standing while the operator g his tools or awaiting their formation by the is thus entirely abolished. It is found that the ghly-finished and accurately-made machinery is a ducation to the men operating it, the tendency ssimilate the character of the work produced to e machinery producing it, and to keep the shop surroundings up to a high standard of cleanli- rder. These tendencies inevitably reflect their stics upon the finished product.

artment is concerned with the production of rork of dynamos, motors, etc., and includes all g, boring, drilling, milling, planing, fitting, and operations on dynamos and motors, with their gearing, etc. Fig. 3 shows the built-up core of armature being slotted ready to receive the bars; the ease with which this operation is ough after the core has been built up is most

FIG. 3.—Milling the Slot in an Armature Core.

ing the machine shop from the yard, immediately is situated the dynamo-testing department, and e steam dynamos for generating the current for g and power themselves. The dynamos for this re direct coupled on to single-acting two-crank steam-engines, one of which is a Willans and and the other a Westinghouse engine built by McClelland. Both dynamos are of the same output, built, of course, by Messrs. Mavor and hemselves; they have armatures 13in. by 22in., itput of 300 amperes at 100 volts when running of 450 revolutions per minute. One of these arranged so that it can be coupled on to a counter- which the belt-driven dynamos are driven for There are also convenient arrangements of steam- making temporary connections for the testing of plants.

he steam dynamos the conductors are led to the itchboard, from which point the whole of the distribution is carried out, which, as in the case rer circuits, is on the company's well-known C.C. system of wiring, in which the positive or ctor is entirely enclosed in the negative conductor, uninsulated and connected to earth. The lighting r are supplied from the same system, but on ircuits. Each circuit is controlled by a switch on witchboard, on which are also placed the necessary and voltmeters to indicate the amount of power at any instant.

The exhaust steam is arranged to either exhaust direct to the air or through the heater to the air, or so that after passing through the heater it is passed through the shops in cast-iron pipes for warming purposes. This arrangement should be much appreciated by the workpeople in the winter months.

Next to the testing department there is a small safe-like chamber, round which the boiler flues pass, and which is used for drying armatures and magnet coils in.

There is a very fine electrically-driven overhead traveller running the whole length of this machine shop, and as the two galleries overhang into the middle bay a little, it also covers these, which is a great advantage in lifting goods between the floor and the galleries. The traveller itself was built by Messrs. Craven Bros., but the electrical equipment was made and fitted by Messrs. Mavor and Coulson themselves. There are three of theis patent enclosed-type motors fitted, one for each motion, and they are all controlled by three liquid resistances with reversing switches attached, placed on a small platform on the underside of the main girder, on which the driver sits to control it. These switches give command over all the required motions, and enables the driver to operate any motion either simultaneously or independently of the other motions; and from its performance while we were watching it, the driver certainly seemed to have the most perfect control of all its movements. The electric current is carried to the crane by a No. 4 copper wire, supported on insulators attached to the main

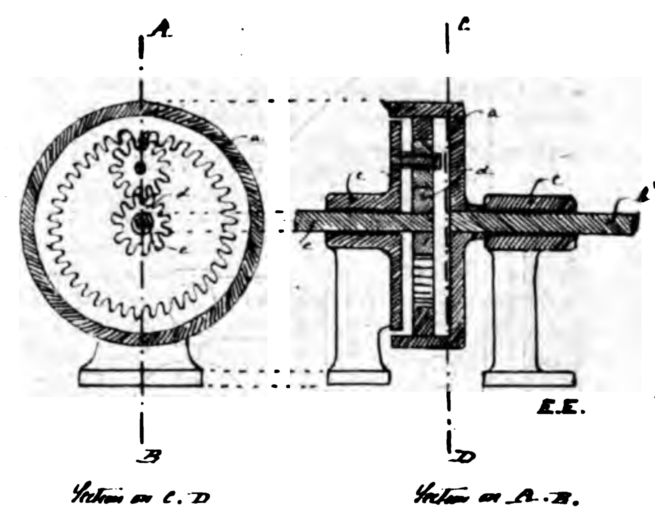


FIG. 4.—The Ross Reduction Gear.

girder on the east side of the shop. A rubbing contact attached to the cage picks up the current from this conductor, whence it is led by cables to the controlling switches. The crane girders themselves are fitted with conductors for carrying current to the hoisting and across traverse motors, the current being picked up by rubbing contacts on the crab. The long traverse is driven by a light spur gear, and the cross and hoisting by special worm gears running in oil-boxes. A view of the crane is seen in the photograph of the machine shop (Fig. 2).

The lighting of the machine shop is principally carried out with arc lamps, one of which is hung from a bracket on each alternate pillar, or six lamps in all, while under the galleries there are 14 Sunbeam lamps of 150 c.p. each. The electric lighting installation for the entire works and offices consists of 230 16-c.p. lamps, 30 150-c.p. Sunbeam lamps, and six 2,000-c.p. arc lamps. There are in all 15 electric motors of 85 aggregate horse-power. The lighting, although on different circuits from the motive power as far as the switchboard, is all the same, run from the same dynamo, the two machines being if necessary, run in parallel.

To refer to all the various machines and various pieces of apparatus that we noticed under construction would be to put a large catalogue before our readers, but some of the things that are more or less of novelties will doubtless be of interest.

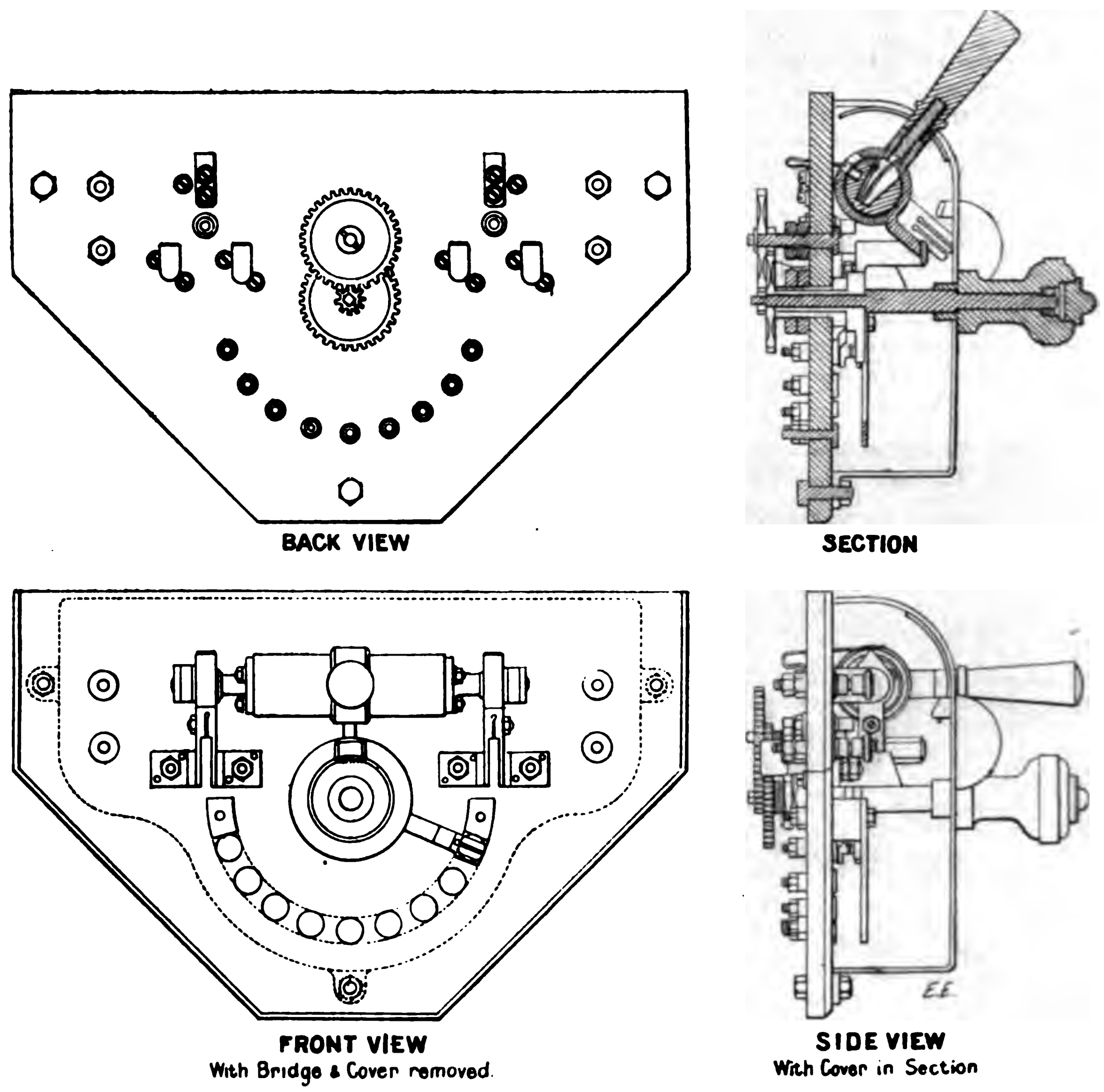
One detail that particularly struck us was the universal use and convenient arrangement of the liquid starting

resistance for the motors, and their strong mechanical appearance, so different to the resistances so frequently seen for that purpose. On an outer cast-iron case is fitted a cast-brass cover, through the top of which a screw works, which by means of a handwheel lowers a conical-shaped plunger of cast iron. The terminals are arranged inside the case, so that outside there is nothing that can possibly get damaged, and the switch can be left in the hands of anybody without fear of any possible damage being done either to the switch itself or to the motor. The liquid is a mixture of soda and water, and the results are said to be most satisfactory.

Another detail that we noticed this firm largely employ n conjunction with numbers of their direct-coupled motors Ross's patent reducing gear. The use of this gear enables a high-speed motor to be direct coupled to a slow-speed machine, thus enabling a much smaller motor being frequently used without clumsy and complicated gear, and often enabling direct coupling to be arranged where, owing to the slow speed required by the machine, it would otherwise have been impossible. The principle of the arrangement is generally shown by Fig. 4, and consists of an arrangement of pinion wheels arranged inside one another. The advantages of the gear over ordinary gearing is that the same line of shaft is maintained throughout, and also that the whole of the gearing is enclosed. When it is fitted on to Messrs. Mavor and Coulson's enclosed-type motor, it makes a most compact and serviceable-looking arrangement.

For the smaller size of both dynamos and motors the type that the firm have adopted as their standard pattern is the ordinary vertical design, with armature at the top. The magnets are made of cast steel, and are cast in one piece with the sole-plate, the yoke being cast on the underside of the sole-plate. For the larger sizes of machines, however, both direct and belt driven, they have adopted a horizontal type of machine, with vertical magnet either side of the armature. In all these machi almost invariably use Sayers's patent armature As regards motors, however, they use a special their watertight pattern, which is being now ver sively used. Inside a cast-iron box is a single co pole-piece, the box itself forming the other pole-p the yoke; small hand holes are left for adjustme brushes fitted with glazed covers. It is to this of motor that Ross's reducing gear has been so suc applied.

We have no doubt that when their works are co and fully equipped, they being at present waiti large number of machine tools which they are u get delivered owing to the recent labour difficulties Mavor and Coulson, Limited, will be a thorougl organised factory.



The Gibbs Motor-Starting Switch.

THE GIBBS MOTOR-STARTING SWITC

Messrs. John Gibbs and Sons, of Liverpool, have to us with respect to the "Questions and Answers" containing details of a motor-starting switch. Our note *re* slow switching-on has induced this firm to us full details of their type of switch. This we i herewith, and the four views give all that is req explain the features of the switch. In the first p current is made and broken by the quick-break s the top. This switch is double-pole, and is so a to interlock with the resistance regulation that th can only be made or broken when all the resis in circuit. This is done by the revolving attached to the resistance-switch axis. This has a gap in it which allows the main swi

' when the resistance switch is at its lowest After the circuit has been made the resistance out, but the reduction gear between the handle ritch axis is such that only a slow motion can be ie regulating handle can be left in any position. 'ormed by the makers that this switch has been by several leading central-station engineers, Mr. Wordingham, of Manchester, and Mr. Lyster Liverpool. It will be noticed that with this is impossible to start the motor without the being in circuit. Thus, even when in the most ed hands, the danger of fusing the armature is The switch can be inspected at 22, Duke-street,

QUESTIONS AND ANSWERS.

iis heading we insert questions and answers cal character relating to central-station work, ork, or construction work; and for each suit-ion offer *one shilling*, and for the best solu-y question we offer *ten shillings*. We also *illings* for every other answer we print. The any question should be sent within 10 days question has appeared, and should be written on the paper only. We would call the attention nding in answers to the fact that the neatness ches sent in is considered when marking the ues of these answers. Questions may be sent :.

QUESTIONS.

re the reasons for and against laying armoured lirectly in the earth ?—S. K. E.

e the arguments for and against a 220-volt supply e consumer's standpoint ?—A. D. J.

ANSWERS.

. 43.—On a power transmission scheme, 500 h.p. be delivered to a station three miles from the ouse. Assuming a loss in the line of 50 h.p., the weight of copper required for lines, if direct is u ed, with that for a three-phase transmission. ximum voltage between the conductors to be 2,000 nd the power factor on the three-phase system ent.

'er to No. 43 (*awarded* 10*s.*).—When comparing stems of transmission as regards weight of ie line, we must first of all agree on a suitable f comparison. That the comparison can only we take the same power delivered, the same d efficiency, will be obvious. The only other ffecting weight is voltage, which is our standard son. In continuous-current transmissions the f voltage is definite; but with alternating is doubtful whether we ought to take effective olts corresponding to the pressure-wave crest on the insulation, and not the effective voltage, r to be taken into consideration, and must form n which different systems of power transmission mpared. Taking the continuous-current system ndard, the condition being that the factor of nst a breakdown of insulation shall be equal in nating and continuous systems, we express the f copper required for the alternate system in he amount required by the continuous system. ions of equal safety require that at no moment E.M.F. between two line wires, or between any earth, exceed the corresponding values obtained ntinuous-current plant. In a three-phase trans-hether star or link coupling is used, the maximum of potential between any two wires is $E\sqrt{3}$, crest of pressure wave in one phase. But the maxi-rence of potential is limited to 2,000 volts in both and continuous. Hence $E\sqrt{3} = 2{,}000$, from which (height of pressure wave) and its effective value of $\frac{2{,}000}{\sqrt{3}}$. As there is a loss of 50 h.p. on the s cases, the power sent into the line must be 550×746 watts. The current carried by the continuous system is $\frac{550 \times 746}{2{,}000}$ amperes, and similarly that carried in one phase of the three-phase system is $\frac{1}{3}$ of $\dfrac{550 \times 746}{\frac{1}{\sqrt{2}} \text{ of } \frac{2{,}000}{\sqrt{3}}}$ amperes. The load factor is only 85 per cent. in the three-phase system—that is, only $\frac{85}{100}$ of the current produces useful work. We must accordingly increase the current in the ratio of $\frac{100}{85}$, so that after allowing for this loss there is still the same amount of useful work done as with the continuous-current system. Hence the current in one phase of the three-phase system is

$$\frac{1}{3} \text{ of } \frac{550 \times 746}{\frac{1}{\sqrt{2}} \text{ of } \frac{2{,}000}{\sqrt{3}}} \times \frac{100}{85} \text{ amperes,}$$

and the ratio between the currents in the two systems is

$$\frac{\text{Continuous}}{\text{3-phase}} = \frac{\dfrac{550 \times 746}{2{,}000}}{\frac{1}{3} \text{ of } \dfrac{550 \times 746}{\frac{1}{\sqrt{2}} \text{ of } \frac{2{,}000}{\sqrt{3}}} \times \dfrac{100}{85}} = \frac{85}{100}\frac{\sqrt{3}}{\sqrt{2}}.$$

Therefore the three-phase current $= \cdot 96$ of the continuous current in one phase. As the loss is the same in both systems, and there being two line wires for the continuous and three for the alternating, we have: loss in continuous $= 2\,R\,C^2$; loss in alternating $= 3\,r\,C^2$; where R = resistance of continuous-current line; r = resistance of alternating-current line; and $C = \cdot 96\,c$; therefore, $2\,R\,C^2 = 3\,r\,(\cdot 96\ c)^2$ and $r = \frac{1}{1\cdot 38}R$, which means that the area of the alternating wire is ·783 of the continuous wire. But the fact of there being two wires for the continuous current and three for the alternating means that the weight of the alternating line must be $\frac{3}{2} \times \cdot 783$ times the weight of the continuous-current line $= 1\cdot 175$ times. Therefore, the weight of copper required for the three-phase line is 17·5 per cent. more than that required for the continuous-current line, allowing a load factor of 85 per cent. for the three-phase system, and assuming the loss on the line and the maximum voltage to be the same in both cases.—H. BRUTON.

[We have received a number of other answers to the above, all of which are more or less faulty. In the first place, the writers have not read the question carefully, and in no case has the actual weight of copper been worked out. These actual weights have a practical value. We therefore throw the question open again on the usual terms.—ED. *E. E.*]

Question No. 44.—Discuss the relative advantages of (*a*) forced lubrication, and (*b*) lubrication by splashing for engine bearings.

Best Answer to No. 44 (*awarded* 10*s.*).—Discussion on the relative advantages of these two systems of lubrication almost necessitates a discussion on the advantages of the two types of high-revolution engines most familiar to us, each type having its own system. For instance, the Willans single-acting engine has been successfully lubricated by the latter system, whereas to adopt the former to this class of engine is impracticable for various reasons, as will be readily seen. I may point out one difficulty. Suppose the oil-ways in crank pins to be on top when cranks are on top. Owing to the constant thrust in one direction, any slack in the brasses (supposing bottom brasses fitted) would allow a free passage for the oil when cranks were on the bottom, in this way releasing the oil pressure from the following crank or cranks when it was required. Then we may take the Belliss double-acting engine. It is unquestionable their great success is due to the fact of the oil pressure taking up the jar or knock that would otherwise ensue on the reversal of the thrust of such quick-revolution engines. With an oil pressure of 10lb. to 15lb. per square inch being maintained on their journals they give no noise or trouble whatever, and after 12 months' working no

perceptible wear will be found to have taken place. Whereas, if lubricated by the latter system, they would rapidly knock and hammer themselves to pieces. But to review the two systems independently of their respective engines. The first cost of system A is undoubtedly greater than B. The latter has no first cost, whereas in case A the shaft requires to be drilled, oil-pipes fitted, and pump supplied, either in connection with the engine or separately, for forcing the lubricant. The loss of power is in each case about the same, in the one case working the pump in the other, the cranks striking the liquid. In the latter case, however, if the liquid is allowed from any cause to exceed its proper height (which should be level with underside of shaft) unnecessary loss will result. System A is more suitable in its general adoption than B, for whereas A would work equally satisfactory for a stationary, sea-going, or locomotive engine, B has been found unsatisfactory even as an auxiliary engine aboard large vessels. The cost of lubricant, generally speaking, would be the same in each case, but a cheaper oil may be used with system A than B. With system A the piston and valve-rod glands should be placed outside the crank chamber, or have some other suitable means of preventing water from the glands leaking passing into the chamber. Strainers should be fitted in pump suction to prevent the passage of any foreign substance. With system B care should be taken that no cylinder oil is allowed to pass down the lines into crank chamber, as it is likely to destroy the liquid as a lubricant. As to the amount of attention required of those in charge, system A requires to have the strainers examined and cleaned, if necessary, about twice a week, the engine-bed emptied and wiped out about once a month, and the old oil filtered and replenished with clean oil. When running, an occasional glance at the oil pressure gauge is necessary. With system B the liquid should be examined daily, and have an allowance of oil added. Should the liquid become acid a little carbonate of soda will sometimes prove beneficial, otherwise the bed must be cleaned out and new liquid formed. But a good deal depends on efficient management. The lubrication of the bearings is in either case effectual when properly looked after — *i.e.*, we prevent the metallic surfaces from coming in actual contact. As to which is the best, independent of their respective types of engines, I unhesitatingly say forced lubrication, for the following reasons: its adaptability is more general; the viscidity of the unguent used may considerably exceed that in the other case; the average driver can read a pressure gauge and clean strainers, whereas he cannot always determine if the liquid may be acid or not.—F. R. S.

Answer to No. 44 *(awarded* 5s.*).*—According to Prof. Thurston, friction of the main bearings of an engine amounts to about 40 per cent. of the power lost in friction in the whole engine, and when running at quarter-load this main bearing friction amounts to about 20 per cent. of the entire load. From this figure it will be seen that it is most important that the bearings should be effectively lubricated, and the question is to discuss the advantages and disadvantages of (*a*) forced lubrication, (*b*) lubrication by splashing. (*a*) Forced lubrication: This system is one whereby the oil is pumped to the bearings by means of a small pump working off the eccentric. This pump draws oil from a well in the base of the engine frame and forces it through suitable channels into the working parts. The advantages claimed for this plan of forced lubrication are automatic lubrication, noiselessness, economy, and freedom from wear. This is due to the working surfaces being kept apart by the film of oil forced between them. Although generally the pressure per square inch on the bearing itself is far in excess of the oil pressure used, yet the relaxation of the pressure on the return stroke in a double-acting engine permits the oil being forced between the metal surfaces. The oil is in the best possible position to take advantage of the momentary relaxation of pressure between the surfaces, and it is under sufficient pressure to push in between the brass and the shaft, completely flooding the bearing, and the fraction of a second occupied on the return stroke is too short a time to allow the oil to be squeezed out. It is in this way, by forced *lubrication, that we get an ideal* method where two metallic
surfaces never come in contact, thus reducing wea
brasses; and engines have been taken in pieces wh
worked by this method, and the brasses are n
worse for wear after four years' continual runni
same oil is used over and over again, being pumped
sieves, which remove the impurities, thus reducing
bill considerably. The only disadvantage to thi
is upon any accident happening whereby the oil-pu
I have at the present time lively recollections of
with an engine worked by forced lubrication owi
accident to the oil-pump, but this, as other thin
requires care. (*b*) Lubrication by means of splashi
above (*a*) system, has been shown to work perfe
double-acting engines, but in single-acting eng
pressure is always constant, and the film of oil
in the above case is impossible, so a simpler m
lubrication is used—that by splashing. In this sy
cranks and eccentric dip bodily into a bath of
water, and splash it over the bearings, where i
greases the journal, as it will be readily seen
supplied by gravity alone, cannot penetrate to any
but if friction and consequent wear of the journa
be prevented, such a film of oil, as forced lubricat
vided between journal and the brass, is essentia
system has the advantage that it has no oil-pum
out of order. Summing up the two systems: (*a*
lubrication—an ideal method, preventing wear,
with economy and noiselessness, but not applica
the same efficient results to single-acting engin
double-acting engines; (*b*) lubrication by splashing
used in single-acting engines, but owing to the
supplied to the bearing by gravity, is not a very
method, and by this method an oil-tight case is nec
F. M. M.

TORQUAY.

Torquay has at last come into line with other seasi
resorts, and has installed the electric light. The
ceremony was held on Thursday, March 17, when
was the light turned on, but the usual concomitant to
ceremonies was given in the shape of a dinner. The
of course, did not pass off without mishap, but very of
a lecturer wants to show a particular experiment s
goes wrong and the apparatus won't act. That is th
course of things human, and has nothing to do with
that yesterday and to-morrow things are all right. Bu
of this, let us to the ceremony; the history of the enter
be gathered from the speeches.

The Mayor and Mayoress (Alderman and Mrs. H
accompanied by members of the Corporation and many
assembled at the station. Alderman Kerswill, chairma
Electric Lighting Committee, at the request of the
turned on the steam and so started the engines and d
Alderman Kerswill stood on a platform near the swit
and asked the Mayoress to switch on the light. W
assistance of Mr. P. Storey, resident engineer, the M
switched on the light amid the hearty applause of the c

Councillor Appleton thanked the Mayoress, and on b
the Mayoress the Mayor returned thanks, saying this
only a red-letter day for Torquay, but an epoch-makin
the history of the town. They were inaugurating an e
which would last, he hoped, as long as Torquay laste
electric light was certainly the light of the future, and
they were pleased with the sample they saw around the
inauguration of the electric light placed Torquay on a l
the first cities and towns of the United Kingdom, a
town would the light be better supplied.

Councillor Smerdon called for cheers for the Mayores
were duly given.

Subsequently the members of the Corporation and th
guests proceeded to the Queen's Hotel, where they we
tained at a banquet by the Mayor and Alderman K
The banquet tables were illuminated by small prettily-
electric lamps arranged by Massingham and Mann.

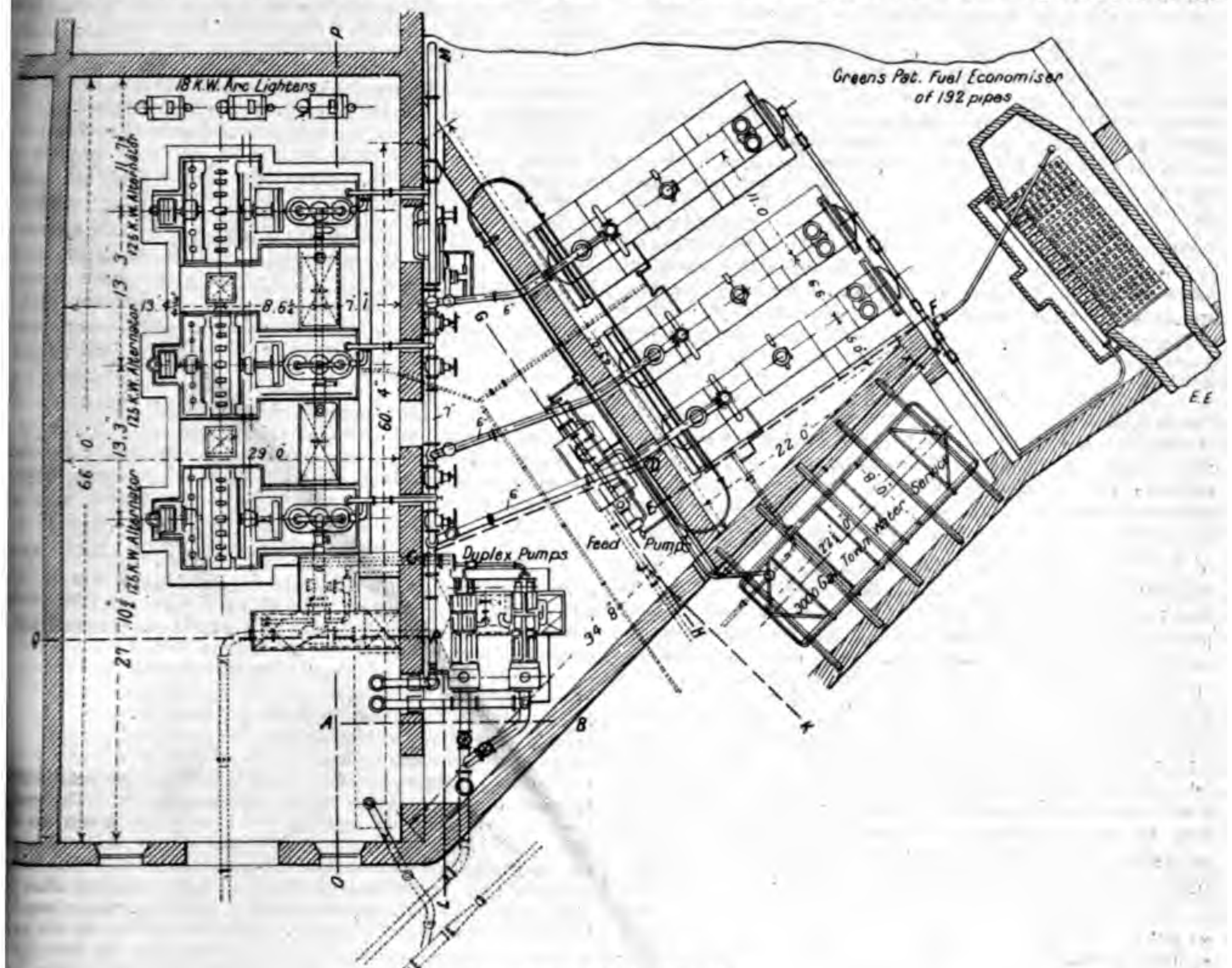
The Mayor presided, and the attendance also included A
Kerswill, Alderman Richardson, Alderman Callard, A
Bovey, Alderman Mortimer, Councillors R. Crocker, W
F. J. Crocker, J. Smerdon, J. Angel, R. Pickard, J. F.
T. H. Wills, W. S. Thomas, R. Smerdon, E. Apple
Buntin, R. L. Butland, Mr. W. H. Trentham, Mr. H.
(Plymouth), Mr. F. B. Harrison (Devonport), the Tow
(Mr. F. S. Hex), Mr. H. A. Garrett, Mr. A. Manley,
Ingham, Dr. Karkeek, Superintendent Roberts, Mr. M
Mr. W. Baily, Captain Pepperell, Mr. W. H. G. Ke

G. N. C. Mann, Mr. P. Storey, Mr. T. P. Wilson, Mr. Spearing, Mr. Dodds, Mr. Munro, Mr. J. H. Rider.

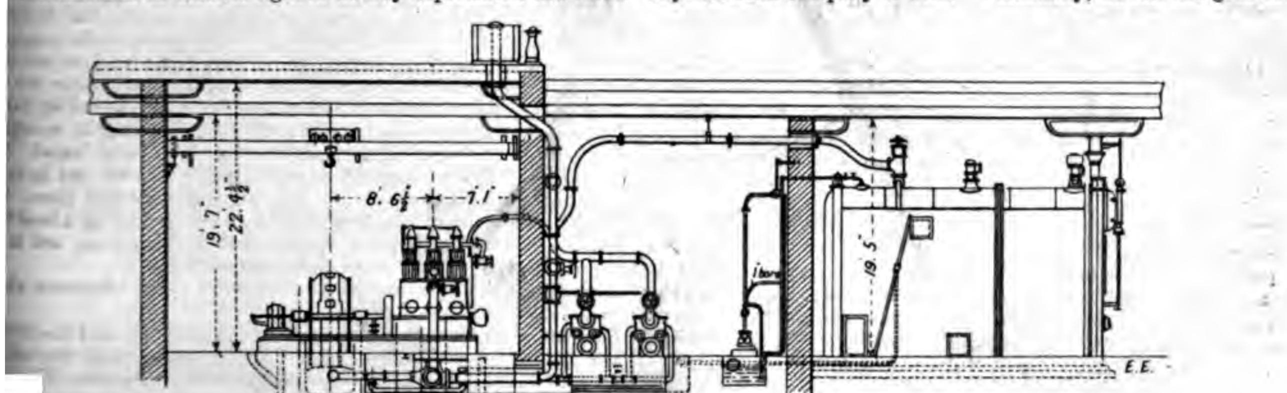
After the loyal toasts,

Mr. J. F. ROCKHEY proposed "Success to the Undertaking." They had brought to a successful close all the preparatory work connected with that important undertaking. The question had been before the town something like seven years, and it was to the credit of the late Local Board that they had the foresight and wisdom to acquire a provisional order to enable the town to keep the electric lighting in their own hands. The chairman of the Local Board at that time was the secretary of the gas company, and it was to his credit that he did all he knew to keep the electric lighting in the hands of the local authority. He was glad to know from the experience of other towns that the introduction of electric light in no way depreciated the value of gas shares. Torquay was the first municipal authority to open a municipal electric light undertaking. He coupled with the toast the name of Alderman Kerswill, who had taken an active and intelligent interest in the question from the outset, and had been an able chairman of the committee.

Alderman KERSWILL replied, and gave a brief account of the inception, progress, and consummation of electric lighting in Torquay. The initiation took place in the year 1891. By the granting of the provisional order powers were conferred upon the local authority to undertake the lighting of the town. A committee was soon afterwards appointed to consider the question, and he was chosen chairman. As all first-class watering places were adopting the electric light, the committee felt that Torquay, in order to retain her proud name as Queen of Watering Places, must also adopt this perfect light and latest sanitary improvement. Almost the first work of the committee was the appointment of Mr. Trentham as consulting engineer. He was recommended to the committee as a man of considerable practical experience in mechanical and electrical engineering, and one of the committee's strongest reasons for engaging him was on account of his not being connected with any electrical company or firm. Personally, he felt the greatest confidence in Mr. Trentham, and he thought the present state of the works showed that his faith in his ability was not misplaced. The question of lighting the town was carefully considered from time to time by the committee, and reports submitted by them to the Council, who in their wisdom sought to extend the duration of the order as long as possible. Three separate reports were submitted by Mr. Trentham to the Council, the one of May, 1895, being eventually adopted. Many different sites were viewed



Torquay.—Plan of Central Station.



Section on lines A.B.-C.D.-E.F.-& Q.R.

for the central station, and after much careful consideration and discussion the cellars near the Bath Saloon were decided upon for three reasons: (1) because the property was owned by the Corporation; (2) because of its nearness to the quay; and (3) because either of the other sites would have cost at least £6,000, whereas the cellars, including the chimney stack, had not necessitated an outlay of more than £2,000. Mr. Storey was appointed engineer, and had up to the present shown considerable ability and given every satisfaction. The contractors had endeavoured most thoroughly to carry out their specifications. The building, which was entrusted to Mr. Blatchford, had given every satisfaction, the boilers by Babcock and Wilcox were deemed very efficient, whilst the stack was built under the supervision of their own borough engineer (Mr. Garrett). The tests of the Willans engines had proved them to be of splendid quality, whilst the switchboard, by Messrs. Ferranti, was compact and efficient. The underground mains and arc lamps had been carried out by the British Insulated Wire Company. The system adopted in Torquay was that of high-pressure, 2,000 volts, alternating current, converted, by transformers fixed in suitable positions in street boxes *en route* of the high-tension mains, into low pressure of 200 volts for private supply. By this method the high-tension current was kept entirely away from the consumer's premises, the low-pressure cables rising from the street boxes carrying a perfectly innocuous charge. The Council were commencing with the Brighton or Wright's system of charging and rebate, which gave special advantages to large consumers. The charges were 7d. per unit for the first hour, and 3d. per unit for every hour afterwards. An all-night supply would commence in September. They had 40 consumers—a very good beginning. It was interesting to know that the experience of all towns went to show that when an installation had once been made the necessity for its extension almost immediately arose, and many were the instances in which it had been essential to largely increase the plant even within 12 months from the date of its first completion. This, he trusted, would be the case with Torquay. At the present time the applications for the light within what was known as the compulsory area were very numerous, and he hoped by September next the demand would be equal to the plant. The advantages of electricity over gas were various. It did not vitiate or consume the atmosphere, and thereby the heat and unwholesomeness which were attached to gas were avoided. In private, as well as with business houses, a great saving in decorations and other things would be found, as nothing arose from the light to cause any discolouration. All ladies who wished to retain their youth and beauty should use their persuasive powers with their worse halves to at once have their houses made complete by the fixing of this perfect light. In its earlier days it sometimes played tricks with its customers, but now that had been mastered, and the light was more steady and reliable than gas. It was to the interest of the community that the working should be both economical and prices reasonable. As the cost of production decreased in proportion to the increase of consumption, he trusted that the ratepayers of Torquay—the real shareholders in the concern—would do all in their power by becoming consumers to support the Corporation in their desire to make the borough up-to-date in all things. Before taking his seat he felt he must take the opportunity of tendering his heartiest thanks to the committee, who had so consistently and perseveringly supported the undertaking, to Mr. Hex for his indefatigable exertions and valued co-operation, to the surveyor and contractors, and to the Press, and last, but not least, his thanks were due to those who had so ably and persistently opposed the scheme.

Alderman Dr. RICHARDSON, proposing "The Engineer," said it was many years ago that he introduced the subject of electric lighting to the notice of the late Local Board. In Mr. Trentham they had a good and true man of great ability, and of the greatest possible tact. Considering the difficulties they had had, Mr. Trentham had carried the work to a most satisfactory conclusion.

Mr. TRENTHAM, in reply, said if it had not been for the great determination of Alderman Kerswill and the firm opinion of Mr. Hex that the Council ought to carry out the work themselves, they would never have come to that pass. Although the work had cost over £23,000, yet he could get the concern bought up by two or three London companies at the present moment for £30,000. They were starting with a very good load, equal to nearly half their total capacity, and when they lit the station that evening they were earning about a shilling a minute. The contractors had spared no pains to carry out their work strongly and efficiently; indeed, Messrs. Easton and Anderson had gone considerably beyond what was required, and had supplied them with a plant equal to 20 per cent. more than what was required of them. In consequence of that the total power they had at their disposal was much more than was necessary, and brought the cost of the total outfit to something like £52 per unit, which, he thought, was lower than any other undertaking in the country, except that at Bradford. Of course, the contractors had no need to do that, and he thought Torquay *ought to thank them for what they* had done. He thought the
result had shown that no one need be disappointed.
the work had been delayed a good while, yet everythin
those who waited. What they had seen fully demonst
the Council were justified in carrying out the work t
instead of delegating their powers to a company. T
been a good deal of complaint among the public a
way the streets had been picked up. But a private
would have made twice as much mess of the roads as
done. They ought, of course, to have opened the
months ago, but the chief cause of the delay had been
neers' strike, which was disastrous for all concerned.
hard character of the rock they had to deal with at th
delayed them. They had taken out about 400 tons of
was necessary to do this to get rid of the vibration,
they had succeeded. The committee had been fully j
fixing up the Bath Saloon as the central station. Mr. T
acknowledged his indebtedness to Mr. Garrett and Mr.

Mr. BUTLAND proposed "The Contractors," and
WILSON, SPEARING, and DODD replied. "The Visit
posed by Mr. R. SMERDON, was acknowledged by Mr
Plymouth, and Mr. MUNRO, Exeter. The MAYOR pro
health of the officials.

The TOWN CLERK was replying and speaking of
auguring well for the future, when, almost as he ut
word "future," the light suddenly went out and left
in darkness. There was a shout of laughter, and the
to be lit.

Mr. GARRETT also replied, and welcomed Mr. S
resident engineer, as a borough official.

The electric lights in the streets were also exting
the same time that those went out at the hotel, but
few minutes all the lamps were in full work again.

It is but just and right that the whole of the persons c
in the undertaking should congratulate each other
successful completion. Outside observers, howeve
acknowledging that the engineer has made the bes
site at his disposal, are inclined to the opinion th
demand increases as the speakers expected, troubl
extension would arise from the constricted area.
close to the wharf, the fuel will have to be carted to the
Then practically there is no office room or lavatory arra
for the staff. The views held at the opening of a
intermittent supply will be found to be impracticable, a
never have been countenanced. No doubt at Torqua
citizens are duly within four walls by one o'clock an
require to go out again before daylight in the morn
however, they should indulge in such mundane
balls and jollifications, no doubt link boys will be
to see benighted passengers home. There are two
circuits, and each takes a different part of the t
the event of an accident to one circuit, that
the town goes into darkness. The circuits ough
arranged so that every other lamp is on a different ci
then an extinction on one circuit only puts out ev
lamp. The plant on the whole strikes us as being
our adverse remarks are more upon matters of polic
apparatus. However, we wish the enterprise all succe

INSTITUTION OF ELECTRICAL ENGINEERS, I

The Cost of Generation and Distributio Electrical Energy.

BY ROBERT HAMMOND, MEMBER.

A paper under the above title was read before the In
last night, but it would require several special issues
duce in full. We have tried, therefore, to condense a
it. The matter is in such a form, however, that th
is a very difficult one.

The author bases his paper almost throughout on t
of Trade returns of electric lighting undertakings. He
the outset that the forms of accounts for municipal und
and companies are somewhat different. This diffe
principally in that in the companies' form the item "Pro
Salaries of Engineers" appears under the headings of
tion" and "Distribution"—i.e., works costs—where
case of local authorities the item has to be include
"Management."

The author thinks it is to be regretted that the
are not identical, because, without readjustment of th
salaries, no trustworthy comparison can be made bet
"works costs" of undertakings of local authorities and
companies. Such readjustment he has made throug
paper in the costs of 1896 and 1897, the whole of th
of engineers being placed under "Management,"
returns of the local authorities. This he admits to b
but it aids in the compilation of long strings of figures

The extent of the data available on the Board
forms may be gathered from the fact that whereas th

ur electricity works in operation in 1886, there were 121 l. The Board of Trade have not published these returns, gineers in the usual way can obtain copies of the various akers. As no paper on the subject has been laid before stitution since Mr. R. E. Crompton's paper on the cost of al energy in 1894, it struck the author that a fairly com- nalysis of these returns might prove useful to the members. ublication of analyses of the current year's returns in the al papers has, in the author's opinion, acted like an t upon the engineers of those works whose costs were nd as a stimulus to still greater economies on the part e whose costs were low.

uthor has summarised the returns of each undertaking United Kingdom, as far as he has been able to obtain They go back to 1890, and in almost every case end he 1896 return, but where the 1897 return has been ble it is included. The figures tabulated refer to those kings that are operating under the Electric Lighting 82-1888, having, of course, electric lighting for their bject, and only being assisted to a very slight extent by d for electrical energy for other purposes than lighting ; in the provisional orders under which they are operating le clear that they are constituted in their districts the s of electrical energy for all purposes that may be ed.

ble I. the author sets out, for all the undertakings in dom, except the very smallest, the following data : (*a*) d—as defined by Board of Trade form ; (*b*) coal used sold ; (*c*) average price of coal throughout the year. cost per unit sold of : (*d*) coal or other fuel ; (*e*) oil, ater, and stores ; (*f*) wages on generation and distri- (*g*) repairs and maintenance. These are totalled to works costs. Then come items for (*i*) rent, rates, and j) management—*i.e.*, salaries, stationery and printing, establishment charges, law expenses, insurance, etc. d totals are then given.

come 14 pages of tabulated figures, which are useful nce, commencing with those for Aberdeen and ending olwich.

be objected that in going beyond the analysis of the sts, the author steps out of the path of the engineer of the statistician, and he would admit the justice of the had the Board of Trade form, in the case of local es, not located engineers' salaries, etc., under the head agement." As by this arrangement works costs become f the important item of superintendence, he feels d, in order to make his returns complete, to bring in e of the management items, though agreeing that the not chargeable to the engineering department.

other hand, general use of electrical energy will depend ely on the works costs, but upon the gross cost of the delivered to the consumer ; and though the engineer s no responsibility for the outlays on management, not fixing of his own salary, he feels that his analyses of ald be incomplete if he did not include all the items ributed. In only the 1896 and 1897 analyses are the f engineers, in the case of companies, included under ing of management, as in the case of local authorities.

lysing the returns there are a few pitfalls that one has are to avoid in order to secure uniformity, and these n carefully considered in the compilation of the accom- tables, with the result that the author can say with e that the costs per unit sold of each undertaking are omparable.

ammond describes the great reduction in cost and price cal energy during the years he has compared. Thus, ngton from 1891 to 1896 the works cost per unit sold ped from 3·53d. to 1·57d., and the total cost per unit 4·91d. to 2·66d. Other comparisons are given which t much lower figures are obtainable than the above. works cost per unit the following figures obtain : ster (1897), 1·29d.; Manchester (1896), 0·94d.; Leeds 0·78d. ; and Edinburgh (1896), 0·63d. The next tables are arranged to show the various towns 94, 1895, and 1896 arranged in order of merit of the items making up the total cost. Thus heading the column each year is the one having the st per unit. In cost of coal per unit the leaders are : nchester, 0·50d. ; 1895, Leeds, 0·30d. ; 1896, Nelson,

, waste, water, and stores, the names at the top 4, Huddersfield, 0·02d. per unit ; 1895, Oldham, 0·05d. ; , Oldham again, 0·05d.

es, Liverpool leads in both 1894 and 1895 with 0·26d. d. per unit respectively, while in 1896 Edinburgh t first at 0·20d.

e items give in 1894 Huddersfield first with 0·11d. per 95, Bedford, 0·03d. ; and in 1896 Newport, with 0·06d. lumns for rents, rates, and taxes are headed each year paying nothing.

management expenses, the City of London heads the 894 with 0·30d. per unit ; Cambridge in 1895 with 0·28d. ; and Whitehaven in 1896 with 0·22d. The author then tabulates the total works cost per unit arranged in the same order of merit. Amongst these Manchester comes first in 1894 with 1·49d. ; Edinburgh in 1895-6 with 0·92d. and 0·63d. respectively. The same towns hold the first positions for total cost per unit sold for the three years with figures as follows : 1894, Manchester, 2·17d. ; 1895, Edinburgh, 1·67d. ; 1896, Edinburgh, 1·13d.

In drawing conclusions from these figures the author considers it well to neglect those obtained in the first year's working, as the plant during this year is usually maintained by the contractor. He then takes the lowest figures per unit for any town for each item, and arrives at a figure for works cost of 0·56 and for total costs of 0·84. The component parts of this result are distributed over the length and breadth of the kingdom ; and the attainment of the built-up figures in any one works may, in the author's opinion, come in time. He then contrasts these lowest obtained items and their total with those given by Mr. R. E. Crompton in his 1894 paper. Mr. Crompton arrived at a total cost of 1·32d. per unit for works producing five million units per annum with coal at 20s. per ton. This figure has been improved upon in Edinburgh, but in this case coal was obtained at a lower figure. The author then points out that none of the metropolitan works have yet reached Mr. Crompton's figures. Mr. Hammond proceeds to consider the question of the influence of the output on costs. For this purpose he gives a series of curves connecting output and costs for different stations. The next series of tables consists of the record figures for the various items making up the total cost of production for different towns arranged in order of output. These extend over three years, and we notice that the London companies hold the record for several outputs.

The next division of the paper deals with the question of load factor, which term the author uses to mean the ratio of the actual units generated to the product of the maximum output into the total number of hours in the year. The load factors of the various towns are then listed, but not in order of merit. The Newcastle and District Electric Light Company claim to have a load factor of practically 27 per cent., which we are inclined to doubt, as the next best figure amongst the provincial undertakings is no higher than 19 per cent. Amongst the metropolitan companies, Charing Cross stands first with a load factor of 26·25 per cent., while the Westminster Company is 15·78 per cent. In the same table a column is given showing the proportion between the units used in distribution and unaccounted for, to units generated. This percentage of energy generated and not used is most interesting. The author concludes that a high load factor is closely connected with low works cost.

The next point taken up is the influence of a day load on the cost of production. The author shows that owing to the rapid increase of lamps connected to the mains, the load factor obtained does not represent accurately the percentage hours of demand upon the plant in any year.

The next sub-division is headed "Reliability of Plant," and the section contains a few hints on the tests to be prescribed. Under "Efficiency of Generating Plant" more information of the specification order is given, and also a table of results obtained from the tests of five different steam alternators, ranging in output from 100 kw. to 200 kw. Under the heading of "All-round Efficiency," the author states that a rough all-round test is given by the coal bill, but that in this case the cost of coal must be considered. He discusses the point of using weight of coal per unit instead of cost of coal, but finds he cannot get figures in many cases, and the different calorific power of the coal used. A table of the coal per unit sold for most of the London stations is given. A large series of curves connecting total costs per unit and the number of units sold is then given.

The author concludes with a reproduction of the form of accounts prescribed by the Board of Trade for electric lighting undertakings.

At last night's meeting of the Institution the following were the candidates balloted for :

Member.—H. T. Lyon, 57, Onslow-square, S.W.

Associates.—C. A. Astrom, 83, Cannon-street, E.C.; H. C. Buchanan, 77, Hayter-road, Brixton, S.W.; W. Davies, Engineering Department, Stock Exchange, London, E.C.; D. Gordon, Oxley House, Bushbury, Wolverhampton; George William Spencer Hawes, Ormond House, Great Trinity-lane, E.C.; M. A. Immisch and O. C. Immisch, 102, Tollington-park, N.; F. A. Knight, 249, Evering-road, Upper Clapton, N.E.; E. J. Marsh 39, Bickerton-road, Junction-road, N.; T. H. Pope, South-street, Ponder's End, Middlesex ; P. R. Rice, The Firs, Wheathampstead, Herts ; C. M. Shaw, Carlton School House, Dewsbury ; J. L. F. Vogel, Hillersdon, East Molesey ; R. Wardell, District Asylum, Maryborough, Ireland.

Students.—J. H. Johnson, 15, Farmdale-road, Westcombe Park, S.E. ; A. H. Read, 542, King's-road, Chelsea, S.W. ; R. Savory, 33, Maryon-road, Charlton, Kent ; E. G. Sheppard and A. W. Wigram, Faraday House, Charing Cross-road, W.C.

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TO CORRESPONDENTS.

 Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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BROCKIE-PELL.

There has been a determined assault made u
company by at least one of the financial pap
is not our *rôle* to defend electrical compani
such onslaughts, but, like the proverbial I
man, we like to see fair play; and that is
never obtained in financial circles. The vag
the Stock Exchange, the bulling or bearing o
and stocks, the creation of unrest, means
financial papers. They do not ascertain fact
to see if their conclusions are just, provided
will bear out their reasoning. Jump upon t
difficulties, harass them, make the directo
managers' lives a hell upon earth, whether d
or not—that is the aim and object of fi
papers. The position of the Brockie-Pell C
is bad enough in all conscience, and in a n
condemnation is deserved, but not the wh
and unqualified condemnation that has been
out to it. The estimated profits in the pro
may have been wrong or may have been
but care was taken at the time of issue t
technical papers could not usefully discu
question. If that be an offence, it is a c
one with the majority of such companie
probably from their point of view the corr
cedure, in that the technical journals know
than the ordinary papers what prospects of b
there are in these special directions. Wha
use of discussing purchase-money or est
profits now? Why did not the financial
analyse the prospectus at the time? It
these sapient advisers of the public purse se
months in which to say, "from beginning to
has been purely and simply a case of profe
promotion." Surely, if that is so, no one is
situated than the editor of a financial paper t
it at the outset, and thus to be in a position to
the public touching the matter. Fancy, after
teen months telling the public that it (the co
should have been "left severely alone"! O
friends would say this method of dealin
money matters is "too thin," and inclines o
to the opinion that other than disinterested
in the pockets of the public guides these a
Why say nothing when plain speaking mig
done good? Why so strenuous in howling w
damage is done? This is shutting the stab
with a vengeance. Now a little on the oth
The financial papers tell us "the business h
been in full swing for a period of from five
months." You hardly expect a new con
start from the mark as if it had been going
well-organised conditions for years. The fi
of most companies is of little import. In tl
is it not true that machinery could not be
had to be designed and made—thus stoppin
ness in every direction? Is it not true that
machinery has been designed and made the co
is earning a profit? Ought not these thing
taken into account? Ought not a fair trial to b
before condemnation. We do not say that
criticism is undeserved. We do say th
allowance has not been made for the troub
difficulties incidental on the starting this b

ɔinions about the prospectus are very strong, 'hether favourable or not, we had no oppor- of stating at the time when such statement have done good service. Of one thing there the shadow of a doubt—the Brockie-Pell lamp ɔod one.

RECENT STORAGE BATTERIES.

was to be expected, in view of the prospective on of accumulator traction on the public ays, invention has latterly been unusually in the direction of storage batteries. The hner accumulator, for which Mr. E. Manby sponsor, was prominently brought before the ɪtion in the discussion of Mr. Epstein's paper. is said to have run during 15 to 17 hours 30 miles without recharging, and to have a ɪum discharge rate of 4·1 amperes per pound ites, which probably corresponds to about mperes per pound of battery. Then there accumulator of Mr. Rankin Kennedy, esti- to yield 13 watt-hours per pound of battery, aving a normal rate of discharge of about nperes per pound of battery. And now we an American accumulator, of which it is ed—though not by the patentee, whose state- seems to have been carefully considered—that , for the same weight, do twice the amount of of any other battery. The Crowdus storage y presents several points of interest, the striking of which appears to be the use of etal aluminium for the conductive support e spongy-lead active material. The advan- of substituting for lead a metal of more six times its conductivity and less than half ecific weight has naturally occurred to many; uch substitution, in the case of the peroxide nt, has been found to be impossible, and, in se of the spongy-lead element, to be surrounded difficulties. The question as to whether it has successfully effected in the case of the present ulator is one of considerable moment; and hould be sorry to say anything to discourage vour in this direction. At the same time we point out that the statement as to the suc- ul solution of the problem, in the case of the ort for the spongy-lead element, cannot be ted on the *ipse dixit* of any inventor or facturer, but should be the subject of a ting investigation, conducted by competent rities, and extending over a considerable d of time. Up to the present it has not been that the spongy-lead active material can be adherent to or maintained in good conductive t with an aluminium support. Another point rest in this battery is the admixture with lphuric acid electrolyte of a percentage of sulphate. This, according to the inventor, ses the "efficiency" of the cell; it certainly, ing to his tabulated results, increases the mean of discharge, and would no doubt be useful ucing sulphatation. But, on the other hand, me of the peculiar merits of the ordinary lead ulator that it is free from the troublesome phenomena of "creeping" and efflorescence which in zinc batteries are due to the presence of a salt in the electrolyte; and this advantage, which is of more importance than it might appear to those who have not been in charge of many cells, would probably be sacrificed in the present battery. The method of connecting together the positive and the negative elements of the battery respectively, so as to secure a uniform and equal electrical and chemical action over all parts of each plate, appears to be analogous to that adopted in the E.P.S. "K" type of cells, where one set of elements is connected along the top, and the other along the bottom of the plates. According to Mr. James K. Pumpelly, whose name was associated some ten years ago with the Pumpelly Storage Battery Company of Chicago, the Crowdus 100 ampere-hour battery weighing 14lb. will give an output of 20 amperes for four hours, or 15 amperes for six hours. Thus, when the rate of discharge is $\frac{20}{14} = 1·43$ amperes, the specific capacity is $\frac{80}{14} = 5·71$ ampere-hours; and, when the rate of discharge is $\frac{15}{14} = 1·07$ amperes, the specific capacity is $\frac{90}{14} = 6·43$ ampere-hours. The additional statement that "the output to the battery is fully 8½ to 9 amperes to the pound of battery all complete," would, if taken by itself, be somewhat puzzling; but the context may perhaps justify us in supposing that for "amperes" we should read "ampere-hours," and that the high capacity thus signified is that which prevails under a much lower or "normal" rate of discharge. Such mistakes as the substitution of amperes for ampere-hours exhibit, however, an absence of care in specifying the advantages of the battery, which is somewhat unfortunate, if not reprehensible. Even if we accept the somewhat startling assertion as to "the output of the battery being fully 8½ to 9 amperes to the pound of battery all complete," it is impossible to justify by this the statement that "the Crowdus battery for the same weight can do twice the amount of work of any other." The Dresden (Marschner) accumulator is stated to give 13 watt-hours per pound of cell; and about the same is claimed for the Rankin Kennedy battery; or, say, 7¼ ampere-hours. The capacity per kilo of electrodes in the case of the Tommasi battery has been given as from 22 to 25 ampere-hours; or, say, 11 ampere-hours per pound of plates, and 7½ ampere-hours per pound of cell. We would not assert that any of these values would hold good under the conditions of practice on a commercial scale, and our scepticism in this direction is not confined to the German, French, and British inventions, but equally extends to that which is imported from Chicago.

MUNICIPAL ELECTRICAL ASSOCIATION.

At a meeting of the council of the Municipal Electrical Association, held at the Westminster Palace Hotel, London, on March 15, it was resolved to call a general meeting of the association to be held at the Westminster Palace Hotel, London, on April 19, at 3 p.m.

The following applications for membership were considered and approved:

Members.—W. H. Chambers, Gibraltar; C. F. Parkinson, Morecambe; J. K. Brydges, Wakefield; the Electric Lighting Committee, Barrow-in-Furness; the Electric Lighting Committee, Darwen; Stanley Clegg, Darwen.

Associates.—S. E. Andrew, Leytonstone; J. C. Vaughan, Leytonstone; T. D. Clothier, Hull; A. N. Puzvet, Brighton; N. McLean, Harrogate.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

ELECTRIC POWER SUPPLY.

SIR,—My attention has been drawn to a note of yours on the paper I lately read before the South Staffordshire Iron and Steel Managers' Institute, on "Electric Power Supply." I much regret that if you noticed it at all, more care should not have been exercised. Towards the end of your note you make statements which give your readers totally wrong impressions of what I meant, and you then go on to attribute to me a deliberate mis-statement of certain facts, whereas the truth is that my facts are perfectly correct, and it is your own deduction which is at fault. Further, my paper was never intended to refer to the work which is likely to be accomplished by large isolated plants for particular purposes, though, even if it had been, I believe a very good showing could have been made, except, perhaps, for plants for certain electro-chemical purposes. I shall be obliged by your publishing this, as your article may be used to throw doubts on the conclusions of the paper by people who are not capable of judging for themselves.—Yours, etc.,

G. L. ADDENBROOKE.

21, Lichfield-street, Wolverhampton, March 21, 1898.

[We have carefully re-read our note, and fail to find the mis-statement complained of by Mr. Addenbrooke, but which we regret if we have made. As regards the doubts thrown on the conclusions of the paper, we do not consider that Mr. Addenbrooke has made out his case. He has not taken the conditions as they actually are, but by assuming a too regular load factor, obtains the rosy figures as pointed out. The power distributing company, in spite of their cost of mains, has to compete with the isolated plants referred to, which can work at practically full load for at least nine hours a day.—ED. *E. E.*]

GALVANEASE.

SIR,—A cutting has been sent to us from your paper on the subject of "Galvanease," in which you compare our appliances with the Harness belt cells, and you state that they "produce sores on the soles of the feet, which are not wanted." We are sorry that you are not better acquainted with our appliances. We beg to state that they do not produce sores, and that they are all constructed of a large number of very small cells, and giving a large voltage, while 100 of them only produce 10 milliamperes. You will, therefore, see that it is almost an impossibility for sores to be produced by the "electromotoforce," and yet produce a decided current from pole to pole. We have much pleasure in enclosing you our new illustrated pamphlet. Those bands used in the soles of the boots are the same as represented on p. 32, Fig. 8, the cells being ¾in. long. A boot would, therefore, have from eight to ten volts. We have worn these boots ourselves with the greatest comfort. The bands absorb the moisture from the feet, keeping them dry. The current naturally passes from the heel to the toe, the negative being at the heel, and the positive at the toe. We should be very pleased if you could give us a call and test these appliances, both through your body with a water decomposer or galvanometer through the circuit, or if you have this instrument at your command we should be pleased to send you the band if you would care to test it yourself. There is no imagination about our appliances, and you will see that there is no comparison in their construction with the
Harness belts, and we must admit that the autho
give you in pamphlet, pp. 55-72, are of a charact
reproach. We certainly object to our applianc
compared with the Harness belts, or saying t
produce sores.—Yours, etc.,

J. L. PULVERMACHER AND CO., L

[After reading the pamphlet, we unreservedly
the Harness reference, but the electrical details an
sions in it are in many places as loose as those
plained of in our note.—ED. *E. E.*]

HIGH-VOLTAGE LAMPS.

SIR,—Allow me to correct an error into wh
reporter has fallen in your account of what I sa
Society of Electrical Engineers the other evening.

I am reported to have said: "By using boron
proportions, the resistance might be made the s
zero to very high voltages, and the boron did no
out even at one watt per candle."

What I said was that the resistance of a com
boron and carbon did not vary from zero to a te
corresponding to an efficiency of one watt per cand
this compound could be rendered durable it
invaluable for resistances, even if useless for lamp

I never asserted that it did not volatilise; I said
of the various compounds mentioned by the auth
paper did not when run at 2·8 watts per candle. A
to my experience, boron is quite useless for lamps,
its rapid volatilisation.

You also report me as having ascribed the pre
of cellulose by *zinc chloride* to Mr. Swan. I st
the precipitation of a cellulose solution through
into a setting solution was due to Mr. Swan (1
did not allude to the zinc chloride process at
was patented by Wynne and another a year later.
a modification of Swan's process, in which nitro
was used, dissolved in acetic acid. More than on
of cellulose has been proposed since, all of which,
involve precisely the same principle as that desc
Swan.—Yours, etc.,

C. H. S

FREE WIRING SYSTEMS.

SIR,—With reference to Mr. Rider's report p
the last impression of your paper, where he ref
Free Wiring Syndicate, whose business this
bought up over nine months ago, may we point
his objections are dealt with by us, and that
prepared to consider contracts on the lines sugges
committee, with one important exception—viz., t
not ask for payment on completion of work.—Y
(For the National Electric Free Wiring Company,

B. H. JENKINSON

Engineer and Works M

PERSONAL.

SIR,—Having heard that the approaching term
my appointment has by many people been conne
the recent engine breakdown at these works, I sh
to point out that my resignation was accepte
Electric Lighting Committee nearly a week pr
the accident. The chairman has kindly allowe
publish his letter in confirmation of the fact.—Y

A. W. RANKEN,

Corporation Electrical E

[COPY.]

Dear Mr. Ranken,—It is a matter of regr
that the resignation of your position as chief
should be in any way connected with the recent
at the works. As a matter of fact, your resign
accepted on the 28th of February, and the
occurred on the 5th of March.—Yours very truly,

RD. MARTINS,

Chairman of Electric Lighting Com

7, South-quay, Great Yarmouth,
March 19, 1898.

FORTHCOMING EVENTS.

FRIDAY, MARCH 25.

ysical Society.—At Burlington House, at 5 p.m., Papers will be read: "On the Circulation of the Residual Gaseous Matter in a Crookes Tube," by A. A. Campbell Swinton; and "On Some Improvements in the Roberts-Austen Recording Pyrometer, and Notes on Thermo-electric Pyrometers," by A. Stansfield.

stitution of Civil Engineers.—Students' meeting, at 8 p.m., "Internal Governor Friction," by H. O. Eurich.

lectro-Harmonic Smoking Concert at the St. James's Hall, at 8 p.m.

MONDAY, MARCH 28.

ndon Chamber of Commerce.—At Botolph House, Eastcheap, at 2.30 p.m., extraordinary meeting to accept a new set of regulations.

ciety of Arts.—At 8 p.m., Cantor lecture, "The Thermo-Chemistry of the Bessemer Process," by Prof. W. N. Hartley, F.R.S.

TUESDAY, MARCH 29.

stitution of Civil Engineers.—At 8 p.m., "Extraordinary Floods in Southern India: Their Causes and Destructive Effects on Railway Works," by E. W. Stoney, M.E., M.Inst.C.E.

al Institution, Albemarle-street.—At 3 p.m., Prof. E. Ray Lankester, M.A., LL.D., F.R.S., on "The Simplest Living Things."

WEDNESDAY, MARCH 30.

ciety of Arts.—At 8 p.m., "Telegraphy Across Space," by Prof. Silvanus P. Thompson.

stitution of Electrical Engineers. —Students' meeting, at 7.30 p.m., "Electrical Instruments," by Mr. R. Gardner.

THURSDAY, MARCH 31.

al Institution, Albemarle-street.—At 3 p.m., Tyndall Lecture, "Recent Researches in Magnetism and Diamagnetism" (Lecture V.), by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., M.R.I.

stitution of Civil Engineers.—Students' visit, at 2.30 p.m., to the Great Central Railway Works, including the Terminus. Assemble at 210, Marylebone-road.

ry Technical College.—At 8 p.m., L. J. Steele on "Electricity Meters."

FRIDAY, APRIL 1.

stitution of Junior Engineers — At Westminster Palace Hotel at 8 p.m., "Mechanical Refrigeration," by Mr. J. T. H. Barrell.

SATURDAY, APRIL 2.

stitute of Junior Engineers.—At 11 a.m., Visit to the Thames Ironworks, Blackwall.

E PRACTICAL OPERATION OF MULTIPHASE CURRENTS.*

BY T. HAWKINS, MEMBER.

n electrical transmission of power plant may be divided three main sections—viz., generators, motors, and line. escribing or inspecting such a plant one naturally starts at power-house. A multiphase generator is an alternating-ent dynamo, having its armature conductors grouped in a manner as to give over a two-phase system two distinct ents differing 90deg. in phase. A three-phase generator ld have its armature conductors arranged to give three nts differing 60deg. in phase. For power plants, where istance between the generator and the various motors is great, and permits of a low-pressure system being used 200 volts), a generator with a revolving armature makes ap and efficient type of machine. Where, however, the M.F. exceeds 500 volts it is better to have the armature ionary, which allows of increased facilities for securing and taining the insulation necessary for high voltages. In this the field magnet is made to revolve, and the exciting coil or need not have a difference of potential exceeding 100 volts, for very large machines.

he generators in use for the different plants described in paper are of the "inductor" type. This is undoubtedly a mechanical piece of machinery than either of the fore-. Its distinguishing features are that all windings are ary, being fixed securely to the main frame, and that are no brushes or sliding contacts whatever, the only ng part of the machine being the iron or steel inductor. rmature consists of two laminated iron rings, enclosed ast-steel frame. This frame serves both as a support and magnetic path between the two laminated rings. As will en from the sectional drawing (Fig. 1), sufficient space is etween the two laminated rings for the insertion of the exciting coil. The armature conductors are embedded in close to the inner circumference of the laminated rings. To prevent eddy currents, the pole-pieces of the inductor are made up of laminated iron strips. A multiphase induction motor has two distinct electrical circuits—viz., the primary and the secondary. The primary circuit, when supplied with multiphase currents, produces a rotary magnetic field. The action of this rotating field is to induce in the secondary circuit currents of low potential. It is the reaction between the rotating magnetic field and the induced currents in the secondary which sets up a torque giving the required rotation. Either the primary or secondary can be designed to revolve. If the primary circuit were revolved, it would be necessary to fit it with sliding contacts, so as to connect it electrically with the feeding circuit. One advantage attained by this method is, that it allows of easy insertion of a starting resistance into the circuit of the secondary; but as there is no difficulty experienced in inserting a resistance in a rotating secondary, if required, it is better to fix the primary and dispense with the sliding contacts. The stationary element is generally spoken of as the stator, and the revolving element as the rotor. It is now the usual practice to have the primary or inducing circuit stationary, and to allow the secondary to revolve, so as to take advantage of the very low potential at which the currents are induced in the secondary circuit; also, because the circuit in this part is enclosed on itself, and is independent of the feeding circuit. Small motors up to 8 h.p. or 10 h.p. are switched into circuit directly from the mains by means of an ordinary three-pole switch without the use of any resistances; but for larger machines, it is advisable to use starting resistances, either in the stator or rotor circuit, otherwise excessive current will be taken from the mains. For large motors, not requiring to start against a heavy load, starting resistances can be used in the stator circuit. These resistances may be of two kinds: either inductive, known as automatic transformers, or non-inductive, which may be either liquid or metallic.

The maximum torque of a motor having a permanently short-circuited motor—*i.e.*, a rotor which is not connected to an outside resistance—is obtained when its full E.M.F. is across the stator. If, however, the motor is not called upon to develop its maximum torque, a lower torque can be obtained by reducing the E.M.F. across the stator terminals to such a point as will give the necessary strength of field for the required torque, the object of this being to reduce the starting current to a minimum and still enable the motor to get away. The auto-transformer is of simple construction, and is similar to the "economy coil" used in alternating-current arc lamps for obtaining a reduced voltage across the arc. As an example, we will suppose the motor is designed to work on a 200-volt circuit; the transformer is divided into four parts, giving 200, 175, 150, and 100 volts. The motor may be connected to any one of these four voltages. We will assume it gives the required torque at 150 volts; a throw-over switch is required, one side of which is permanently connected across the 150 volts, and the other side across the maximum voltage of the circuit. To start up, the switch is put on the 150-volt side, and when the machine has attained its normal speed it is thrown over to the 200-volt side, the automatic transformer being at the same time thrown out of circuit. If a liquid resistance is used, it is made sufficiently large to prevent a sudden rush of current when the circuit is closed. The plates are then lowered into the liquid until there is sufficient E.M.F. across the stator to start the machine. When the machine has attained its proper speed, this resistance is entirely cut out. If it is necessary that the motor shall develop its maximum torque at starting, it is obtained by inserting a resistance in the rotor circuit (see Fig. 2). A starting resistance of this description is necessary, for the following reason: When the primary current is switched on, the rotor is, of course, at rest, and the lines of the rotating field are cutting the rotor conductors at a maximum rate, thereby inducing very large currents in the rotor, which has a very low resistance. These induced currents in turn react on the stator field and weaken it. To obtain the greatest torque, we must keep up the strength of the stator field, and this is got by introducing resistances into the rotor circuit. Of course, the result of introducing the external resistance is to check the currents in the rotor, and so prevent them from unduly overpowering the stator field. There is a certain resistance which allows the exact amount of current in the rotor to obtain maximum starting torque. The starting resistance should, however, be designed with resistance in excess of this, so as to prevent too great a current in the line when closing the circuit. This variable resistance is connected in the rotor circuit in a three-phase motor, through three slide rings; the winding of the rotor and of the resistance box being in three circuits. The resistance is gradually switched out while the machine is running up to its normal speed; when this speed is attained, the resistance is short-circuited and the three brushes lifted. The motor is now running quite free, without any sliding contacts or resistances, and for all constant-speed machinery these slide rings are only used for starting up. I think I am right in stating that there is a much larger demand for constant-speed motors than for motors with a variable speed. It certainly is more economical to run the machines at the speed at which they are designed to give their

*Paper read before the Northern Society of Electrical Engineers.

maximum efficiency, and obtain, if possible, the variations by mechanical methods. Of course this cannot always be done.

I have described to you the three ways which are commonly used for starting up multiphase motors. Motors up to 10 h.p. to be merely switched into circuit without resistance; motors of larger sizes requiring to give, say, twice their normal running torque at starting, to be switched in with the resistance in stator; and motors above 10 h.p., requiring to develop their maximum

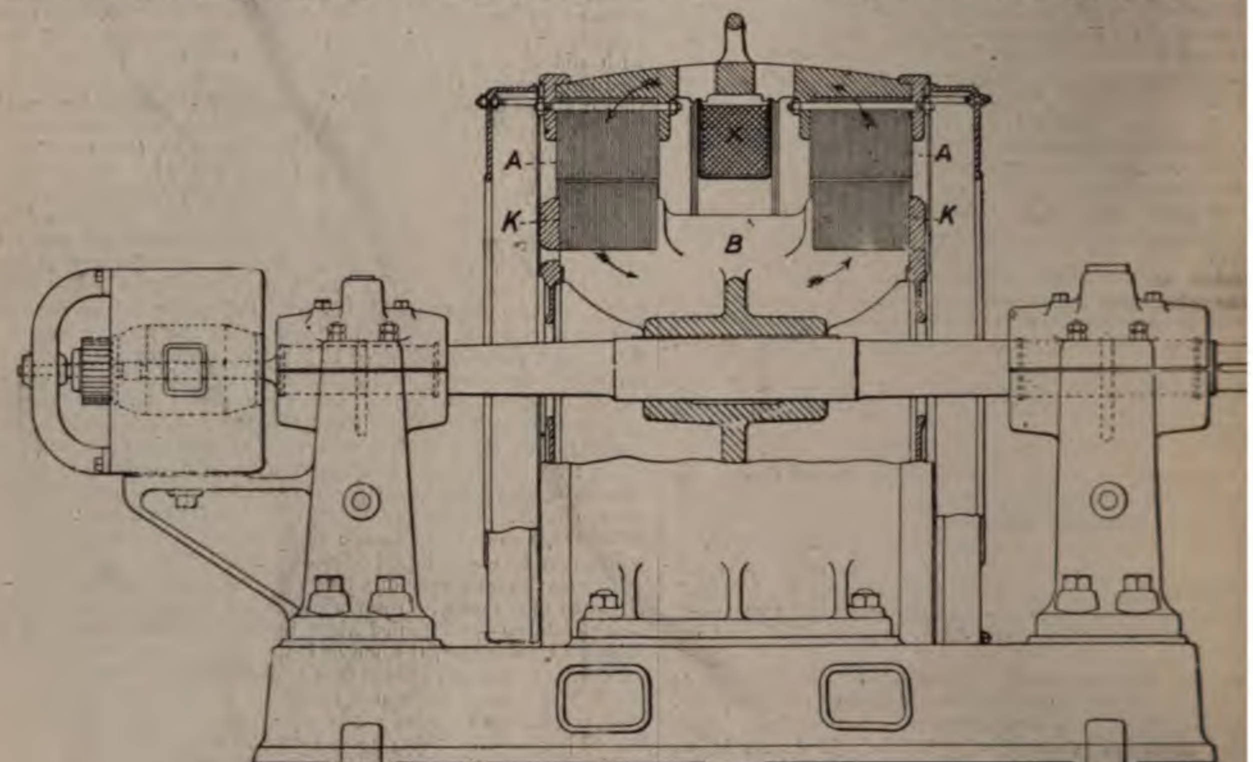


FIG 1.—Section of an Inductor Alternator.

torque, to be fitted with sliding contacts, these sliding contacts to be used for starting purposes only. Now, in a power plant calling for an aggregate of, say, 300 h.p. in motors, it is likely that only a small number would be required to develop their maximum torque, and these could be supplied with a starting arrangement and slide rings. We can suppose there are 20 motors below 10 h.p. absorbing a total of 130 h.p., four motors

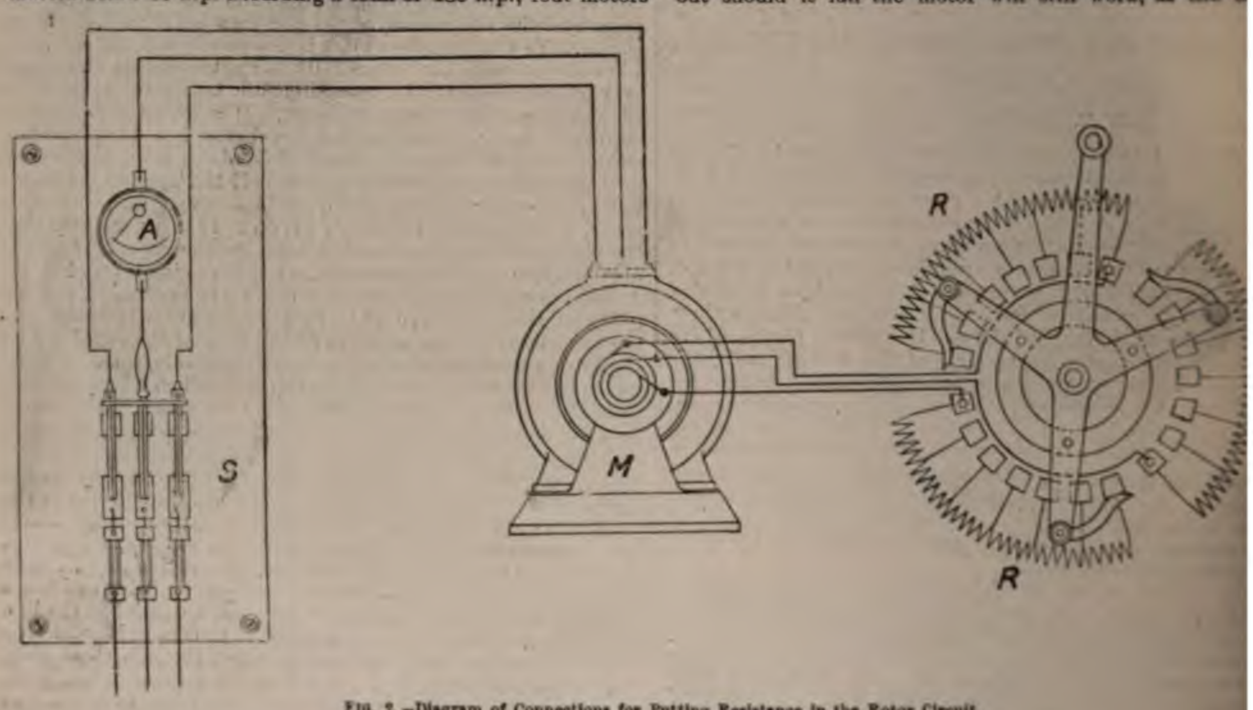


FIG. 2.—Diagram of Connections for Putting Resistance in the Rotor Circuit.

of 15 h.p. with automatic transformers, two motors of 30 h.p., and one motor of 50 h.p., with slide rings, making in all 27 motors, three of which would be fitted with slide rings. Here is a fairly large installation, requiring only three starting boxes amongst 27 motors, 24 having no sliding contacts whatever, and three having sliding contacts in use for starting purposes only. ...'s were a continuous-current installation, there would be, ...gin with, 27 boxes; and to compare the motors, there

would be 27 commutators and about 150 carbon brush
brush-holders. The stator we may consider as correspon
the field magnet of a continuous-current motor. Both can b
reliable, and, as a rule, give little or no trouble. But it is
merits of the rotor I particularly wish to call your attentio
minus the commutator, brushes, and intricate brush wor
instead of taking the full potential of the circuit it has a diff
of potential of only a few volts. It is simply a laminated cy

with holes round its periphery, in which are placed
rectangular bars connected at either end by a copper c
casting, as shown in Fig. 3. The only part which h
insulation at all is the conductor, which has a light cove
tape, and this is only put on to confine the induced curr
the copper. The insulation gives a slightly increased eff
but should it fail the motor will still work, as the b

already purposely short-circuited at certain points to th
supports of the rotor. Fig. 3 also shows a rotor in which
bars are bolted directly to the end rings; no solder is
The bolts have split spring washers under the nuts to al
expansion and contraction of the metal, and still kee
contact. I may say that this particular rotor is one cons
by the Westinghouse Company. You will notice, to
there is no need for any binding wires or string. Not

part of the machine simplicity itself, but we have dispensed comparatively high voltages, and as the machine is com-

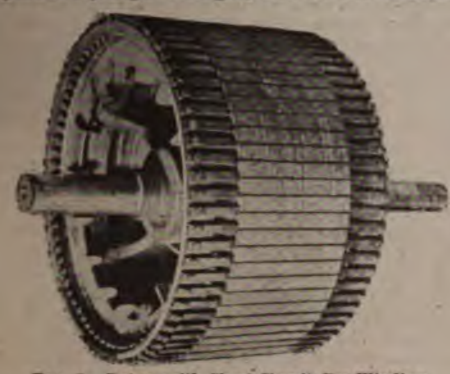


FIG. 3.—Rotor, with Short-Circuit Bar-Winding.

orless and brushless, we can, once and for all, dismiss our minds any anxiety as to sparking, even with sudden

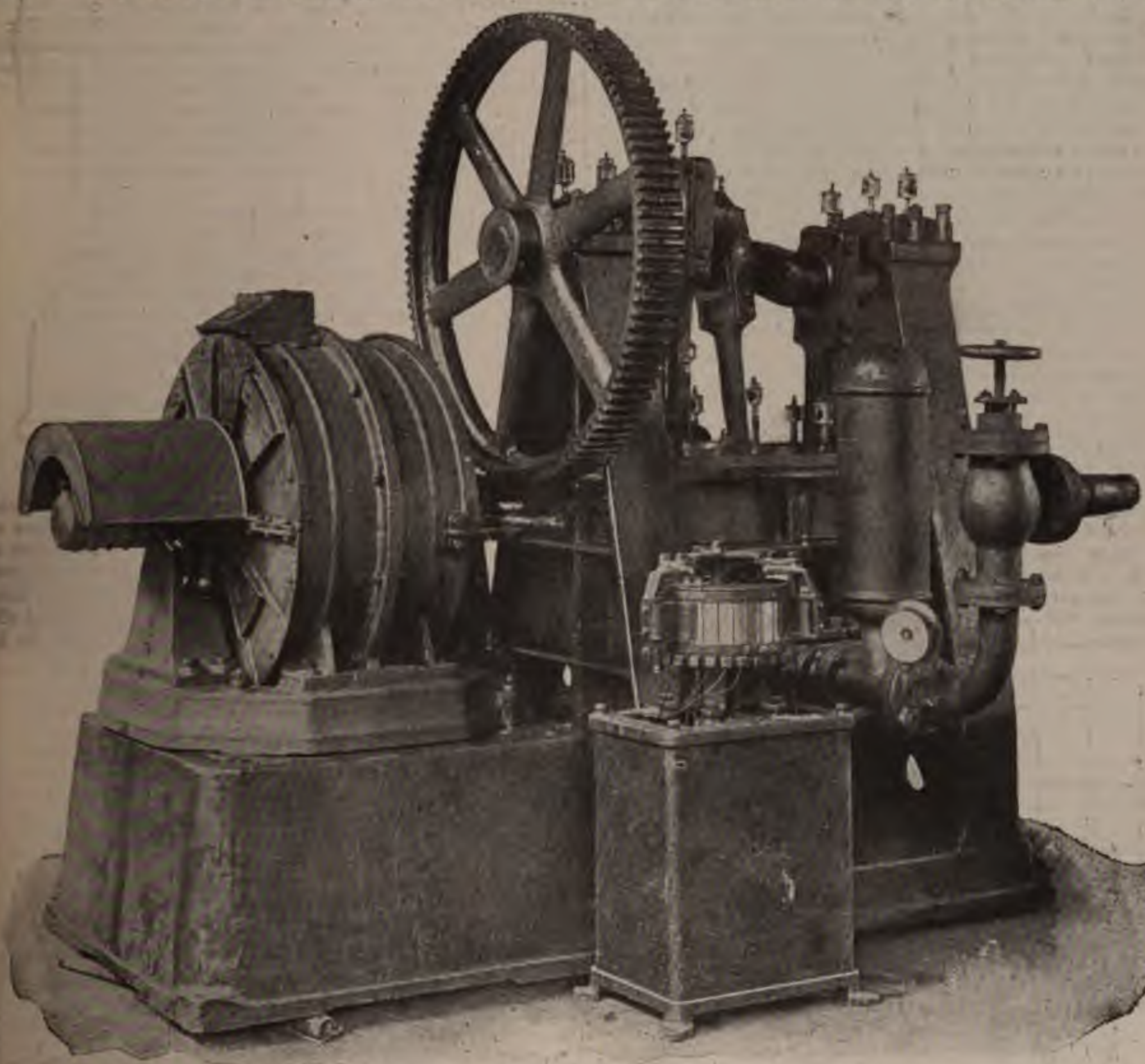


FIG. 4.—Three-Phase Pumping Plant for the Witwatersrand Mine.

loads, as sparking cannot occur unless the circuit of the ary or secondary is forcibly broken. The only limit to put is the heating of the stator on continuous overload. ar and tear is reduced to the friction of the bearings, and as g as these get their proper supply of oil the machine requires ther attention. As an example, the multiphase motors at General Electric Company's works at Manchester are only ected once a month, and then only for the purpose of plying fresh oil, if necessary. The constant-speed multiphase or is a good regulator. Between no load and full load for verage size machine the variation is about 4 per cent. The d at which the motor runs depends upon the speed of the field, and the speed of the rotating field is controlled imber of the stator poles and the frequency which is d in the installation.

point it would be as well to state that one cannot lay a general law as to what frequency is best. As a rule for work it is not more than 60 cycles. The frequency is one e two factors which control the speed, and it depends in a measure on the class of machinery which is to be driven as to what is the best frequency to adopt. One would be inclined to keep it as high as possible, so as to keep down the weight, and therefore the price of the machine, as the speed varies directly as the frequency. For instance, a motor giving 10 h.p. at 60 cycles and 1,150 revolutions per minute, would at 30 cycles run at 575 revolutions per minute and give only 5 h.p. The other way of decreasing the speed of the motor is to increase the number of stator poles, but this is not usually done, as to have too large a number of poles means great leakage, and, as a rule, the motors are, in the first place, designed with the maximum number of poles compatible with high efficiency.

I have stated that the multiphase generator need have no rotating windings at all; the only rotating part being a steel or iron casting. This reduces the attention and upkeep to a minimum, and I may here state that some installations which have been running in this country for two years have as yet, required no repairs whatever, and are practically as good to-day as the day they were put in. In a power installation, the generator is the part which is usually well protected and gets the best attention. If a continuous-current machine is used, the brushes will at intervals require to be adjusted and renewed, and the commutator trued up and kept clean; still, there is always a skilled attendant at hand to keep the machine in order. It is, however, the motors, scattered in many instances over a considerable area, which have often the greater strain and harder work to do, and yet have less attention where the three-phase system to my mind has the advantage, especially where motors are only required to run at one constant speed. As regards the line, a saving of copper is effected by using the three-phase instead of the continuous-current system, but there must be three wires if the former be used, which brings the cost of the distribution on a low-pressure system to about the same. At the works of the General Electric Company, Limited, at Manchester, there is a three-phase power plant. The generator has an output of 100 h.p. at a pressure of 190 volts, and runs at 450 revolutions per minute, giving 45 cycles. The list of motors is given on the next page.

The 24-h.p. and 18-h.p. motors are not working on more than threequarter load. Each motor drives a 120ft. length of main shafting at 300 revolutions per minute, the main shaft being loaded along its entire length by high-speed lathes and other machinery. The other belted motors drive shafting in the

LIST OF MOTORS.

No.	H.P.	Speed.	Geared to	Kind of gearing.	Starting device.
1	24	910	Shafting	Belt	Liquid resistance in stator.
1	18	910	Shafting	Belt	,,
1	9	910	Shafting	Belt	None.
1	3½	910	Boring machine	Belt	,,
2	3½	1,360	Shafting	Belt	,,
1	3	1,360	7ft. radial drill	Worm gear	,,
1	2	Variable	Lathe	Belt	Resistance in rotor.

erecting shop, and are loaded nearly to their rated capacity. In addition to the above there are three motors, 6 h.p., 4½ h.p., and 1 h.p., used on a five-ton three-motor crane. The reduction of speed is obtained by worm gearing running in an oil bath. This gearing is most carefully cut, the thrust of the worm being taken up by ball bearings. The 6-h.p. and 1-h.p. motors are mounted on the crab and have only one speed, being switched in and out of circuit without the use of any starting device. The lifting and transverse motions are limited to one speed. The 4½-h.p. motor gives the longitudinal motion, and has two speeds: full speed and half speed. The higher speed is obtained by halving the number of stator poles, this operation being performed by a throw-over switch. The starting and reversing is done by a second throw-over switch. For cranes above five tons the lifting and longitudinal motors are equipped with a starting device, connected to the rotor through slide rings. Such an arrangement has not the peculiar property of the series-wound continuous-current motor, of self-regulation of speed in accordance with the weight being lifted; but this is the only advantage that the continuous-current motor has over the three-phase machine. This, I think, is fully compensated for by the less delicate and complicated equipment the latter requires. The three-phase motor will stand a heavy overload or sudden reverse without fear of damage. Usually the lifting motor is designed for a maximum speed at heaviest load. This speed cannot be increased for lighter loads, but can be regulated at will under such a limit.

The Liverpool Grain Storage and Transit Company, Limited, have adopted a three-phase plant for their storage warehouse at Bootle. It has been running some 15 months, and there are at present nine motors giving a total of 150 h.p. The generator has an output of 165 h.p., and is coupled direct to a Belliss engine. They have no reserve generator, and do not stock any spare parts for either generator or motors. An extension of this plant is now in progress, consisting of two 48-h.p. and one 60-h.p. motor. This installation furnishes an example where lighting and power are taken from the same mains. There are about 200 lamps, which are connected across two phases; the lamps being arranged so that the current is distributed equally over the three circuits, so as to maintain the balance of the system. Another method of combining lighting and power on a three-phase system is to run a fourth wire from the common junction, if the star connection be used. The lamps are connected between this fourth wire and any one of the three main cables, thus doing away with the necessity for balancing the three circuits.

For mining work the multiphase system is specially adapted, and already a considerable amount of work has been done in this direction. The General Electric Company, Limited, have recently sent out from their Manchester works some three-phase plant for several South African mines, particulars of which may interest you. The largest of these plants was one sent to the Vogelstruis Mine. The generating plant consists of two 150-kw. three-phase generators. They are belt-driven at a speed of 300 revolutions per minute, with a frequency of 30 cycles and a pressure of 950 volts. Three triplex single-acting pumps, with plungers 6½in. by 8in., coupled direct by means of single-reduction gear to 35-h.p. motors.

(To be continued.)

ABERDEEN ELECTRIC LIGHTING.

The following is an abstract of Prof. A. B. W. Kennedy's report on the west end extension tramway traction and the dust destructors, for which we are indebted to the *Aberdeen Journal*:

Prof. Kennedy, consulting electrical engineer for Aberdeen, has, as requested, furnished the Town Council with notes on the joint report by Mr. Smith and Mr. Blackman on the proposed extensions of the electric lighting system to the west end and other points. The professor thinks the proposed extension a wise policy, and one that will add materially and profitably to the income of the undertaking. He is in agreement with the engineers that it is advisable as far as possible to supply current
for all purposes in Aberdeen from one station. He also
with them that it would be better to adopt a high-
continuous-current system of feeders, with rotary transfo
than to use low-tension feeders working at so small a
density as 500 amperes per square inch. There are other me
however—such as the transformer and booster systems—by
the work could be carried out, and these he considers in
detail. His conclusion is that if the increased plant at the
station will give a pressure of 550 volts so as to put at d
an available drop of 110 volts, the delivery of the 400
consumers at the west end would require two pairs of cable
having an area of 0·67 square inch, and all that the Corp
would have to provide would be these cables, without any
apparatus either inside or outside the station. In worki
station, they would simply have to arrange that one of the
voltage machines should always be working on the we
feeder. The cost of this arrangement would be £5,750. W
it would be best for Aberdeen to adopt the simple feeder
with the drop of 110 volts, or to adopt the booster system
depend upon the time at which they expect to be able to
current to the west end and the rate at which they expe
demand to come on. As to these points the resident en
must speak. But the professor advises the Council most dis
that he should prefer either of these arrangements to the
with 2,000 volts, as he believes it would be not only consid
less in capital cost, but also more efficient in transmission.

Passing to the question of electric traction, Prof. Kenned
he cannot, of course, in the absence of detailed informat
into any figures about this, but he says, in general, that
Corporation decide to work the tramcars electrically there
reason why the current for this purpose should not be se
from Cotton-street and supplied by machines (probably li
one which has just been ordered), which should also be
for electric lighting.

As to the question of a dust destructor, the professor
has been again to Oldham since visiting Aberdeen, and
from that place the very latest results, the general na
which he indicated to the committee. The amount of
available per cell has been considerably increased from
was to begin with, and the station is now getting som
considerably more than merely nominal help from the dest
He has made several enquiries as to the cost of a des
suitable to Aberdeen. The makers consider that it wo
better to leave the 20,000 tons of market refuse alone,
attempt to burn it. He supposes it has a certain value or
manurial purposes—that it might probably rather decrea
increase the output of the cells. But if the Corporation
put up a destructor to deal with the combustion of about
tons of house and shop refuse per annum, this destructo
cost about £16,000, and might give steam enough for from 3
to 400 h.p. net under reasonably favourable conditions
however, the destructor could not always be at work, it w
necessary to spend additional capital in spare boilers, whic
be fired in the ordinary way, and which would be used w
destructor was not at work. The total capital expendit
therefore somewhat large. How far 300 h.p. or 400 h.p. w
in working the tramways, he is not at present in a position
but it is certainly an amount of power which would
valuable, and the fact that in the case of tramways th
would be wanted all day long, which is just the conditio
suitable for the destructor, is an additional point of advanta
the Corporation decide on the erection of a destructor, he
they would do well to consider whether it could not pos
placed so near the present station in Cotton-street that
from it could be taken to the engines there. Even if the
land were a little higher, it might well be balanced by e
in other matters.

Toronto Electricity Works.—These works hav
rebuilt after the destructive fire which took place
beginning of 1897, and the new arrangements ar
described in the current issue of the *Canadian E*
In order to avoid a recurrence of the fire the new b
consists entirely of iron, brick, and stone. There i
lutely no wood used in any part. We are surprised
however, that belt driving has been retained in t
equipment, and that in some cases a countershaft
used. The arc light switchboard, which extends acr
end of the building, is somewhat unique in both its m
and construction. It is built of pressed brick, with
cotta facings. The terminals of the circuits are m
on glazed tiles let into the face of the work. A
meters for each circuit are also mounted on other
tiles, and are large enough to be seen from any part
building. It is not necessary for the attendants t
the switchboard, but they can see the state of the
circuits at any time and wherever they may happen
The coaling arrangements are good, and will ensur
works' costs. The engineer of the station, Mr. J. J.
claims that he is now producing power at a cheap
than that at which it can be transmitted to Toront
Niagara.

NORTHAMPTON INSTITUTE.

›fficial opening and inspection of the above-named institute ace on the 18th inst., when the Lord Mayor, the Lady es, and the sheriffs paid a visit in state. A large crowd ly waited for over an hour outside the building, and were rewarded by the sight of feathers and gowns, uniforms, earer, sword bearer, etc., to say nothing of the gold-laced ›. The 21st Middlesex Rifles formed the guard of honour porch, and presented arms as the procession, headed by y Marshal resplendent in scarlet and gold, passed them ›und its way up the centre aisle of the densely packed here those waiting had been entertained with an organ by Mr. H. Davan Wetton. The guests on the daïs sed, besides the Lord Mayor, the Lady Mayoress, Mr. Green, Mrs. Green, the Misses Davies, Sir Philip Magnus, agnus, Lord Alwyne Compton, M.P., Sir Henry Longley, , Sir A. K. Rollit, M.P., E. W. Mountford, Esq., the t, and W. Wallis, Esq., contractor of the building, and asters and Wardens of the Skinners' and Saddlers' nies.

members of the governing body and the heads of depart- having been presented to the Lord Mayor,

Charles Dorman, chairman of the governing body, ed the Lord Mayor, and requested him to declare the e open. He said the scheme of the Charity Commission which the City Polytechnic was founded was dated Jan. 23, nd in it provision was made for the affiliation of two existing tions—the Birkbeck Institution in Bream's-buildings and ty of London College in White-street, Moorfields, with a stitute to be built in Clerkenwell on land generously given late Marquis of Northampton and by his son, the present is—hence the name of the Northampton Institute. The provided that members of any one of these institutes shall med to be members of the City Polytechnic, and entitled to nefits and privileges belong to any of the institutes. The ing $1\frac{1}{2}$ acres, a special Act of Parliament had to be passed the gift could be made. There were now 7,000 members in st-named two institutions, their own membership being After describing the building with its lecture halls, work- laboratories, swimming-baths, gymnasium, and recreation he said that gifts of books and engravings would be able. A statement which was greeted with long-lasting se was that he hoped the Charity Commission would see ay to allow smoking in the building. [As the social side of stitution is so accentuated, it seems almost incredible that striction should exist.] The building had cost £80,000 so d it would take another £10,000 to £15,000 to complete it. ound was valued at £25,000 to £35,000. Owing to the low f consols at the time of the investiture of the funds they en enabled to increase the educational building by an storey. Their income was £10,000 a year, of which orshipful Company of Skinners contributed £1,000, the pful Company of Saddlers £500, £4,500 was derived from y Parochial Trustees, £2,400 from the Technical Education and the rest from fees.

Lord Mayor, in his reply, dwelt upon the time when he prenticed not a stone's throw from where the building He contrasted the old times with the present, when now stitutions were open to those willing to profit by them. ly declared the building open "free and for ever." (The as perhaps not strictly correct, as the institution is not is not always open—it being closed on Sundays. How- are informed that an apprentice can enjoy the privileges stitution for eight months for the modest sum of 1s. 3d. Sundays—as long as the public-house is open—the reading a place like this should certainly also remain open.)

hief Charity Commissioner (Sir Henry Longley, K.C.B.), g a vote of thanks to the Lord Mayor and the Lady s, said the completion of the building marked the end of k planned out and begun 15 years ago. The institution efited by the accumulation of funds, the experience of stitutes, and the advances made in appliances, building, etc.

L. M. Beachcroft, in seconding the vote of thanks, praised guilds for the interest they took in secondary education, l that the Clothworkers' Company devoted one-half of their income of £40,000 to that purpose.

Alwyne Compton, M.P. (in the absence of his brother, quis of Northampton, who is abroad at present), supported s of thanks in an earnest and short speech, which elicited t marked applause of the evening.

Lord Mayor briefly acknowledged the vote of thanks, and ised the necessity of commercial education and the study gn languages.

Lord Mayor and party and the specially invited guests spected the buildings, after which light refreshments were We hope to describe the electrical laboratory in this e at an early date. This, and all the outfit of the s, has been selected and laid down under the supervision R. Mullineux Walmsley.

M.—The electrical engineer's report to the Council states ring February the income was £664. 6s. 7d., which was se on the amount reported in February of last year. The of lamps now put on is nearly 16,000, and 1,420 are about lded. Charles-street and Bridge-street are to be lit by ty.

COMPANIES' MEETINGS AND REPORTS.

SHEFFIELD ELECTRIC LIGHT AND POWER COMPANY, LIMITED.

Directors: Mr. George Franklin, J.P., Broomfield, Sheffield, chairman; Mr. Joseph Gamble, Southbourne, Sheffield; Mr. William Samuel Laycock, J.P., Oakbrook, Sheffield; Mr. George Senior, J P., Elmfield, Sheffield; Mr. William Tasker, 1 Parker's-road, Sheffield. Manager and secretary: Mr. William Johnson, M.I.M E.

Report of the directors submitted to the seventh ordinary general meeting of shareholders held on March 21, 1898:

The accounts, made up to Dec. 31 last, which are presented herewith, show the balance of profit as follows:

	£	s.	d.
Balance from last account	99	12	$11\frac{1}{2}$
Net profit for the year	11,392	16	8
	11,492	9	8
From which must be deducted:			
Interest on debentures	1,125	0	0
Leaving a balance of	10,367	9	8
The directors recommend the payment of a dividend after the rate of $12\frac{1}{2}$ per cent. per annum, free of income tax, which will absorb	9,464	11	8
Leaving a balance to be carried forward	902	18	0

The issue of shares, referred to in the last annual report, was wholly taken up, and realised a premium of £3,792, which the directors have applied as follows:

Costs of increasing capital of company written off	£200	3	0
Depreciation fund account	1,903	3	1
Reserve fund account	1,688	13	11
	£3,792	0	0

The depreciation fund account now stands at £6,642. 13s. 1d., and the reserve fund £2,970. 3s. 8d. The whole of the machinery and plant of the Company is in excellent order and condition. Notwithstanding the reduction in the price of current from 6d. to 5d. per Board of Trade unit, which took place on Jan. 1, 1897, the directors are glad to report that their anticipations of the increased demand following upon the reduction have been fully justified. The following statement shows the revenue that has been derived from the sale of the current during the five completed years of the Company's operations: 1893, £3,555. 11s.; 1894, £4,849. 9s. 4d.; 1895, £6,935. 4s. 1d; 1896, £11 257. 15s. 4d.; 1897, £14,318. 17s. During the past year a sum of £19 980. 1s. 11d. has been expended upon machinery, mains, and other appliances, which is about £1,600 more than the amount expended upon similar items during the preceding year. The offices and showrooms in course of construction in Commercial-street are now approaching completion. In consequence of the difficulty in obtaining new machinery from English manufacturers, owing to the dispute in the engineering trades, the directors, in July last, in the interest of the then existing consumers, notified their inability to accept new customers for attachment before Christmas, 1897. Happily, the difficulties are now removed, and new machinery has recently been laid down having a distributing capacity of 450 kw., and further orders have been placed representing a distributing capacity of 1,200 kw. The directors retiring by rotation under the Company's articles are Mr. Joseph Gamble and Mr. William Samuel Laycock, who, being eligible, offer themselves for re-election. The Company's auditors, Messrs. T. G. Shuttleworth and Son, also retire at this meeting, and are also eligible for re-election.

The secretary had been empowered by the directors to issue the following circular to the shareholders in view of the sale of the Company's undertaking to the Sheffield Corporation:

Gentlemen,—I am desired by my directors to place before you the following facts in connection with the proposed sale of the Company's undertaking to the Corporation of Sheffield. The Company's provisional order, which received the Royal assent on June 27, 1892, expressly stipulates that the Company, on receipt of a notice from the local authority requiring them to sell their undertaking, shall sell the same upon the terms of the Corporation issuing or transferring to the undertakers such an amount of Sheffield Corporation stock as will produce by the interest or dividends thereon an annuity of 5 per cent. per annum upon the sum properly expended by the Company upon the undertaking, and chargeable to capital account, with a further provision that if the local authority exercise the power before the expiration of 10 years from the commencement of this order, the local authority shall, in addition to the said stock, pay to the undertakers a sum equal to the aggregate amount of a dividend of 5 per cent. per annum on the said capital expenditure less the aggregate amount of the dividends declared by the undertakers from the date or dates of such expenditure to the date of purchase. On March 15, 1897, the Corporation served a notice requiring the Company to sell its undertaking under the terms of Section 60 quoted above, upon which the Company, acting under competent advice, made objection that the annuity of 5 per cent. required by the order could only be satisfied by the issue of irredeemable stock, and that the Corporation had no power to issue such stock. The Corporation disregarded this objection, and on June 15, 1897, issued a writ to compel the Company to sell its undertaking. In view of the fact that the Company was under obligation to sell,

negotiations were opened up with a committee of the Corporation, and it was agreed that as the Corporation's power to issue irredeemable stock was doubtful, the sum of £220 of 2½ per cent. redeemable stock should be considered the equivalent of the annuity of 5 per cent. admitted to be payable. An agreement was drawn up and practically approved by which the Corporation would take over the Company's undertaking from May 31, 1897, the amount expended upon capital account having been ascertained to be £104,427. On July 5, 1897, the Parliamentary Committee of the Corporation passed a resolution breaking off the negotiations until a legal decision should be given in the action which they had already commenced. On Dec. 7, 1897, Mr. Justice North gave his decision in the Corporation's action in favour of the Company, dismissing the action with costs, to be paid by the Corporation. On Dec. 15, in response to a request from the Corporation to reopen negotiations, the Company intimated that they were prepared to consider terms for a transfer of the undertaking upon the basis of the capital expenditure being ascertained as on Dec. 31, 1897. On Jan. 13, 1898, the Corporation made an offer of £220 Sheffield Corporation redeemable stock for every £100 of the capital properly expended by the Company on their undertaking and chargeable to capital account, the sale to take effect from Sept. 29, 1897, and the capital expenditure to be limited to £112,000, any expenditure beyond that amount to be repaid with 5 per cent. interest only. Upon this offer the directors, through the Company's solicitors, Messrs. Broomhead, Wightman, and Moore, entered into negotiations with a committee of the Corporation, and, subject to the approval of the shareholders, the directors propose to transfer to the Corporation the whole of the Company's undertaking and property.

The following are the main features of the terms provisionally agreed upon: (1) The capital expenditure to Dec. 31, 1897, is agreed at £124 472. 7s. 5d.; (2) the Corporation are to transfer to the Company £220 2½ per cent. redeemable Sheffield Corporation stock for each £100 of the capital properly expended by the Company up to a total of £118,500 (with an option to the Company to require £213. 8s. in cash for each £220 of stock, and the sum of £5,972 7s. 5d., being the balance of the capital expenditure, is to be repaid to the Company with 5 per cent. interest from date of payment; (3) the Corporation are to pay such a sum as, with the dividends declared by the Company, will be equal to an aggregate dividend of 5 per cent. per annum on the total capital expenditure from the date or dates of such expenditure to Dec 31, 1897; (4) the Corporation take over the book debts, stock, and stores of the Company, paying the proper value thereof; (5) the Corporation require further parliamentary powers to carry out the agreement and as from Dec 31, 1897, until completion of the sale the Company is to be entitled to a dividend after the rate of 10 per cent. per annum upon their paid-up capital.

The sealed agreement will be laid before the shareholders at the extraordinary meeting convened for the 21st inst. The directors, however, have given careful consideration to the matter, and believe that the terms are fair and equitable, and in accord with the spirit of the provisional order under which the Company obtained its powers, and they therefore recommend the confirmation of the agreement.

At the meeting of the shareholders, and which was held at the Cutlers' Hall on the 21st inst., Alderman G. Franklin (Lord Mayor, and chairman of the Company) presiding, the above report was carried unanimously.

DOVER ELECTRICITY SUPPLY COMPANY, LIMITED

Directors: Sir W. H. Crundall, J.P., chairman; C. W. Bagshawe, J.P.; R. Percy Sellon, M.I.E.E.; B. H. Van Tromp. Consulting engineer: A. J. Lawson, M.I.E.E.

Report of the directors presented at the fourth annual general meeting of shareholders held at Dover on March 9:

The capital expended during the year amounted to £11,932. 7s. 9d.; making the total to Dec. 31 last £62,836. 7s. 9d. Of the amount thus expended £7,915. 0s. 3d. was for additional generating plant necessary for the supply of current to the cars of the Dover Corporation tramways, the running of which, commenced in September last, has given great satisfaction to all concerned, and it is not unlikely that the present service may be increased, additional cars having lately been ordered. In the early part of the year it was decided to issue £25,000 4½ per cent. debenture stock, and the whole was subscribed for at a considerable premium, of which the balance, amounting to £761. 2s. 6d., after payment of all legal and other charges in connection with the issue, has been applied to reduction of the previous debits to revenue account. Your directors consider the result of the year's working very satisfactory, since, instead of a loss of £455. 19s. 11d. as in the previous year, there has been a gross profit of £1,127. 17s. 5d. on revenue account. The Company may now be considered as fairly established on a profit-earning basis, and your directors believe that in future years the annual increments in gross profits will at least equal, if not exceed, those for the year just ended, as during the construction and after the completion of the national harbour at Dover the trade of the town will largely increase to the benefit of all its present established undertakings. During the year applications have been received for the equivalent of 2,748 8-c.p. lamps, including nine additional arc lamps for street-lighting (of which there are now 40 in all), making the total applied for on Dec. 31 last 10,376, and of these 10,137 were then connected to the Company's mains. With the view of inducing an increased average daily use of electricity by householders, your directors decided to adopt, as from July 1 last, the demand indicator system of charging, and to reduce the cost of current after the first two hours' dail[y con]sumption from 5d. to 3½d. per unit. This system has been [intro]duced in Brighton and many other towns, where it has [given] general satisfaction; and your directors believe that as its [advan]tages become more generally known, both consumers a[nd the] Company will correspondingly benefit. The retiring direct[ors,] Mr. C. W. Bagshawe and Mr. R. Percy Sellon, who, being el[igible,] offer themselves for re-election. The auditor, Mr. R. H. [...] chartered accountant, also retires, and is eligible for re-elect[ion].

REVENUE ACCOUNT, YEAR ENDED DEC. 31, 1897.

Dr.	£	s.	d.	£
Generation of Electricity.				
Fuel	£1,631	4	2	
Oil, waste, and stores	93	8	9	
Water	9	0	0	
Superintendence	51	10	4	
Engineers' salaries	248	9	8	
Wages	513	4	9	
Repairs: buildings, £18. 14s. 2d.; boilers and heaters, £41. 8s. 5d.; engines and condensers, £165. 2s. 6d.; alternators and exciters, £17. 15s. 11d.; electrical instruments, £9. 19s. 1d.; tools and other machinery, £1. 17s. 2d.; traction plant, £4. 7s. 4d.	258	14	7	
Station lighting	7	15	5	
Works sundry charges	57	15	0	
Engineers' office expenses	3	6	4	2,874
Distribution of Electricity.				
Superintendence	43	6	8	
Engineers' salaries	58	6	8	
Wages	34	11	4	
Repairs: mains and street work, £11. 17s. 9d.; transformers and transformer stations, £50. 6s. 11d.; apparatus on consumers' premises, £58. 6s. 1d.	120	10	9	25[illegible]
Public Lamps.				
Trimming	54	12	0	
Repairs	59	17	10	
Carbons	57	19	1	17[illegible]
Rents, Rates, and Taxes.				
Rents	2	12	7	
Rates, etc.	112	7	2	11[illegible]
Management Expenses.				
Directors' fees and expenses	51	6	5	
Salaries, head office	270	3	4	
Stationery	38	9	0	
Advertising	41	0	3	
Postage	16	1	6	
Travelling	19	11	5	
Office expenses	77	2	9	
Sundry charges	67	1	4	
Board of Trade auditors	19	0	0	
Shareholders' auditor	21	0	0	62[illegible]
Law charges				1[illegible]
Insurance				1[illegible]
Balance to net revenue account				1,17[illegible]
				£5,24[illegible]

Cr.	£
Sale of current by meter and otherwise	3 96[illegible]
Public lighting	1,09[illegible]
Meter rentals	11[illegible]
Transfer and registration fees	[illegible]
Sundry trading	[illegible]
Pupils' premiums	[illegible]
	£5,24[illegible]

GENERAL BALANCE-SHEET, DEC. 31, 1897.

Dr.	£
Capital account—Share capital issued	24,30[illegible]
4½ per cent. debentures	25,00[illegible]
Sundry creditors—County of London and Brush Provincial Electric Lighting Company, Limited, advances, £17,000; general, £4,278. 2s. 9d.	21,27[illegible]
	£70,57[illegible]

Cr.	£
Capital account	62,83[illegible]
Stores: coal, £211. 18s. 1d.; oil and waste, £27. 11s. 5d.; general, £469. 13s. 5d.	70[illegible]
Sundry debtors for current supplied, £2,048. 7s.; general, £194. 1s. 4d.	2,24[illegible]
Preliminary expenses	63[illegible]
Cash at bank and in hand	41[illegible]
Balance from net revenue, £4,486. 10s. 1d.; less debenture issue premiums after legal charges, £761. 2s. 6d.	3,72[illegible]
	£70,57[illegible]

:NT OF ELECTRICITY GENERATED, SOLD, ETC., YEAR ENDED DEC. 31, 1897.

;enerated in B.T. units		317,190
›old — Public lamps	78,624	234,074
Traction	27,116	
By contract	4,279	
Private consumers by meter	124,055	
ɪsed on works		9,037
ɪtity accounted for		243,111
ɪot accounted for		74,079
f public lamps		40

ɪaximum supply demanded for lighting, 183 kw.; ditto n, 105 kw.

ɪ ELECTRICITY SUPPLY COMPANY, LIMITED.

ɪual general meeting of the above-named Company was ɪe 17th inst. at the office, Cadogan-gardens.

:rving Courtenay, who presided, said that only since the lid the £60,000 ordinary share capital subscribed in 1896 ɪ the ordinary capital previously subscribed, but the ɪ the business enabled them to show a profit which would ; per cent. being paid on the ordinary shares, as com- h 5 per cent. on the smaller capital of previous years, forward £1,652 to meet contingencies. They had added ; security to their property in the form of freehold land tantial buildings on this land to the extent of over ɪnd they had increased the plant, machinery, mains, and ' nearly £35,000. Their progress during the year had been ɪs and steady, and it really seemed as if an average of 00 to 18,000 lamps annually would continue to be added. ɪre making considerable extensions into the western f their district, and a sub-station was being built for this n that quarter. The new sub-station in Pavilion-road ɔped sufficiently to deal with the maximum demand ever arise in its neighbourhood. About 9¼ miles of casing, f accommodating 36 miles of conductor, and containing ɪt present about 16½ miles of conductor, had been laid he year. Their total number of lamps now exceeded With regard to their Bill in Parliament for the com- ɔurchase of property in Chelsea, he thought that they ɪve the same facilities and equal protection with railways ays and other public companies having statutory obliga- satisfactory increase was shown in the revenue account. ɔroviding for the maintenance of plant and buildings, placed £2,000 out of profits to the renewals fund, and derably strengthened the position of the Company by the premiums to the extent of £20,851 to the reserve ɪing the total of that fund £36,717.

General Webber seconded the motion, which was ɪsly adopted.

LONDON ELECTRIC SUPPLY CORPORATION, LIMITED.

rs: George Ellis, Esq., J.P., chairman; Captain E. Iron- managing director; Bennett Fitch, Esq., M.I.C.E.; ɪippe, Esq.; Algernon Turnor, Esq., C.B. Secretary: . Webster, Esq. Engineers: Messrs. Kincaid, Waller, ·ille.

of the directors and balance-sheet presented to the ordi- ɪral meeting of shareholders held at Winchester House, l-street, E.C., on 21st inst.:

ing their first report to the shareholders, the Board are ɔ be able to state that the works of the Corporation are g in a satisfactory manner. The first subject which he Board's attention was that of obtaining a suitable site ɪtral station and dust destructor, which, by virtue of an t with the Vestry, had to be approved by that authority. ɪented much difficulty, and caused unavoidable delay. ɪvenience was, however, fully compensated for by the acquisition of the most favourable site for the purposes ɔrporation within the parish of Lambeth. The land is and consists of three acres on the north-west side of the Chatham, and Dover Railway between Loughborough and Denmark Hill Stations. Possession was obtained at ɪas, 1897, when the contractors, Messrs. Manlove, Alliott, Limited, were instructed to proceed with the erection of ɪary buildings and dust destructor. Arrangements have le by which current is being obtained from a neighbour- ric supply company pending the completion of the central and thus the nucleus of a promising business is being

About 2½ months have elapsed since a portion of the ɪre made available for a supply of current. The total of 8-c.p. lamps for which energy has already been applied ɪnts to 2,659. The directors are pleased to report that the the issue of share capital offered last March, amounting 00, has been subscribed. This places the Corporation in financial position, and obviates the necessity of curtailing ɪcts which at one time appeared inevitable. The action ɔard in placing the balance of the original issue which applied for when the Corporation was brought out, has ɪwhat criticised. The directors are satisfied that they the best interests of the Corporation, and are confident ɪn will be supported by the general body of the shareholders. ɪt a time has elapsed since the commencement of opera- l no electric supply had been made up to the end of 1897, ɪnts merely take the form of a balance-sheet to Dec. 31 the position of the Company at that date. Mains already laid are shown on maps which can be seen at the Corporation's offices, and amount in all to 21 miles laid in about eight miles of streets. The necessary machinery and plant is being constructed as rapidly as possible. The directors appointed Messrs. Price, Waterhouse, and Co. to be the first auditors of the Corporation. These gentlemen now offer themselves for re-election.

Dr. BALANCE SHEET, DEC. 31, 1897.				£	s.	d.
Share capital—authorised 65,000 shares of £5 each				325,000	0	0
Issued 55,841 shares of £5 each, £2 each paid				111,682	0	0
Add calls paid in advance				1,874	0	0
				113,556	0	0
Deposit from contractors on account of repaving the streets				100	0	0
Sundry creditors				126	3	4
				£113,782	3	4

Cr.				£	s.	d.
Capital expenditure—viz., cost of acquisition of provisional order, including cost of subscription of capital, brokerage and other expenses, under contract of March 19, 1897				46,649	0	0
Law costs of Lambeth Vestry				1,000	0	0
				47,649	0	0
Freehold land, including proportion of administration expenses considered chargeable to capital expenditure	£9,715	1	0			
Expenditure to date on buildings, ditto	5,067	3	8			
				14,782	4	8
Ditto on machinery, ditto				5,463	15	7
Ditto on mains, ditto				11,288	2	7
Engineer on account				500	0	0
				79,683	2	10
Furniture and fittings				97	9	7
Stock of meters				38	8	0
Sundry debtors				189	19	3
Deposit with Vestry as guarantee for completion of works	5,000	0	0			
Ditto for repaving streets	100	0	0			
				5,100	0	0
Cash at bankers and in hand				27,766	18	9
Sundry administration and other expenses—						
Preliminary expenses relating to capital after issue	236	13	5			
Proportion of directors' fees	300	0	0			
Salaries, printing and stationery, law charges against revenue, office expenses, advertising, and general establishment charges	476	14	5			
Rent of offices and of a shed at Brixton	65	16	9			
	1,079	4	7			
Less receipts—transfer fees and shareholders' lists sold, £40. 12s. 6d.; mains leased at a rental, £20; interest and discount, £97. 7s. 2d.; sale of turf, £15	172	19	8			
				906	4	11
				£113,782	3	4

The ordinary general meeting of the Corporation was held on Monday last at Winchester House, E.C., Mr. George Ellis, J.P., the chairman, presiding.

After the notice convening the meeting had been read, the **Chairman** proposed the adoption of the report given above. He referred to the steady progress being made with the works, and to the power site which had been obtained. He remarked that it had been stated that no dividend could be paid till the cost of the order and expenses, amounting to £47,000, had been paid off. This was not true; the expenditure could be placed to a suspense account. No doubt some might think that £47,000 was a large sum for the order and the expenses. On the face of it, in the present position, he admitted it did seem large, but it was not so in fact. The Board of Trade had insisted upon the capital being underwritten to the extent of £200,000 before they would let the Company have the order, and that in itself, with the brokerage, absorbed £24,000 of the amount. He compared the expenditure with that of two other large companies in London—namely, the Westminster and the St. James's Companies—and said that the Lambeth order had not cost them one-half of what the above had cost, because in one case they had had to redeem their founders shares at a cost of £120,000, and in the other case at £150,000, whereas £47,000 is the absolute cost to the shareholders of their order. He then gave full details of the allotment of the balance of the shares to Mr. J. Atherton, on which subject fault had been found with the directors.

Mr. Brooke-Hitchin seconded the motion.

Mr. A. Brooke then moved the following amendment: "That the report be received but not adopted, and that a committee of five shareholders bo appointed, with power to add to their number, to enquire into the formation and past management of the Company, and the relations between the Board and the promoter, and with power to call for books and documents, and to obtain such

legal and professional assistance as may be necessary, such committee to report to a meeting to be called for Monday, April 18, 1898." He contended that the affairs of the Company, particularly with reference to the allotment of the shares to which the chairman had alluded, had been managed, not in the interests of the shareholders, but for the substantial benefit of Mr. Atherton.

Mr. Wheelock, who, in reply to a question, said he held 10 shares, seconded the amendment, maintaining that his criticism of the conduct of the Company was amply justified by the circumstances.

After some discussion the amendment was negatived, only four votes being recorded in its favour, and the report and accounts were adopted.

Messrs. Price, Waterhouse, and Co. were re-elected auditors, and at an extraordinary general meeting subsequently held a formal alteration was made in the articles of association.

We are indebted to the *Financial Times* for the above report.

CENTRAL LONDON RAILWAY COMPANY.

A special meeting of the shareholders in this Company was held on the 19th inst. at the offices, 16, Great George-street, Westminster, for the purpose of increasing the number of directors to six, and appointing Sir Henry Oakley (late general manager of the Great Northern Railway) chairman and a director of the Central London.

Mr. Henry Tennant presided, and after speaking in very eulogistic terms of Sir Henry Oakley, proposed: "That the number of directors be increased to six, and that Sir Henry Oakley be, and he is, hereby appointed a director of the Company."

Lord Colvil e of Culross seconded the proposition.

A **Shareholder** asked whether the addition of Sir Henry to the Board would increase the remuneration of the directors, which was a very important item in the future success of this undertaking.

The **Chairman**, in reply, said the directors' fees would be the same as originally settled, but they could not expect six gentlemen to give their attention to the affairs of the Company for the same remuneration that five received. The directors' fees were £3,500, but the addition would, however, be very small.

The motion was then unanimously agreed to.

A vote of thanks having been accorded the chairman for his past services, and regret expressed at his retirement, the meeting closed.

At a subsequent meeting of the Board, Sir Henry Oakley was, on the proposition of **Lord Rathmore**, seconded by **Lord Colville**, unanimously elected chairman of the Company.

METROPOLITAN ELECTRIC SUPPLY COMPANY, LIMITED.

Directors: Sir Eyre M. Shaw, K.C.B., chairman; Admiral of the Fleet Lord John Hay, G.C.B.; Sir James Pender, Bart, M P; W. Harrison Cripps, Esq; John Birkbeck Lubbock, Esq.; John Verity, Esq.; Frank Bailey, Esq., engineering director. Secretary: E. Cunliffe Owen, Esq, C.M.G. Acting engineer: A. H. Walton, Esq., A.M.I.C.E. Consulting engineers: Lord Kelvin, D.C.L., F.R.S.; Dr. John Hopkinson, F.R.S.

Report of the directors (with abstract of accounts) to be presented to the shareholders at the eleventh ordinary general meeting, to be held at Winchester House, Old Broad-street, E.C., on Tuesday, March 29, at 12 noon:

The capital expenditure, which at the end of 1896 amounted to £757,035. 13s 11d., has now reached a total of £850,831. 10s. 9d., the increase during the year having been £93,795. 16s. 10d. The principal items are mains and apparatus, and the purchase of a site for future extensions. The balance of capital in hand at the end of the year was £29,597. 18s. 10d. The gross revenue for the year amounted to £138,267. 14s 6d against £116,459. 4s. in 1896, being an increase of £21,808. 10s. 6d. The cost of generation, which in 1896 was £52,619. 4s. 9d., amounted in 1897 to £58,604. 5s. 4d., or an increase of £5,985. 0s. 7d. The balance to the credit of the revenue account, before providing for depreciation, is £58,721. 10s. The directors have set aside £15,000 as an addition to the depreciation account, carrying to the credit of the net revenue account the sum of £43 721. 10s., which, with the balance brought forward from last account and other receipts, makes a total of £46,947. 3s. 6d. After deducting debenture and share interest and other charges, there appears a balance of £22,989. 6s. 6d. An interim dividend of 5s. per share on the ordinary share capital was paid on Oct. 15, 1897, amounting to £12,475, and the directors recommend that a further dividend of 7s. per share on such shares be now paid, making a total distribution of 12s. per share for the year, or 6 per cent. on the capital. The dividend upon the new shares, being for six months only, will be 6s. per share, or one-half the total amount of dividend upon the original shares. This will absorb a further sum of £21,215, and leave a balance of £1,774. 6s. 6d. to be carried forward to the next account. The number of 8-c.p. lamps supplied by the Company increased during the year 1897 from 308 000 to 360 000. The present number of lamps connected is 374,000, and the applications show no signs of decrease. A report from the Company's engineering director is appended, showing that the satisfactory condition of the stations, machinery, and plant has been maintained. In accordance with the articles of association, the following directors—viz., Admiral of the Fleet Lord John Hay, G C.B., W. Harrison Cripps, Esq., and John Birkbeck Lubbock, Esq.—retire from the Board, and are eligible for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., also retire, and are eligible for re-election.

Report of Engineering Director.—I have pleasure in certifying that, subject to normal depreciation, the Company's stations, machinery, and plant are being maintained in an efficient [condi]tion, and have worked satisfactorily up to the present [date].—FRANK BAILEY, engineering director.

REVENUE ACCOUNT, YEAR ENDED DEC. 31, 1897.

Dr.				
Generation of Electricity.				£
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£34,294	1	8	
Oil, waste, water, and engine-room stores	4,575	17	1	
Salaries of engineers, superintendents, and officers	2,726	19	2	
Wages and allowances at generating stations	6,649	12	10	
Repairs and maintenance as follows: buildings, £736. 4s. 5d.; engines and boilers, £5,991. 18s. 11d.; dynamos and exciters, transformers, motors, etc., £1,114. 12s. 1d.; other machinery, instruments, and tools, £1,080. 13s. 10d.	8,923	9	3	
Purchase of current	1,434	5	4	
				58,60[illegible]
Distribution of Electricity.				
Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same	567	6	8	
Repairs, maintenance, and renewals of transformers, meters, and other apparatus on consumers' premises	1,278	2	8	
Royalties	—			
				1,84[illegible]
Rents, rates, and taxes				4,11[illegible]
Management Expenses.				
Directors' and trustees' remuneration	3,235	18	9	
Salaries of management, secretary, engineers, accountants, clerks, and messengers	5,158	6	8	
Wages of meter readers and wiring inspectors	454	10	0	
Stationery and printing	552	4	2	
General establishment charges	2,531	6	2	
Auditors—Board of Trade, £85; Company's, £157. 10s.	242	10	0	
				12,17[illegible]
Law and Parliamentary Charges.				
Law expenses	653	3	2	
Parliamentary charges	1,193	3	3	
				1,84[illegible]
Special charges—insurances				93[illegible]
Depreciation account				15,00[illegible]
Total expenditure				94,54[illegible]
Balance carried to net revenue account				43,72[illegible]
				£138,26[illegible]

Cr.	£
Sale of current	129 35[illegible]
Less provision for bad and doubtful debts	1,00[illegible]
	128,35[illegible]
Rental of meters and other apparatus	9,57[illegible]
	137 93[illegible]
Rents receivable	9[illegible]
Net proceeds of work done for and goods supplied to sundry consumers	7[illegible]
Surplus properties—rents and profits after deducting cost of repairs, rents, rates, taxes, and expenses of management	1[illegible]
	£138,2[illegible]

GENERAL BALANCE SHEET, DEC. 31, 1897.

Dr.	£
Capital account—amount received	880,4[illegible]
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc.	28,3[illegible]
Sundry creditors on open accounts	6,4[illegible]
Depreciation account	42,8[illegible]
Balance at credit of net revenue account	22,9[illegible]
	£981,0[illegible]

Cr.	£
Capital account—amount expended for works	850,8[illegible]
Stores on hand: coal, £470. 14s. 10d.; oils, waste, etc., £285. 19s. 11d.; general, £7,358. 9s. 11d	8,1[illegible]
Sundry debtors for amounts paid on account of contracts in course of completion	2,0[illegible]
Sundry debtors for current supplied	57 4[illegible]
Other debtors	1,6[illegible]
Suspense accounts waiting adjustment	1,7[illegible]
Deposits (provisional orders, vestries, etc.)	6[illegible]
Investments at cost	31,1[illegible]
Cash at bankers on deposit and current accounts	27,4[illegible]
	£981,0[illegible]

WILLANS AND ROBINSON, LIMITED.

rs: Mark Robinson, Esq., M.I.C.E. (chairman); Sir .. Clayton-East, Bart. (deputy-chairman); Captain H. key, R.E. (Ret.), M.I.C.E.; Lieut.-General Sir Richard y, K.C.B., R.E.; Thomas O. Lazenby, Esq., J.P.

half-yearly report of the directors, to be submitted at iary general of the Company to be held at the City Hotel, Cannon-street, E.C., on Wednesday, March 30, p.m.:

riting off as depreciation from plant, patents, etc., the ,277 8s. 4d., against £4,162. 11s. 2d. last half year, and terest upon debenture stock, the balance to the credit and loss account for the half-year (including £1,859. rought forward) is £16,053. 0s. 10d. Out of this the propose that dividends be paid at the full rate of 6 per annum upon the preference shares, and at 8 per cent. m upon the ordinary shares, together amounting to ls. 7d. The amount payable to the original directors, in e with the articles of association, is £1,832. 5s., leaving of £5,512. 18s. 3d. From this the directors propose to 000 to the debenture redemption fund, and £1,500 to the ind (against £1,000 last half-year), leaving a balance of 3s. 3d. to be carried forward. The directors feel that actory results of the half-year's trading, achieved under nces not altogether favourable, coupled with excellent for the future, justify them in recommending a moderate of dividend. In accordance with the announcement made t report, applications have been invited from the share- r the balance of the unissued shares—viz., 3,000 prefer- 3,000 ordinary shares. As required by the articles of n, two of the directors—viz., Mr. Robinson and Capt. retire, but are eligible, and offer themselves for re-elec- e auditors, Messrs. Cooper Bros. and Co., also retire, but le for re-election.

DIRECT SPANISH TELEGRAPH COMPANY.

ort of the directors of this Company for the year 1897, esented at the general meeting to be held in London nst., states that the accounts show, after providing for n and redemption of debentures, a balance to the credit of £12,975. After adding the usual sum of £5,000 to ve fund, the balance will amount to £7,975, and the recommend the declaration of dividends for the year per cent. on the preference shares and 4 per cent., free tax, on the ordinary shares, absorbing £5,486. The eipts show a decrease of £2,927 as compared with the , which was an exceptional one. The reserve fund now o £44,769. In commemoration of her Majesty's Diamond he directors have granted a bonus to all employés in the 's service.

TINGS AND ST. LEONARDS ELECTRIC LIGHT COMPANY.

nual meeting of the shareholders of this Company was he 15th inst. at the Queen's Hotel, Hastings, there being tendance. Mr. F. A. Langham (chairman of the Board) The report, in which the directors recommend a dividend ent., and which has already appeared in our columns, ed. The retiring directors, Messrs. Roddis and Ward, nimously re-elected. Mr. G. Hart was elected auditor in Mr. Tibbetts, deceased. A vote of thanks to the directors meeting.

NTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

(Spain).—Tenders are required for electric lighting of the pply to the Mayor of Zafra (Badajos), Spain.

uth.—Tenders are required for alterations to tramcars. itions apply Corporation Tramways Office, Plymouth.

(Belgium).—Tenders are invited for electric lighting of . For particulars apply to the Mayor of Ghent. Tenders h 30.

han.—Tenders will be called shortly for electric installa- light and power. Particulars may be obtained from the f the town

-under-Lyne.—The Corporation invite tenders for the g of premises in the borough. Tenders by April 5. For rs refer to our advertising columns.

stead.—The Vestry invite tenders for the supply, , and erection at their central station, Lithos-road, -road, of various plant. Tenders by March 31.

ria (Australia).—According to the *Victorian Contractors'* the Government will shortly advertise for tenders for electric light cables and fittings for the railway depart-

.—The Derby School Board are prepared to receive tenders ectric wiring of their Traffic-street Board School, Derby. by April 11. For particulars refer to our advertising

mond (France).—Tenders are invited for lighting the lectricity or otherwise. Particulars are to be obtained from, and tenders addressed to, Municipal Authorities at above place (Department Loire) by March 31.

Ipswich.—Tenders are invited for the supply of electric lighting, wiring, and plant, including the boiler and engine, for the Guardians of Ipswich Union. Applications to be sent in so as to be received by 29th inst. to Mr. A. G. Vulliamy, clerk, 6, Tower-street, Ipswich.

Madras.—The Secretary of State for India in Council announces that the time allowed for the receipt of tenders by the Chief Engineer for Irrigation, Madras for the utilisation of water power of the Periyar Lake has been extended from Oct. 31, 1897, to July 1, 1898.

Seraing (Belgium).—Tenders are invited for electric installation for public and private lighting and for power transmission for 30 years, to commence from Feb. 1 1899. Particulars are to be obtained from, and tenders addressed to, Municipal Authorities at Seraing, Belgium, by April 1.

Alexandria (Egypt).—Tenders are invited for indiarubber tubes, etc., for the Post and Telegraph Department. Specifications may be obtained from and samples inspected at, the Gabbary Stores, and tenders are to be addressed to the President of the Council of Administration, Cairo, by March 28.

Badajoz (Spain).—Tenders are required for the sole right of public lighting by electricity for 20 years. The deposit required is 700 pesetas (350 provisional). Particulars are to be obtained from, and tenders addressed to, the Local Government Administration Department, either at Madrid or Zafra. Tenders by March 29.

Derby.—Tenders are invited by the Corporation for electric wiring of their Ford-street yard and premises. Specifications, etc., may be obtained from the Engineer and Manager of the Electric Lighting Works, Sowter's-road, Derby, on prepayment of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders to be addressed to Mr. H. F. Gadsby by April 12.

Bournemouth.—Tenders are required for motor vehicles for the collection of house refuse, street scavenging, and conveyance of road materials. Specification, etc., accompanied by drawings, should be delivered at the office of Mr. F. W. Lacey, M.I.C.E., borough engineer and surveyor, Municipal Offices, Bournemouth, in a cover marked "Tender for Motor Vans," by April 4. Outline specification and form of tender can be obtained on application to the Borough Engineer's Office.

Darwen.—Tenders are invited by the Corporation for (A) quick-revolution steam-engines and dynamos; (B) steam and exhaust pipes, etc; (C) accumulators; (D) switchboards, balancing apparatus, etc.; (E) underground mains, etc; (F) arc lamps, pillars, etc. Conditions, etc., may be obtained at the offices of the Borough and Electrical Engineers, on payment of £2 per specification, or £5 for the entire set of specifications, which sum will be returned on receipt of a bona fide tender. Tenders by noon on March 28.

London, S.W.—The Secretary of State for War is prepared to receive offers in writing, accompanied by competitive designs and specifications for the supply of portable electric search-light apparatus. General particulars as to requirements can be obtained on application, either by letter or personally, to A. Major, director of army contracts, War Office, Pall-mall, S.W. The offers and designs must be delivered at the War Office, Pall-mall, London, S.W., by April 27, addressed to the Director of Army Contracts, and marked on the outside "Designs for Search-Light Apparatus."

Leyton.—The Council invite tenders for the supply and erection of (No. 1) two dynamos, one continuous-current balancing transformer; (2) two gas-engines and connections; (4) switchboards. Specifications to be obtained from Mr. H. Collings Bishop, the electrical engineer, Cathall-road, Leytonstone, on and after March 21, on payment of £2. 2s. for each copy, which sum will be refunded upon the receipt of a bona fide tender. Tenders, accompanied by a £10 Bank of England note to be enclosed with the tender and to be forfeited if the tender is withdrawn before the contract is signed, must be received at the Town Hall, Leyton, Essex, by April 4.

Victoria (Australia).—Tenders are invited by the Council of the city of Hawthorn for the supply and erection, or for the supply only, of: (Section A) buildings only; (B) boilers, water-heater, pumps; (C) engines, dynamos, switchboard, mains, sub-mains, transformers, meters, arc lamps, insulators, testing instruments; (D) supply of poles and their erection; running of the plant for three years. Specifications and forms of tender can be obtained at the office of the Agent-General for Victoria, Lieut.-General Sir Andrew Clarke, G.C.C.M., Victoria Office, 15, Victoria-street, Westminster, London, S.W., on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Tender for Electric Lighting," and addressed to the Mayor of Hawthorn, Victoria, Australia, on June 24, at 5 p.m.

RESULTS OF TENDERS.

London, S.E.—The tender of the Private Wire and Telephone Installation Company, for telephones in Guy's Hospital, has been accepted.

West Ham.—We are informed that Messrs. Allingham and Fennell's tender of £1,139. 15s. for the wiring of the public buildings on the "Nomorfyre" system is under consideration.

Wimbledon.—Messrs. Henley's tender, corrected from £15,792 to £15,000, has been sealed by the Council. *Re* Mr. Burgess's tender of £3,386 and that of Messrs. Minter at £2,990, the resolution in favour of acceptance of the former has been rescinded.

Huddersfield.—The County Borough Council have accepted the tender of Messrs. Siemens Bros. and Co., Limited, for the supply of two sets of generating plant—Siemens alternators with McLaren engines—at the price of £13 054, the first set to be delivered in eight months from the receipt of the order.

Glasgow.—The following offers have been accepted by the Corporation: (1) the offer by Messrs. Laing, Wharton, and Down, for one engine and dynamo of 700 h.p. at the price of £5,064; (2) the offer by Messrs. Mirrlees, Watson, and Yaryan Company, Limited, for one engine and dynamo of 400 h.p. at the price of £1,970; (3) the offer by Messrs. Mavor and Coulson for one engine and dynamo of 900 h.p. at the price of £5,775; and (4) the offer by Messrs. Mirrlees, Watson, and Yaryan Company, Limited, for one engine and dynamo of 200 h.p. at the price of £1,265.

West Derby.—Tenders have been accepted by the West Derby Board of Guardians for the following work in connection with the lighting of the Mill-road Infirmary: (Contract No. 1) Messrs. Fawcett, Preston, and Co., Liverpool, two dry-back return-tube boilers each to evaporate 4,000lb. of water per hour, £1,075; (2) Messrs. Scott, Anderson, and Beith, Sheffield, three 50-b.h.p. coupled engines and dynamos, one booster, two feed pumps, one feed-water heater, one switchboard, steam etc., piping, tanks, etc., £2 085; (3) Chloride Electrical Storage Syndicate, Manchester, one secondary battery of 900 ampere-hours capacity, £440; (4) Messrs. W. and J. Robinson, Bootle, wiring of infirmary, administrative buildings, and nurses' home, and cable connections from the main switchboard to above buildings, £1,411.

BUSINESS NOTES

Exeter.—The City Council have decided to borrow £7,000 for additional plant and cables.

Durham.—The erection of an electric lighting station is in contemplation by the gas company.

Brockie-Pell Arc Lamp, Limited.—The transfer books of this Company are now closed until April 4.

Aberdeen.—West Parish Church is to have the electric light, and half the initial expense of £160 is to be borne by the Kirk Session.

Bradford.—The City Council have appointed Mr. C. F. Spencer, of Walsall, manager for the Bolton-road and Great Horton electric trams.

Hammersmith.—At the last meeting of the Vestry the Electric Lighting Committee asked for a loan of £31,000 to extend the electric lighting works, and it was agreed to.

Eastern Telegraph Company, Limited.—The usual interim dividend of 2s. 6d. per share on the ordinary shares, free of tax, in respect of the quarter ended Dec. 31 is announced.

Willans and Robinson, Limited.—The general meeting of this Company will be held in London on the 30th inst. The report to be presented at the meeting will be found in another column.

Poplar.—A resolution to rescind the decision of the Board of Works to act at once upon its provisional order and supply electricity within their area has been defeated by two to one.

Maidenhead.—The report of the Electric Lighting Committee, amended to read that £75 be included in the estimates for the purpose of appointing a consulting engineer, has been carried.

Hampstead.—The Guardians have decided to ask a firm of electrical engineers to prepare plans and specifications for wiring the whole of the Hampstead Workhouse for the electric light.

Stirling.—The Police Commissioners have asked Mr. R. F. Yorke, electrical engineer, Stirling, to report on the water power available at their reservoirs for the electric supply of the town.

Removal.—We are informed that the offices of the syndicate making the Cowper Coles' parabolic reflectors have been removed from 2, Carteret-street to 39 Victoria-street, Westminster, S.W.

Swansea.—The committee are considering a report of Mr. Manville on the electric lighting of the borough, and a separate report from the borough surveyor on the dust destructor part of the question.

Ramsgate.—It was announced that the Board of Trade on Friday last confirmed the order authorising the construction of the Isle of Thanet light railway, but it appears that the statement was not correct.

Competition.—Prizes of an aggregate of £120 are to be awarded for the best plans and estimates of an electricity station to be worked by water power. For particulars apply to the Government of the Canton Fribourg, Switzerland. Open until April 30.

D. Bruce Peebles and Co., Edinburgh.—We are informed this firm is taking up electrical manufacture, and that Mr. R. S. Portheim is visiting the United States on their behalf in order to investigate the latest American practice in electric transmission of power.

Gourock.—The report by Mr. Munro, electrical engineer, just submitted to the Commissioners, states that the cost of an installation, including plant for the lighting of the whole burgh and the erection of 16 arc lamps along Shore and Kempock streets, would be £8,600.

Kensington.—At a meeting of the St. Mary Abbotts Vestry on the 23rd inst., the Notting Hill Electric Lighting Company and the House-to-House Electric Light Supply Company received permission to extend their mains in various places subject to the usual conditions.

Newington.—The Vestry have decided to open
account with the treasurer for the electric lighting
in accordance with the requirements of the Board of
to accept the offer of the treasurer to place at the
the Vestry £5,000, pending the completion of a loan.

Electric Installation Company.—This Company
100,000 shares of £1 each, and has been formed for
of making installations of electric plant for lighti
purposes in public institutions, hotels, mills, factorie
warehouses, shops, etc., on the hire-purchase system o

Brighton.—An electricity main is to be laid in D
at an estimated cost of £50, and the lamps in that s
by electricity instead of by gas. A movable woode
screen is to be constructed for the purpose of keepin
the running machinery at the electricity station at a
cost of £30.

Hendon.—On Saturday Mr. G. A. R. Fitzgerald
Boughey, C.S.I., Light Railway Commissioners, concl
days' public enquiry into the light railway scheme
missioners decided that the necessity for the railway h
proved, and they therefore declined to grant an o
construction.

Metropolitan Electric Supply Company, Lin
eleventh ordinary general meeting of this Company
on Tuesday, 29th inst., at Winchester House. The
presented at the meeting will be found in another col
transfer registers of the ordinary and new ordinary s
Company are closed until the 29th inst.,

Alexandra Palace.—The Alexandra Palace, at M
will be opened again on Good Friday. An electric railw
to carry passengers from the railway station to the pal
which is a considerable distance off has been laid dow
is on the overhead trolley system. The cars will be
long, and will each seat 60 people. This is the first r
kind that has been fitted in London.

Chiswick.—At the District Council meeting a lon
took place as to the letters and interviews with Mr. C
son on the proposed tramways extension question, and
they could come to terms. Several preliminary nego
entered into on the understanding that the rights an
of the parishioners should be respected. The questi
fallen through, and the proposed poll of the parish wa

Morecambe.—The award of Mr. Thursfield and
made in the reference to arbitration respecting the s
deducted from the price of the plant, apparatus, etc
from the Morecambe Electric Light and Power Compa
for deterioration and articles missing since the date of
has been published. The amount awarded to the Co
be deducted for deterioration was £1,144. 10s., and
missing £34. 10s., making a total of £1,179.

Dorking.—The Clerk reported to the Urban Dis
that 259 of the ratepayers had voted for the Counci
undertaking the carrying out of the electric light in
195 in favour of a company doing the work. Forty
ratepayers had either objected to any system or r
voting cards blank. Thus 501 of the electors out
1,600 had voted on the question. A motion to postpo
consideration of the whole question until the new
into office was carried.

Hackney.—The fate of the electric lighting
undecided, and there does not seem to be any
prospect of the Vestry taking a decided step. The
the joint committee for handing over the electric
dust destructors to one of the three firms who tende
out the scheme have been discussed by the Vestry fo
time in committee. After two hours' heated discussi
seem to have got no nearer to a settlement, and by
vote the question was again adjourned for a fortnight

Lambeth.—The Clerk (Mr. H. J. Smith) stated a
meeting that the preamble of the City and Brixton
had been passed. The railway could thus be now m
been instrumental in getting clauses inserted in the
the maximum workman's fare from 2d. to 1d., and
company to promise to run not less than 12 trains
o'clock in the morning at a halfpenny per mile. The
also agreed to issue return tickets at double the a
single fare before seven o'clock, such tickets to be
time during the day. It was resolved to enter the cler
on the minutes.

Appointments Vacant.—The Corporation of Brig
a working electrical engineer to look after an installa
600 to 700 lamps, including about 30 arc lamps; three
must be thoroughly versed in working and maintena
to keep the plant in proper repair. Applications,
experience, and wages required, with copies of three
monials, to be sent to the Town Clerk, Brighouse,
endorsed "Engineer," from whom all information ca
Particulars of other vacancies will be found in ano
notably at Dewsbury and one by the British Elec
Company, Limited.

Southport.—Colonel C. H. Luard, C.E., held an
Southport Town Hall on Friday last, on behalf
Government Board, into an application by the Sou
Council for power to borrow £21,178 for electric li
electric light extensions consist of the erection of a
and alternator combined, the laying down of two m
the town, and various works connected therewith. T

crease in the demand for electricity, the number of 8-c.p. ps connected having grown from 534 in March, 1895, to farch, 1898, while there are applications for 2,00C more. ted that the proposed extensions will meet the require- e town for 18 months or two years.

—A report of the Light Railways Committee was the Town Council on the 22nd inst. The report e following recommendations: (1) That the Town their own expense, construct and electrically equip tramway, or light railway, from Queen's Cross to th the consent of the local authority of Rowley Regis, hat authority should object, to the boundary in that the borough of Dudley; (2) that the town clerk be autho- nploy counsel and take whatever steps the Railway and Electric Lighting Committee deem desirable to application of the British Electric Traction Company to construct the branch line from Queen's Cross to The committee having considered the question of elec- ing in the borough, recommended that the system should d out without delay.

—The following recommendations of the Lighting tee have been adopted by the County Council: "The com- recommend that application be made to the Local Govern- oard for sanction to borrow £1,000, the sum to be paid to tish Thomson-Houston Company, Limited, upon the Corpo- aking over the works. Under the provisions of the Crystal District Electric Lighting Orders, 1890 and 1894, the l now have power to acquire so much of the company's aking as is within the borough. The committee therefore nend that Prof. Kennedy be requested to report upon this tion, having in view the provision of a supply of current to th Norwood district as well as Upper Norwood. The com- further recommend that Prof. Kennedy be also requested rt upon the cost and best mode of an extension up the -road as far as the Thornton Heath pond."

—At the monthly meeting of the County Borough it was stated that the users of the electric light had d during the month from 618 to 632, and there was an of 17,043 units used, or 40 per cent., on the corresponding f February last year. The town clerk had reported to the Lighting Committee that he had again applied to the ter-General for a license authorising the Corporation to alise the telephone system in the borough. The applica- s now under consideration. The General Purposes Com- ad also passed a resolution supporting the claim of the utual Telephone Company, Limited, for a license. The e had further resolved to communicate with Sir J. T. se, M.P., upon the subject of the application made to master-General, with a view to its being brought under e of Parliament. The Council approved the committee's ings.

—At the last meeting of the Rural District Council the Lighting Committee reported that the number of con- at the end of February was 104. They regretted to report r paying interest on loans and providing sinking fund s a deficiency of £531. 17s. 7d. This, with the loss of . 10d. on the previous year's working, made the total y of the undertaking up to Dec. 31 last £977. 1s. 5d., and iew to meeting the same the Finance Committee had been d to include in the next rate estimate the sum of £400 in hereof. The Board of Trade had asked the Corporation their reasons why the Board should not dispense with the of the Corporation to the application by the Midland Corporation for Power Distribution, Limited, and the rk had replied that the Council strongly object to the pro- the company to supply electricity within the borough. The s adopted.

—A deputation, appointed for the purpose by the e council of the Tradesmen's Alliance, waited on Mr. on, of the Woking Electric Supply Company, with the get better terms than the 8d. per unit now paid to the . Mr. Shrimpton said the charge in his opinion was not . As for better light, a new cable was to be put in tely for the Woking main circuit, and this would have t of improving the illuminating power of the light. A tchboard, costing some hundreds of pounds, was also to ided, and would prevent the present fluctuation. At a meeting of the executive council on Monday night, the f the conference was reported, and was generally regarded tisfactory. It was decided to write to Mr. Shrimpton his attention to the system of discounts at Guildford, ting that for the present the alliance would be satisfied similar arrangement, if the company would consent to its ption.

—At the last meeting of the Parish Council Mr. Lloyd the question of lighting, and said the result of the recent the matter was the outcome of ignorance. He believed ple did not understand the matter, and his opinion was opportunity should be taken at the annual parish meeting he matter plainly be'ore the parish. If the people under- hat while they were without gas or electrical lighting, ment was impossible, they would be more inclined to look atter in a sensible manner. He thought the arrangements the opportunity of making with the Walsall Corporation t satisfactory. He asked if the chairman would make d statement at the next parish meeting, giving the full n, so that when the matter was reintroduced, as it surely they would more thoroughly understand the question. Several members approved of this suggestion, and it was tacitly understood that Mr. Lloyd would speak on the matter at the annual meeting.

Costa Rica Electric Light and Traction Company.—The Costa Rica Electric Light and Traction Company, Limited, have issued this week, at 90 per cent., £130,000 5 per cent. first debentures of £50 and £100 each, payable at par in 50 years, redeemable at the Company's option at any time on six months' notice at 105 per cent. The Company has a share capital of £130 000, in £1 shares, and it has been formed with the object of supplying electric light and electric traction in San José, the capital of Costa Rica, and of electric light in Cartago. The Company will take over from the vendor all the shares of the local company (£60,000) owning the existing electric light system of these two cities and supplying in San José the public arc lights and 2,000 incandescent lights (the equivalent of 4 000 8-c.p. lamps), and in Cartago the public arc lights only. The contract provides for the carrying out of considerable extensions and an electric tramway at San José, to cost £27,000. The purchase price is £107,000 cash and all the Company's share capital, leaving from the present issue £10,000 as working capital.

Bournemouth.—The Joint Pier, Winter Gardens, and Parks Committee have considered a report by the surveyor and a letter from the engineer of the Bournemouth and District Electric Supply Company on the question of the electric lighting of the pier and gardens, and have recommended that the pier and lower pleasure gardens be lighted by electricity, subject to satisfactory terms being made with the electric supply company. At the Council meeting it was proposed: "That steps be taken to ascertain at what price the electric supply company will supply and maintain an installation and supply electric current at the pier and lower gardens up to the square, in accordance with the scheme in the borough surveyor's report, under a contract for four years." An amendment, however, was carried to the effect: "That the necessary installation be laid by the Corporation, at an estimated cost of £800, and that application be made to the Local Government Board for sanction to borrow the amount, and that the surveyor be instructed to obtain tenders for carrying out the work." After some discussion, the Council adopted the report.

Extensions of Mains.—At the London County Council meeting notices from the Vestry of St. Pancras, under the St. Pancras Order, 1883, of intention to lay various mains, were approved of. A notice from the County of London and Brush Provincial Electric Lighting Company, under the Southwark Order, 1892, of intention to lay high and low tension mains in, and at several places across various streets, also to construct nine transformer boxes, which was disapproved by the Council on Feb. 15 last at the request of the Vestry of St. George-the-Martyr, Southwark, the local authority of the district concerned, was formally disapproved of. Notices from the same company, under the Wandsworth Order, 1892, of intention to lay low-tension mains, and of similar notices of the Charing Cross and Strand Electricity Supply Corporation, the Notting Hill Electric Lighting Company, the House-to-House Electric Light Supply Company, and the Metropolitan Electric Supply Company were approved under the usual conditions. With regard to a notice from the Vestry of Islington, under the Islington Order, 1893, of intention to lay certain mains, the Vestry is the undertaker under the order, and the Council has no power of approval or disapproval of the works.

Tees-side.—The *Middlesbrough and Stockton Evening Telegraph* says that the work of laying the cable in connection with the new Tees-side electric tramways is progressing very speedily. It has now been laid down along the footpath from Norton to opposite Church-row, Stockton. The standard street posts have received their first coat of paint, and now present a much more pleasing appearance to the eye. When the painters have finished with the decoration of the posts, which will be of a somewhat ornate character, they will look handsome, and add local colour to the thoroughfares through which the tramways will pass. The work at the power-house at the depôt in Bridge-road, Stockton, is now in a forward state, Mr. Holliday and his staff having spared no effort in pushing on in all departments. The machinery and plant are being rapidly laid down, and all the arrangements completed and closed up against the time when the preliminary trials will have to be made. It is satisfactory to note the record way in which everything has been done from its inception to its finish, and when the history of the Tees-side line comes to be written it will be found that as a piece of scientific engineering work on such a large scale it will take a foremost place in the annals of constructive skill and ability in this or probably any other country. The credit of all this is due to Mr. Clifton Robinson, the able and resourceful engineer of the company, and his talented second in command, Mr. Holliday, who have been backed up manfully by the heads of the departments.

Nantwich.—Mr. Clegg, representing the Birmingham Installation Company, attended the last meeting of the Urban District Council, and gave some information with respect to the company's scheme for the introduction of the electric light at Nantwich. The company, he said, was prepared to light the Council's lamps, 150, for certain hours, upon an annual payment of £330. They were also prepared to provide electric light to private consumers at a cost of 7d. per Board of Trade unit, and public lighting at 4d. per Board of Trade unit. The whole cost of the works he estimated at £8,000, and what the company proposed to do with the consent of the Council was to apply for a Board of Trade license and to sell the undertaking to the Council at the end of seven years, at a premium of 12½ per cent. Mr. Clegg went on to state that to apply for a provisional order in the first instance would be very

expensive, but by obtaining a license for seven years the Council would have the option of obtaining a provisional order within that period. The Board of Trade license was only granted conditionally upon a provisional order being applied for. The charge of 7d. per unit was the maximum charge, and, of course, could easily be reduced. In Birmingham at the present time it stood at 7d., as compared with a charge of 3s. 7½d. per thousand for gas. After the granting of the license, the company or the Council would have to apply for the provisional order. The Council thanked Mr. Clegg for the information he had furnished, and the matter was then referred to the committee.

Charing Cross and Strand District. — The Highways Committee of the London County Council in their report presented to the Council, stated that the Charing Cross and Strand Electricity Supply Corporation had given notice, dated March 14, 1898, of intention to lay mains along Wellington-street, in and across the Strand, along Burleigh-street and Tavistock-street, across Southampton-street and along Maiden-lane to the company's station. The proposed works were in substitution for those specified in the company's notice, dated Nov. 1, 1897, sanctioned by the Council on the 16th idem, it having been found necessary to alter the line of route then proposed to be followed. They were of opinion that the consent of the Council might be given to the works, subject to the condition that those in Wellington-street and the Strand should, when commenced, be carried on without cessation by day and by night until completed. They recommended, "That the sanction of the Council be given to the works referred to in the notice dated March 14, 1898, from the Charing Cross and Strand Electricity Supply Corporation upon the following conditions: that the company do give two days' notice to the Council's chief engineer before commencing the works; that the works in Wellington-street and the Strand, when commenced, be carried on continuously both by day and by night until completed; that no street boxes be constructed until full details shall have been submitted to and approved by the Council's chief engineer; that the concrete floor of the street boxes be 9in. thick, and the York stone at the top 4in. thick; that the longitudinal girders (if used) in the boxes be laid on 3in. stone templets the full thickness of the brickwork, which shall be 9in thick; and that adequate means be taken to prevent the accumulation of gas in the boxes and conduits."

Dublin.—The Board of the Dublin United Tramways Company are seeking for power to extend and make certain alterations in their lines. Should these powers be granted, according to the *Dublin Mail*, it is the intention of the directors to constitute Nelson's Pillar the terminus for the Terenure trams, and to have the cars on the other lines running through journeys—that is to say, that it will be possible to start from Dollymount and arrive at another of the suburbs without changing. A memorial has been lodged with the Lord-Lieutenant for an Order in Council authorising the extension and doubling of the lines of their system in various districts in the city. Amongst the proposals is one to extend the system into the Phœnix Park. The proposed new line commences at the end of the existing tramway in Parkgate-street and passes through the gate of the Phœnix Park into the main avenue, and thence by the gate of the Zoological Gardens and the constabulary barracks out through the northern park gate, where a junction will be formed with the existing tramway on the North Circular-road. The estimated cost of this work is £9 120. It is proposed to double the Glasnevin line at an expenditure of £9,324, to double the Drumcondra line at an expenditure of £15,936, to extend the Dolphin's Barn line to Rialto Bridge at a cost of £4,584, to make a new line from the existing tramway in Capel-street through Great Britain-street, Summer-hill, across Clark's Bridge, over the Royal Canal, at Ballybough-road, and ending near Ballybough Bridge. A connecting line from Merrion-row to Lower Fitzwilliam-street, at a cost of £3,360, and lines opening up the Ringsend district from Westland-row at a cost of £12 540. There are also several connections proposed in the neighbourhood of St. Stephen's Green. The total proposed expenditure amounts to £74,838. The Corporation and the Grand Canal Company have dissented from the proposals, and no answer has been given by the Alliance Gas Company or the Board of Works.

Leicester.—At a special meeting of the Town Council, Alderman Lennard moved the adoption of the report relating to the financial statement of the electric lighting department. He said that with regard to the capital account of that department, although they had got further borrowing powers they had not exercised any of them during the half-year for which this account was published. With regard to the revenue account, their total receipts were £3,654, as against £3,068 for the corresponding half of the previous year, showing an increase of about £566. But it should be remembered that in the corresponding half they were charging 6d. per unit for their current, while in the present balance-sheet they were only charging 5d. per unit; that meant a loss to their revenue account of £664. On the expenditure side they had a total expenditure of £1 897, as against £1,436 for the corresponding half of the previous year—an increase of £461. The only item he need mention as being an exceptional increase was that for repairs and maintenance of works, plant, machinery, etc., which showed an increase of over £300 and that was due to the committee having deemed it wise to hire an extra engine and dynamo in view of the possibility of a heavy demand through the winter, and in case they were not able to get through with their present plant. They scarcely required it at all, he was glad to say, but they were bound to make provision for a little extra capacity. The total profit on the profit and loss account was £1,757 for the half-year, as against £1,631 for the corresponding half of the preceding year,
so that while their business had increased something like
cent., they had only a net increased profit of £126; th
after paying interest and sinking fund charges they only
net profit of £449, as against £457, being really £8 less p
the extra business they had done. The net result up to d
that whereas at the end of June they stood with a debit
on revenue account of £1,819, they now deducted £449, n
leaving the debit balance £1,370, and their sinking fund no
at £3 741. The resolution was agreed to, and the procee
the committee generally were approved.

London County Council and the Telephone Compan
adjourned report of the Highways Committee on the
Telephone Company's underground works recommended
Council do approve of the insertion in the draft agr
between the Council and the National Telephone Compan
pared in accordance with the resolution of the Council of
1897, of the following clause, and of the schedule therein r
to: "The company shall not during the time this agreemen
be in operation without the previous consent in writing
Council charge to subscribers for telephonic supply or othe
any amount larger than the amount of the annual subscri
which would be payable by subscribers to the company with
metropolitan area of the company according to the general
ment of tariffs contained in Schedule C hereto (Schedu
contains general statement of tariffs in the metropolitan ar
follows: On five years' agreement—first connection, £12 per an
second and additional connections, £10; private houses, £8
a yearly agreement—first connection £15 per annum;
and additional connections, £12. 10s.; private houses,
N B.—These tariffs include an area of 609 square miles,
comprises the towns of Dartford, Reigate, Redhill, Cro
Epsom, Richmond, and Kingston on the south side of the Th
and Tilbury, Woodford, Romford, Epping, West Ham, Ha
Ealing, and Hampton Court on the north side of the Thames)
that the solicitor do inform the company that the Council re
that the clause numbered 18 in the draft agreement shall re
Mr. Beachcroft objected to any departure from the reso
passed by the Council last June. The amended propos
unreasonable in some respects, and was not likely to be ac
by the company. Mr. Benn moved an amendment to ref
recommendation back to the committee with instructions to
on the terms imposed on the National Telephone Company
leading provincial cities for the protection of the streets a
securing reasonable charges to telephone subscribers. S
Hutton seconded the amendment, which, on a division, was c
by 69 votes to 12.

Ilkeston.—A meeting of the Town Council as a General Pu
Committee was held last week for the purpose of considerin
question of providing tramlines within the borough, and an
cation from Messrs. Derbyshire Bros., of Nottingham, to be al
to undertake the work. A resolution was passed to the effe
the Council approved of tramways being provided for Ilkest
vided that the engineering difficulties could be satisfactorily
come. The next question was whether the Council should und
the work themselves or whether they should leave it to a p
company. Alderman Sudbury thought it would be many
before the tramways were profitable, and said that he pre
that a private company be left to carry out the scheme. M
Derbyshire Bros. wanted a concession of the right to use the
free of charge for a period of 28 years, and would not tou
matter unless that period were granted them. At the end o
time they might be compelled to sell to the Corporation at a
valuation of the line, irrespective of any profits. They suggest
electric trolley system and it was suggested that the Health
mittee generate the electricity required by means of their destr
and sell it the company. A long lease was desired because only
last few years would the company recoup themselves for their o
Councillor Hunt was strongly in favour of the Corporation
taking the work themselves. There was every evidence of p
profit, and it would be a protection of their rights and priv
If a privileged company were allowed to supply electric e
the next step might be to provide electric lighting for the
The Corporation had already obtained a provisional order to p
their rights in that direction. He was satisfied that the be
safest course was for the Corporation to put down the lines,
much as a speculative concern as a provision for the require
of the borough, and he moved a resolution to that effect.
cillor Trueman thought it a risky thing to give a private co
a monopoly of this kind, and seconded the resolution, whi
adopted. The meeting was then adjourned *sine die* for the
clerk to get all the information he could. The scheme is to
tramline from Bridge-street, Cotmanhay, to Hallam Fields.

Paris.—The French Chamber of Deputies have adopted
authorising the city of Paris to borrow £6,600,000 for the co
tion of a metropolitan railway. The Compagnie Générale de
tion and the Société Creusot, together with the Banque
nationale and Messrs. Bénard and Jarislowsky, are the c
sionnaires. The *Financial News* correspondent wires the foll
particulars concerning the matter: "The new railway is
65 km. long, is to be worked by electric traction, and with
boundaries of the town to run underground. The first rai
be laid down from the Bois de Boulogne to the Bois de Vinc
and the circle line will measure 42 km., and must be com
within the next eight years. The first part only, however,
in working order by 1900. Whilst the municipality will be re
sible for the construction of the track, the concession f
working has been granted to the Compagnie Générale de Tr
together with the Société Creusot, who for this purpose
formed a company with a capital of £1,000,000. Besides the

as there are connected with the enterprise the bankers . Bénard and Jarislowsky, as well as the Banque Interale. The concession is for 35 years, but the Town l has reserved for itself the right to repurchase it after nd at the termination of the period the whole line, together he stations and workshops, reverts to the town without any nt whatsoever. The expenditure for the track is estimated 00,000, which will be raised by a loan. The interest and ption of the latter at 3½ per cent. only require £220,000 75 years, and the issue is to be spread over a period of ars. The concessionnaires receive neither subvention nor tee. The fare is a uniform one of 15 centimes for the second f which about two-thirds belong to the company and one- o the town. If the number of passengers carried is more 40,000,000, the participation of the town in the profits is ed by $\frac{1}{10}$ centime for every other 10,000,000 fares. The rt of 110,000,000 persons is consequently required to cover ses of the loan, whereas 130,000,000 people have to be rted before the company can pay its own working expenses, shareholders the interest on their capital, and redeem the The issue of debentures is only permitted after the first 2 km. has been laid down."

ess Outfall Electric Lighting.—At last Tuesday's of the London County Council the following report on ric lighting of the Crossness outfall was submitted by the ainage Committee, but was postponed until next week by ling orders of the Council. The committee state: "We report that the gas plant at the Crossness outfall has worn out and inadequate, and that it is necessary that uld be taken without delay to provide means for lighting during the next winter. The existing plant was erected years ago, and extensive repairs have consequently had ied out in recent years, but the time has now arrived plant should be renewed and enlarged or electric nstalled. After carefully considering the whole question, come to the conclusion that the Council should adopt course, and in coming to this decision we have had the desirability of providing for the lighting of the nd reservoirs and to the fact that there is sufficient wer at the station to generate the electricity, and engines and dynamos can be placed in a portion uxiliary engine and boiler house. The engineer has y, under our direction, prepared a scheme for ic lighting of the whole of the station, and has to us the necessary drawings and specifications. It is o have the work carried out under two contracts—viz., dynamos, engines, switchboard, and principal mains, her for the service mains, wirings, and fittings—and the of opinion that the total cost will not exceed £7,000. ginal cost of the gas plant amounted to about £1,500, an f £5,500 will be submitted to the Finance Committee as g the additional value of the buildings and machinery ged to capital account, and provision has been made in l estimates for the balance of £1,500, which will be maintenance account. We recommend (*a*) that the £5,500 to be submitted by the Finance Committee be and that the Council do agree to the installation of ght at the Crossness outfall in accordance with the resented to the Main Drainage Committee, at an esti- of £7,000; (*b*) that tenders be invited for the supply complete of the dynamos, engines, switchboards, and mains, and also for the supply and fixing of the service ing, and fittings."

.—The shareholders in the Sheffield Electric Light and pany on the 21st inst. agreed to sell their undertaking field Corporation. The capital expenditure was fixed 2, of which £5,972 is to be paid in cash and the is to be satisfied by issuing in respect of every £100 rporation 2½ per cent. stock. The company have given after the 31st inst. another penny is to be taken off the current, which will thenceforward be sold at the rate r Board of Trade unit.—The reconstruction of the ystem of Sheffield is rapidly proceeding. The whole tion of the route from Nether Edge to the junction of oad with Sheffield Moor—a distance of nearly two been relaid with double tracks, under the direction of rveyor (Mr. C. F. Wike). In addition to this, states l *Daily Telegraph*, the paving between the tracks and space has been done, and the paviors are energetically n with the laying of the paving between the rails and Various sewers, also, which were known to be defective nvestigation to be worse than was anticipated, and they aken up and entirely reconstructed. When it is stated Nether Edge section alone some 3,600 yards of rails relaid since the second week of this year, one may the substantial progress which has been expeditiously ite all the difficulties which have had to be overcome. on of the section in South-street, Moor, is not being ed at present until the gullies for taking away the er have been connected with the main sewer, and ntilators and inspection chambers have been pro- e sewer. As quickly as the workmen's services can l with on the Nether Edge route they are transferred y portion. At the end of the city one line of rails has taken up from Lady's Bridge to a point approaching bridge, a distance of three-quarters of a mile, and the new rails, and subsequently the paving, is being ted. Another large gang of men has been set to work ley end, and between Newhall-road and the Board school several hundred yards of rails have been removed, and the track is being relaid with new rails. Many of the old rails have been found to be badly worn, and they would not have lasted much longer. This was one, among various other reasons, which induced the Tramways Committee to take this section in hand before dealing with any other. A good deal of the paving has had to be removed, and new concrete laid. Permanent points and crossings are being fixed, and, as they differ from each other in pattern, a certain amount of difficulty in getting them made has been experienced. Another new feature of this particular tram route is the provision of drain rails at the bottom of inclines, so that water may get away instead of lodging in pools, as happens where no such facilities for it running off the road have been provided. Nearly 700 workmen are employed at present, and this number is being increased. Another difficulty which adds to the length of time taken, and also enhances the cost very materially, is having to keep the tramway traffic going while the alterations are being effected. This has necessitated the putting down of temporary crossings at intervals along the line—an expensive procedure—and also a considerable expenditure for lighting, watching, and guarding the roadway and line. As soon as it is considered practicable and safe to do so, the centre of the city—that point between the Moorhead and Lady's Bridge, including Pinstone-street, Fargate, High street, and Waingate—will be taken in hand. Directly the centre of the city is reached it is probable that the tramway system will be continued along Church-street and West-street, and up the heights. From the fact that the rapidity with which the new lines are being laid makes it very probable that not Walkley alone, but one or two other routes will be taken in hand sooner than was originally anticipated. Anyway, the rails are already on order for several sections. The contracts for the new cars are being pushed forward by the Thomson-Houston Company, who are also getting the electrical machinery ready. There are 25 cars on order, and they will be ready in about nine months from now. They are being made by Mr. Mills, of Birkenhead, who has already supplied some of the horse cars now running. The new cars will be of the style known as double-decked, each holding 51 passengers. As is known, the Tramways Committee have arranged for the purchase of the Kelham Island site for the erection of a power station, and plans for the station are now being prepared. It is hoped to let the contracts for this work within a very short period.

PROVISIONAL PATENTS, 1898.

MARCH 14.

6179. Improvements in secondary batteries. Oswald Hamilton, Cosgrove Priory, Northamptonshire.

6162. A new medical electrical device. Arthur Leland Burgess, New-road, St. Sampson's, Guernsey.

6184. Improved electric light for use as a search or signal light or for photographic and other purposes. Edward Munro Brown, 52, Chancery-lane, London.

6223. Improvements in electric railways. Charles Melbourne White, Birkbeck Bank chambers, Southampton-buildings, Chancery-lane, London. (Benjamin Coplin Seaton, United States.) (Complete specification.)

6235. Improvements in electrical insulato s and method of making the same. John William Boch, 47, Lincoln's-inn-fields, London. (Complete specification.)

MARCH 15.

6270. Improved electrical lampholder. Frederick William Heaton and Harry Smith, 27, Sidney-street, Salford, Manchester.

6328. A new or improved method of and apparatus for generating electricity. Charles O'Donnell Barrows and Charles Henry Smith, 70, Chancery-lane, London.

6350. Improvements in or connected with the manufacture of carbons for electric arc lamps. John Jarl Waddington, 47, Lincoln's-inn-fields, London.

6357. Improvements in or in connection with electric motors for cars or other vehicles and in brakes therefor. William Phillips Thompson, 6, Lord-street, Liverpool. (Thorsten von Zweigbergk, United States.) (Complete specification.)

6360. Improvements in or relating to electric light carbons. Johann Wilhelm Strauss, John Goldie Chapman, and Horatio Foster, 322, High Holborn, London.

6362. Improvements in electric switches. Thomas Gillies and Edward Hornidge, 322, High Holborn, London.

6371. Improvements relating to the driving of sewing machines by electricity. Henry Lea, 18, Southampton-buildings, Chancery-lane, London.

MARCH 16.

6414. Improvements in or relating to electric plug and ordinary switches. Thomas Topping, 8, Quality-court, Chancery-lane, London.

6451. Improvements in apparatus for electro-plating pins and other small objects. James Steel Morrison, 6, Lord-street, Liverpool.

MARCH 17.

6478. Improvements in electrical connections for lampholders and other electrical appliances. Robert Frederick Hall, 24, Temple-row, Birmingham.

6482. **Improvements in electric light advertising.** Edward Lightheart, 115, St. Vincent-street, Glasgow.

6498. **An improved arrangement for forming or mounting the armatures of field magnets of small electromotors.** Francis Arthur Darton and Frederic George Phillips, 142, St. John-street, London.

6525. **Improvements in apparatus for electrolytic purposes.** William George Luxton and the United Alkali Company, Limited, 47, Lincoln's-inn-fields, London.

6526. **Improvements in apparatus for electrolytic purposes.** William George Luxton and the United Alkali Company, Limited, 47, Lincoln's-inn fields, London.

6535. **Improvements in propelling barges and boats on canals and other waterways by electricity.** William Edward Kenway and Theophilus Vaughan Hughes, 7, Staple-inn, London.

6559. **Improvements in electric arc lamps.** Guy Carey Fricker, 46, Lincoln's-inn-fields, London.

MARCH 18.

6605. **Improvements in telephonic intercommunication system.** William Aitken, Oxford-court, Cannon-street, London.

6607. **A new or improved separator for the plates or electrodes of secondary batteries or accumulators.** Edward James Clark, 73, St. Stephen's-road, Upton Park, London.

6619. **Improvements in microphones.** Lars Magnus Ericsson, 4, South-street, Finsbury, London. (Complete specification.)

6633. **An electrical charge indicator.** Frederick William Cooke and Thomas Ireland, 21, Finsbury-pavement, London.

6637. **Improvements relating to the electrolytic production of metallic alloys and to apparatus therefor.** Charles Ernest Acker, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

6649. **Improvements in dynamo-electric generators and motors.** Claude William Atkinson and William Henry Johnson, 1, Queen Victoria-street, London.

MARCH 19.

6667. **Improvements in electrical coherers.** Herbert Godsal, 13, Buxton-street, Berkeley-square, London.

6672. **An improved receiver for electromagnetic waves.** Arthur F. Eves, 12, Chelmsford-road, Dublin.

6695. **Improvements in electrical regulating apparatus.** Rookes Evelyn Bell Crompton and Sidney Walter Ashley, 55, Chancery-lane, London.

6704. **Improvements in switchboards for the control of high-voltage electric circuits and apparatus.** Horace Field Parshall, 83, Cannon-street, London. (Complete specification.)

6712. **Improvement in insulators.** Louis Frederick Rembe, 111, Hatton-garden, London.

6714. **Improvements in electric switches.** Everett Mason French, 111, Hatton-garden, London.

6720. **Improvements in depressible rail systems for electrical railways** William Grunow, jun., and Zalmon Goodsell, 322, High Holborn, London.

6758. **Improvements in electric furnaces.** Amédée Mathurin Gabriel Sébillot, 53, Chancery-lane, London.

6762. **Improvements in the means of and apparatus for transmitting pictures and the like by electric currents.** William Edmund Simpson, 28, Victoria-street, Westminster, London.

SPECIFICATIONS PUBLISHED.

1897.

4994. **Portable electric lamps.** Boult. (Hubbell and Boland.)

5031. **Method and apparatus for reproducing pictures and the like at a distance by means of electricity.** Szczepanik and Kleinberg.

5157. **Electric arc lamps.** Davy and Thomas-Davies.

5258. **Electrically-propelled motor road vehicles.** Epstein.

5714. **System of fitting up electric bells.** Johnston.

5948. **Means and apparatus for discharging, neutralising, or removing electrical charges from paper and like material during and after the process of manufacture.** Rogers and Mordey.

7772. **Alternating-current motors.** Langdon-Davies.

10280. **Electric incandescence lamps.** Egger.

13100. **Primary or galvanic electric batteries.** Gauzentés.

25655. **Apparatus for making observations by means of Rontgen or X rays.** Boult. (Wertheimer.)

26412. **Electrical transformers.** The British Thomson-Houston Company, Limited, and Hobart.

27483. **Electric arc lamps.** Spies, Newall, and Shout.

1898.

817. **Electric railway conduit systems.** Thompson and Sullivan.

1869. **Electric insulators.** Renault.

1872. **Curve tracer of electrical measurements.** Smith. (Rosa.)

1921. **Telephones.** Exner and Kraft.

TRAFFIC RECEIPTS.

Dover Tramways.—The traffic receipts for the week March 19 were £117. 17s. 5d. The total receipts for th 1898 are £1,166. 8s. 11d. The mileage open at present is 2¼

Bristol Tramways.—The traffic returns for the week March 18 were £2,503. 3s. 4d., compared with £2,053. for the corresponding period of last year, being an incr £449. 15s. 11d.

Birmingham Tramways.—The traffic receipts for the ending March 19 were £3,480. 0s. 1d., as compared £3,248. 6s. 3d. in the corresponding week in 1897, bei increase of £231. 13s. 10d.

Liverpool Overhead Railway.—The traffic receipts railway for the week ended March 20 amounted to £1,3 compared with £1,360 in the corresponding week of the pr year, being a decrease of £44.

City and South London Railway.—The returns for th ended March 20 were £1,030, compared with £1,012 for the sponding period of last year, being an increase of £18. Th receipts for the half-year amount to £12,826, compared £12,818 for the corresponding period last year, being an in of £8.

South Staffordshire Tramways.—The traffic returns f week ending March 18 were £552. 9s. 5d., as compared £573. 2s. 10d. in the corresponding week of the previous The aggregate receipts for the year are £6,341. 19s. against £6,269. 8s. 9d. in the corresponding period previous year.

Dublin S.D. Tramways.—The traffic receipts for the ending March 18 were £403. 4s. 6d., as compared £363 15s. 4d. in the corresponding week in the previous being an increase of £39. 9s. 2d. The number of pass carried was 68,513 in 1898 and 59,721 in 1897. The agg returns up to date are £4,378. 17s. 11d., as compared £4,669. 13s. 10d. last year, being a decrease of £290. 15s. 11d mileage open is the same as last year—viz., 8 miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Pr… Wedn…
Birmingham Electric Supply Company	5	[illegible]
Brush Company, Ordinary	2	[illegible]
—— Non. Cum., 6 per cent. Pref.	2	[illegible]
—— 4½ per cent. Debenture Stock	100	[illegible]
—— 4½ per cent. 2nd Debenture Stock	100	[illegible]
Callender's Cable Company, Debentures	100	[illegible]
—— Ordinary	5	[illegible]
Central London Railway, Ordinary	10	[illegible]
——	6	[illegible]
—— Pref. Half-Shares	1	[illegible]
—— " "	5	[illegible]
Charing Cross and Strand	5	[illegible]
—— 4½ per cent. Cum. Pref.	5	[illegible]
Chelsea Electricity Company	5	[illegible]
—— 4½ per cent. Debentures	100	[illegible]
City of London, Ordinary	10	[illegible]
—— Prov. Cert. 90,001-100,000	2	[illegible]
—— 6 per cent. Cumulative Pref.	10	[illegible]
—— 5 per cent. Debenture Stock	100	[illegible]
City and South London Railway, Consolidated Ordinary	100	[illegible]
—— 4 per cent. Debenture Stock	100	[illegible]
—— 5 per cent. Pref. Shares	10	[illegible]
—— " " " '96	10	[illegible]
County of London and Brush Provincial Co., Ordinary	10	[illegible]
—— 6 per cent. Cum. Pref.	10	[illegible]
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	[illegible]
—— 5 per cent. Debentures	—	[illegible]
Edison and Swan United Ordinary	3	[illegible]
—— 5 per cent. Debentures	5	[illegible]
—— 4 per cent. Deb. Stock, Red.	100	[illegible]
Electric Construction, Limited	2	[illegible]
—— 7 per cent. Cumulative Pref.	2	[illegible]
—— 4 per cent. Perp. 1st Mort. Deb.	100	[illegible]
Elmore's Copper Depositing	1	[illegible]
Elmore's Wire Company	2	[illegible]
W. T. Henley's Telegraph Works, Ordinary	10	[illegible]
—— 7 per cent. Preference	10	[illegible]
—— 4½ per cent. Debentures	100	[illegible]
House-to-House Company, Ordinary	5	[illegible]
—— 7 per cent. Preference	5	[illegible]
India Rubber and Gutta Percha Works	10	[illegible]
—— 4½ per cent. Debentures	100	[illegible]
Kensington and Knightsbridge Ordinary	5	[illegible]
—— 6 per cent. Pref.	5	[illegible]
London Electric Supply, Ordinary	5	[illegible]
Metropolitan Electric Supply, Limited, Ord. No. 101-50,000	10	[illegible]
—— " " " 50,001-82,800	10	[illegible]
—— 4½ per cent. First Mortgage Debenture Stock	100	[illegible]
National Telephone, Ordinary	5	[illegible]
—— 6 per cent. Cum. First Pref.	10	[illegible]
—— 6 per cent. Cum. Second Pref.	10	[illegible]
—— 5 per cent. Non. Cum. Third Pref.	5	[illegible]
—— 3½ per cent. Deb. Stock, Red.	100	[illegible]
Notting Hill Company	10	[illegible]
Oriental, Limited, £1 shares	1	[illegible]
—— £5 Shares	5	[illegible]
—— £4½ shares	4½	[illegible]
Oriental Telephone and Electric Company	1	[illegible]
Royal Electrical Company of Montreal	—	[illegible]
—— 4½ per cent. First Shares Mortgage Debentures	100	[illegible]
South London Electric Supply, Ordinary	2	[illegible]
St. James's and Pall Mall, Limited, Ordinary	5	[illegible]
—— 7 per cent. Pref.	5	[illegible]
—— 4 per cent. Deb. Stock, Red.	100	[illegible]
Telegraph Construction and Maintenance	12	[illegible]
—— 5 per cent. Bonds	100	[illegible]
Waterloo and City Railway, Ordinary	100	[illegible]
Westminster Electric Supply, Ordinary	5	[illegible]
Yorkshire House-to-House	5	[illegible]

NOTES.

atulations.—We congratulate Mr. W. H. Preece, .S., on his being nominated as president of the n of Civil Engineers for the forthcoming year.

g-Magnets.—Electromagnets capable of picking tons are used by an Illinois steel company to teel beams or plates from one part of a ship to

ess Telegraphy.—On Wednesday last Captain Kennedy, R.E., delivered a lecture on the above fore the Royal Service Institution. Lieut.-General t Grant, R.E., K.C.B., was in the chair.

ich Telephone Company.—This company has table of comparative telephone rentals and the to the number of instruments used per head of n in different countries and towns. The list is to February this year.

ay.—Our remarks on this station, it is pointed be misleading if we do not make it clear that on lamp-post are placed two incandescents, which operation automatically if the arc lamp circuit ig. Thus the district served by the arcs could id of light.

ation of Civil Engineers.—At the ordinary held on Tuesday last Sir John Wolfe Barry, F.R.S., the president, in the chair, the paper 'Extraordinary Floods in Southern India; their nd Destructive Effects on Railway Works," by . Stoney, M.E., M.I.C.E., was read.

l Palace Engineering School.—The com- directors of the School of Practical Engineering ed us to inspect the various departments of the Wednesday morning next. Sir Henry C. Mance, I.C.E., will take the chair at noon, and announce certificates awarded by the examiners.

loo and City Railway.—May 2 is spoken of ning date of this line, but the effects of the late g strike makes it rather likely that all the will not be ready by that date. One of the new this electric railway has been standing for some siding of the South-Western line ready to be i to the rails below.

ic Lighting in Cuba.—The troubles in Cuba means ended yet, and, from what we hear, the hting and gas companies are suffering with the Spanish Government is conducting its operations tirely on credit, and as a result money is very oughout the island. In the cities the gas com- the electric light companies can collect nothing. ess for payment, their plants are threatened by nment with confiscation.

:masione. — On Wednesday last the con- of the Siemens's Engineering Society was held harlton Assembly Rooms. The attractions of ig, besides a musical programme, were a large scientific exhibits illustrating the past history . Siemens Bros. and Co. as an electrical firm. rom many cable expeditions were also on view. mpany were present, and appreciated an exhibi- cinematograph by Mr. J. Peschek.

r Power Scheme.—The *Scientific American* s that a syndicate of New York and Saratoga has purchased, at a cost of £12,000, the land in ty of Hell Gate Rapids, on the upper Hudson, m miles above Glen Falls. The intention is to great water power at the place for an electrical plant. A dam and power-house are to be erected, and with the electricity generated therein a railroad, to be known as the Saratoga Northern, running between Saratoga Springs and South Glens Falls, will be operated.

Association of Municipal Corporations.—At a meeting of the above association, held last Saturday, the following resolution was proposed by the City of London Solicitor: "That it is undesirable that the jurisdiction of local authorities over telephone companies should be curtailed or interfered with by the undue exercise by her Majesty's Postmaster-General of his rights or privileges under the Telegraph Acts; and that a representation to this effect be made to her Majesty's Government." The resolution was carried, and referred to the council for action to be taken upon it.

Electric Testing Fees.—The London County Council have issued a new list of rules for testing electricity meters and for measuring the pressure supplied to a consumer, etc. We notice, however, that there is no essential differ- ence between them and those printed in our issue of Feb. 12 last year. The scale of charges is also practically the same, the only difference being in the charges for test- ing service lines and the insulation resistance of a con- sumer's wires. Now if the tests take more than two hours, a fee of 5s. per hour is charged instead of 3s. 6d. as formerly. The testing establishment of the Council at 42, Cransbourne-street is a most useful and necessary one.

Electric Lighting in Queensland.—The Rock- hampton (Queensland) Gas and Coke Company have forwarded to us their annual balance-sheet. From this we gather that the company have developed a healthy electric lighting department, which is showing a fair return on the capital expended on it. We notice, however, that the com- pany's Order in Council under the Electric Light and Power Act of 1896 is still under consideration, and may be issued at any time. An electric arc lighting contract has just been entered into by the company with the Rockhampton Harbour Board, which will mean increased revenue to the electrical department. From other parts of the report we gather that the two rival illuminants are being pushed equally, and that the arc lighting is much appreciated by the public.

Preserving Meats.—The Chemical Society of the Massachusetts Institute of Technology, composed mostly of instructors in the chemical department, have described recently a new process of preserving meats. The process proposed is simply to sterilise the meats by placing them for a certain number of hours close to an electric light. The actinic rays of light, not only from an electric light, but from almost any kind of light, are fatal in time to all kinds of germs, even the bacteria of anthrax. While the meats are exposed to the light, a stream of hot air at temperatures ranging from 115deg. F. to 150deg. F. is sent up through the box in which the meats are placed, to dry them. Then the thoroughly dried meats are powdered, and are thus ready for Klondike expeditions and for army and navy use.

Municipal Glasgow.—The Americans are booming the municipal enterprise of Glasgow to such an extent that at last they are assured that the cannie Scotch town pays all its expenses out of its commercial undertakings. The reply of the Lord Provost to queries as to the truth of the suggestion is as follows: "The Lord Provost of Glasgow has received communications from all parts of America desiring confirmation of a statement to the effect that the citizens of Glasgow would be free from all taxes or rates in consequence of the profits derivable from their gas, water, electric lighting, and other undertakings of the govern-

ment. I have accordingly been requested by the Lord Provost to inform you that this statement has no foundation in fact. There is no probability of this city being exempt from taxation.—Signed, JOHN S. SAMUEL."

A Digest of a Digest.—Mr. Carl Hering's digest of the current electrical literature in the *Electrical World* for March 19 contains the following: "Alternating-current motors. Atkinson. London *Electrical Engineer*, Feb. 25.—A brief abstract of a recent paper before the Institution of Civil Engineers on the theory, design, and working of alternating-current motors. The abstract contains no information, being merely a description of the paper." Mr. Carl Hering lays himself open to the *tu quoque* retort, as his digest is not even a description. The fact that the Institution of Civil Engineers do not permit any unofficial report or abstract of their papers is the cause of the want of detailed information complained of. Still, the official condensation we published did give a reader an idea of what to expect from a perusal of the paper.

Vacuum Tube Lighting.—The *Electrical Age* gives details of the work of Mr. John H. T. Haines in this field, and gives a number of photographs taken by the light from vacuum tubes. The author states the apparatus he has devised, and with which he produced vacuum tube lighting of pure whiteness, is unique. His tubes run perfectly cold and will stand a 10-hour test. With the wattmeter recording 200 watts in the line, he kept 16 tubes 5ft. long and 2½in. in diameter brilliantly illuminated. The photographs contained in the article were taken in a room, having no reflecting screens, with a 40-second exposure, at a distance of from 6ft. to 8ft. from the source of illumination. One of the important features of Mr. Haine's apparatus is a discharge occurring between two pairs of brass spheres, which he calls a double spark-gap. This device is adjustable automatically, and is devised for the purpose of keeping the two gaps in resonance. The articles goes on to state that Mr. Haines has produced the only successful open arc lamp, which burns with any frequency.

Proposed Autocar Tour.—The members of the Auto-mobile Club of Great Britain are arranging a six days' tour for Easter, which promises to be a most enjoyable one. On Thursday afternoon, April 7, the party will leave the club (4, Whitehall-court, London) and journey as far as Guildford, where they will halt for the night. On Good Friday the journey will be continued to Winchester, a halt being made at Farnham for luncheon. Winchester will be reached about 6.30 or 7 o'clock, and at 7.30 the club will dine at the Royal Hotel under the presidency of General Montgomery, who will next day join the party for the remainder of the tour. On Saturday evening Chichester will be reached, and on Sunday Worthing will be the headquarters, a visit being also paid to Brighton. On Monday Worthing will be left, and the members of the party will have the option of returning direct to London or going to Tunbridge Wells, and resuming the journey to London on Tuesday. It is to be regretted that electric motorcars will have difficulty in getting their accumulators recharged in most of the above towns.

Bicycle Lamps.—The idea of providing an electric lamp on a bicycle, and lighting it by means of a small dynamo driven from the wheels, is not new, but the *Electrical World* creates new interest in the subject by the reduction to watts of the actual work expended by a cyclist. Some recent tests made by Prof. Carpenter, of Cornell, to determine the power required to drive bicycles if reduced to the watt as a unit, shows that for a speed of five miles an hour on a good level road the rider works at the rate of about 19 watts, which is about one-third the power used in an ordinary 16-c.p. incandescent lamp.
10 miles an hour the power applied by the rider is abo
30 watts, and for hard, continuous riding, 100; for
short period a good rider can work at the rate of abo
250 watts. From this it will be seen that even for a 2-c.
lamp the extra exertion required to light it up would
felt as much as a head wind, as it must be remember
that the efficiency of a very small dynamo is low.
fact, from a 2-c.p. lamp we estimate that extra work
the equivalent of about 20 watts at least would be require

Street Transformer Boxes.—The Board of Tra
has given its decision on the matter in dispute between t
London County Council and the County of London a
Brush Provincial Electric Lighting Company as to t
placing of transformers in boxes under the pavemen
The County Council refused its consent to a notice of t
intention of the company to put down some street tra
former boxes, on the ground that too much public sp
was being utilised. The electric lighting company promp
appealed to the Board of Trade for permission to overri
the above decision. The Board gave its award on March
allowing the appeal, and approving the construction of t
transformer boxes, subject to the following conditions: (
that the said transformer boxes be constructed in a mann
precisely similar to the transformer boxes construct
within the area of the County of London (North) Electr
Lighting Order, 1892; (*b*) that there shall be no gas-pip
within such distance from any box as is equal in feet
the diameter of the gas-pipe in inches. This last cla
seems to be badly drafted, as a 24in. gas main down th
centre of a street would prohibit entirely the placing of
transformer box unless the road was at least 48ft. wid
We think a constant added to a much smaller multiple
the diameter of the pipe would give a result more co
sistent with the dangers to be avoided.

London Traffic.—Mr. Douglas Young read a pap
on London traffic problems and their solution before
Auctioneers' Institute on Tuesday. He began by a revi
of the growth of London, fixing the date of the first city
1107 B.C. At that time the traffic at the Bank was n
felt to be an inconvenience. The well-worn phrase th
"London is paved with gold" was emphasised by th
author, who stated that the time lost in the Strand ea
year owing to the congested state of the road was equivale
to the interest on £1,000,000. Mr. Young finally recom
mended the trolley system of electric traction for th
suburbs, saying that he had seen this system at work
Bristol, Rome, and Milan, and from an æsthetic point
view little or nothing was to be urged against it—in fa
the pillars or wires suspended from place to place we
made to hold the electric lamps, and became an ornament
feature. The system was safe, rapid and elastic as
speed, clean, comfortable, and flexible enough to apply
all routes, and met all contingencies of street traffic und
ordinary circumstances. It was supplanting all oth
systems, and in the farther suburbs the prospect
tramcars running in connection with a well-conceived circ
system of underground electric railways, opened up
bright future for largely solving the problems of stre
traffic, and for the comfort and convenience of the peop
and city.

Improvements in Electric Accumulators.—
a meeting of the members of the Liverpool centre of
Self-Propelled Traffic Association this week at the Roy
Institution, Colquitt-street, an interesting paper by M
J. T. Niblett, dealing with some recent improvements
electric accumulators and their application to traction
common roads, was read. It explained at length th
improvements which have recently been made in batteri

for road traction, and indicated how they are best d. Electric locomotion on common roads, the said, presented enormous possibilities, but the noisy gear should be done away with, and methods ırging would have to be seriously considered. r great the convenience of electric haulage, however s reliability, ease of manipulation, sanitary aspect, ıeral convenience, the question as to whether it is not has still to be satisfactorily answered. The cost and cost of maintenance of the batteries ıd would be the controlling factor. Whatever turn ı of electrically-propelled motorcars might take, it cessarily always involve the use of some apparatus ng and giving out electrical energy. The modern y battery left very much to be desired, but still ere several very good batteries for this purpose ıle, and these might serve to tide over the period ing before the advent of the ideal cell yet to be l.

Deputation Question.—The practice of sending r of committeemen to various places to investigate of electric lighting is in itself a good thing, as it those largely responsible for electric lighting enter- Still, it is sometimes doubtful if the expenses are really equivalent to the experience gained. spondent to the *East-End News* is assured that the trips are not made in *boná fides*, and proceeds what he considers to be instances of this. Not to the name of the place is only just, as we do not is belief, but the following paragraph shows his style: "In the expenses of the committee's ı trip is included 3s. for packs of playing cards! lerstood that any losses at 'nap' sustained by the ı will not be charged on the rates, but the cards Cigars and whisky were also provided at the of the rates. It is not known yet whether the the committee to see the pantomime, 'Dick gton,' is to be paid for by the ratepayers. It ave been more appropriate if the committee could en 'Aladdin; or, the Wonderful Lamp.' They o doubt, have been able to have reported fully on ılt of that gentleman's experiences." The corre- t finally lapses into poetry which, if the committee pelled to read, will counteract any pleasure they e had in the course of their excursions.

Bordeaux Muddle.—We gather from *L'Electricien* citizens of Bordeaux are to lose the electric lighting The gas company had previously undertaken to lectricity as well as gas, but it seems that they ithout legal authority in so doing. The facts s: The gas company have a perpetual monopoly ting by gas in Bordeaux, and in November, 1890, to take up electric lighting. The proposal was d by the majority of the shareholders, but as there issentients to the alteration in the objects of the y, it has been held by the courts that the change egal. Still, the company has laid down electric mains and plant and supplied a large number of ers. Lawsuit ensued over the question, and finally urt of Appeal in Paris has decided against the y. The defence was that gas-engines were used to the electrical energy, and hence that it was really lopment of their gas undertaking. This did not tter, and hence the gas company have to discontinue ply of electricity. The author of the long article contemporary contends that Bordeaux is worse off fore the judgment was passed, as he considers that n authorities have no power to grant an electric concession. Hence he argues that the theatres and other users of electricity will have to revert to gas as an illuminant. We can hardly, however, understand his argument that the monopoly of the gas company will prevent its electric rival from being used.

Temperature Effects on Magnets.—Mr. Carl Hering, in his digest published in the *Electrical World*, abstracts a long paper by Mr. Ashworth on methods of making magnets independent of change of temperature, and on some experiments with abnormal and negative temperature coefficients. He describes experiments made to ascertain what kinds of iron and steel are least liable to change under moderate temperature conditions. The samples were subjected to alternate streams of cold water and steam, the magnetism being measured at the time; this process was continued until the intensity fluctuated between two nearly constant values. The chief conclusions are that the temperature coefficient is generally less in hard iron and steels, and is particularly small in hardened cast iron. Certain hardened nickel steels have very small negative coefficients. He discovered negative coefficients in music wires. A change of sign of the coefficient by alteration of temper and dimension ratio was found, and this leads to methods of obtaining zero coefficients. He also found some relation between the dimension ratio and the self-demagnetising factor, temperature coefficient, and permanent loss of magnetism after alternate heatings and coolings. He observed an increase of intensity after a portion of the wire was dissolved; an original negative coefficient was made positive by increase of thickness. There are two practical ways of obtaining zero coefficients, by altering the hardness or the dimension ratio; the material of the magnet must also have certain chemical and physical properties not yet determined, the physical being the more important.

Scottish Society of Arts.—Last Monday Mr. G. K. Grieve read a paper on "The Comparative Cost of Gas and Electricity as Sources of Light, Heat, and Power" before the above society at Edinburgh. We hoped to be able to reproduce the gist of this paper in this week's issue, but Mr. Grieve writes to say that he does not wish to pose as an authority on the subject, and also that we should not be likely to agree with his views. We are, however, quite prepared to give him every opportunity of stating his case, and also the credit of his own opinion even if we do differ. He premises, however, that the electric lighting is promoted too much under false pretences and that its merits are unduly pushed by the electrical Press, who continually assert that it is cheaper than gas. The expression "cheaper" is, of course, open to many meanings, and must not be entirely restricted to a comparison only of cost for a given light. As an argument, Mr. Grieve sends us the following: At the lecture he had the hall lighted by incandescent gas lamps at a cost per hour of 1·3d., while electric light cost 5½d. per hour. Also, according to a statement the author has received, the Edinburgh street-lighting stands thus: present light, 538 arc lamps at £16 = £8,608; previous light, 1,614 gas lamps at 30s., £2,421; showing an increase of £6,187 for electric light. The additional light obtained is not to be valued by the author at anything. These latter figures were not included in the paper. As regards the cost of lighting a given room as above, we find, again, that the candle-power is not given, but we must also point out that the cost per annum rather than the cost per hour is required.

Paris Electricity Work.—The electric supply in Paris is in the hands of several companies, who at present are rather uncertain as to the ultimate duration of their concessions. In spite of this, new works have had in several cases to be laid down lately to keep the supply

up to the demand. The Compagnie Parisienne de l'Air Comprimé, which supplies a large area on the right bank of the Seine, is one of these, and their new works are fully described in *L'Industrie Electrique*, from which paper we cull the following details. The company started on the Chelsea system of using a number of battery sub-stations, and charging them in series. In fact, at the end of 1892 they had 21 such sub-stations, with about 785 tons of accumulators. Our contemporary says that these batteries had a charging capacity of 13,000 kilowatt-hours, and a capacity in discharge of 93,000 kilowatt-hours. This looks like an efficiency of 700 per cent., so we suppose a zero has got astray. A pressure of 4,000 volts was used for charging. In the next year rotary transformers began to be introduced, with a five-wire system at 110 volts. Four machines were always used in series, so that they had about 110 volts on each of the low-tension ends. The gradual change over to this system lasted to 1896, when the new station at the Quai de Jemnapes was constructed. This station contains some 23 sets of steam dynamos, each of 1,300 h.p. The engines are arranged on the ground floor, over these, again, on the first floor are the boilers, and over all provision in the way of coal-bunkers and water storage is provided. Full drawings of the station are to hand, but the details of the electric plant are left over to the next issue.

Prof. Forbes's Nile Scheme.—As is well known, Prof. George Forbes has been commissioned to draw up a report to the Government on the possibilities of using the power of the Nile cataracts. He has, says the *Daily News*, visited and surveyed the Nile from Assouan, the site of the first cataract, to a point not far from Abu Hamed, at which the fourth cataract is situated. The country between the fifth cataract, which occurs between Abu Hamed and Berber, and the sixth and last of the famous cataracts, was left alone, for the present at all events, though it is believed that scientific irrigation would make it some of the richest country in the world, being formed of ancient Nile mud. The river between the third and fourth cataracts was merely traversed, or roughly surveyed. The really serious and detailed investigations were made at the first, second, and third cataracts. The question which had got to be settled was whether it would be possible to use the force of the waterfall at those three points for driving power. This famous river, from half a mile to a mile wide, flows through a country mostly mountainous, sterile, and sandy on both banks beyond the narrow strip of a few hundred yards on either bank which is cultivated. It was thought that whilst they were about to construct the reservoirs for supplying the cultivators with a constant supply of water for their crops—sugar, cotton, rice, corn, and so on—it might be wise at the same time to see if some cheaper means of pumping could not be devised than by steam power. So, if the scheme is adopted, the waterfall will generate the electricity, which will be produced in the usual way, and supplied to pumping engines, factories, or works of any sort which require power. One of Prof. Forbes's duties, we understand, was to discover the wants of the cultivators, and already he has tabulated 18 distinct industries which would be largely and immediately benefited by harnessing the Nile.

Municipal Electricity Work.—Our esteemed contemporary, the *Journal of Gas Lighting*, is becoming a great believer in the success of electric lighting undertakings, and offers to its readers this week some most moral remarks on the taking over of the Sheffield supply by the Corporation. After mentioning the fact that the charge in future is to be 4d. per unit, it adds: "This is a result on which the Corporation, the consumers, and the electri lighting interest, both financial and technical, are to congratulated. The decision to acquire the undertakin at this time is a very rational one; and the price to paid is not high in the circumstances. The chief point be considered, of course, is the low price at which undertaking can supply current and pay a certain 10 p cent. dividend. This datum being ascertained, the Corpora tion are probably very well advised in taking over undertaking before it grows any bigger. They wish come in with the flowing tide, and not wait till it is hig water. This is wise; for there is probably plenty of roo in Sheffield for an electric light undertaking twice thrice the size of the present establishment." That, th *Journal of Gas Lighting* maintains, is the only criterion value for such concerns. It seems to us to be a rath indefinite criterion to apply when buying, and in the abov case the price was fixed more by the profit being made b the electric lighting company. Our contemporarary adds "Of course, there is a market for electric lighting Sheffield and every other town of sufficient importan When the fact of the existence of such a market established, the only proper thing to do is to serve it the best and cheapest way possible under the conditions. It is exactly the same with a gas undertaking The worst misfortune that could come to a business either kind would be to fall into the hands of incompeten administrators, who should think themselves permitted charge what they liked for their commodity because th public are bound to go to them for it. Sheffield fortunate in having real, live business men at the head both the electricity and gas undertakings. So long as th condition obtains, it will not matter to the public one whether the property belongs to the ratepayers or private proprietors." This we hardly understand, as pa experience shows that companies are not created consider only the convenience of the public, but to ear the maximum dividend out of this convenience.

The Glasgow Telephone Question.—The deputa tion to the Postmaster-General from Glasgow respectin the result of the late enquiry have had their interview The Duke of Norfolk, owing to ill-health, received th deputation in his own house. From the *Glasgow Hera* we glean the following account of the interview, which said to have been strictly private. The deputati disclaimed any desire to discuss the report of the com missioner who held the enquiry in Glasgow, but th sought to impress specially on his Grace a few speci points. The first was that the Corporation had nev admitted that it would be "a grave public inconvenie to have a telephone exchange confined to the area of th municipality of Glasgow." They believed it would be great public benefit to have such an exchange, although would be a still greater benefit to have it for the wid area embraced in their second application. They assur his Grace that the difficulty of the Corporation obtaini the necessary wayleaves for underground wires outside th limits of their own jurisdiction, which the granting of th second application would render necessary, was a pur imaginary difficulty. The outside authorities might, probably would, object to the National Telephone Com or any company working for private profit, obtaining wayleaves; but they were ready, and nearly all of had expressed their readiness, to grant facilities to Corporation of Glasgow, whose only object was the p interest. In the next place, the deputation urged, assu that the opinion which the Postmaster-General had obta that the Corporation, in the present state of the law, no power to carry on the business of a telephone exch

ct, that his Grace should exercise the discretion him and grant the application of the Corporation ise, subject to the condition that the Corporation ecure the necessary powers from parliament ntended that in any possible application to it they should not be prejudiced by a pronounce- the Postmaster-General which might be pressed ients into an argument for refusing the parlia- application. The Duke of Norfolk expressed his act impartially, and asked if the granting of a nditionally might not be held to prejudice any 1. The deputation replied that they were perfectly at the granting of a conditional license should be rded and hedged in as to leave most unfettered to Parliament in dealing with the Corporation's . In the course of the conversation the deputa- ated the decision of the Town Council under no nces to grant the Telephone Company the right to e streets. The Duke of Norfolk assured the n that he thoroughly understood the position, ould give it his careful consideration, and that he nmunicate with them shortly.

ulators on Ferry Boats.—The uses of ors to even-up loads are many, and as long amounts of power have not to be stored and en out over long intervals great advantage is rom their employment. In such cases large not so much an object as high discharge rates l efficiency. Our contemporary, the *Electrical* hose technical leaders are always well thought gests the employment of accumulators on ry boats. It argues as follows: "The con- f load necessary for the most advantageous accumulator system are almost exactly those ed by the engine of the ordinary steam ferry boat, when the distance the boat traverses in regular small. When the boat is resting at either journey the demand upon engine and boilers ile their full output is demanded when the oving at full speed. In the case of a boat 10-minute service—five minutes under way minutes at rest at either end—the average pon the engine would be less than half the maxi- and (less than half because of the periods when is allowed to drift in stopping). This is a highly way of operating engine, boilers, and fires, and, on, requires the equipment of the boat with an machinery twice as large as would be requi- rnish the average power. It has been found e that multiple-expansion high-pressure engines service do not give the economy which expected of them, owing to the time neces- bring the cylinders to the proper temperature g. In the case of a boat making such a schedule ove, and requiring 1,500 h.p. at full speed, the uipment might be replaced by an engine and f 750 h.p., a dynamo of 600 kw., a motor of on the screw shaft, and a battery of about 1,000 hours capacity. The boilers, engine, and dynamos worked all the time under a perfectly steady load erator fields were suitably wound and connected dition permitting the highest economy of working. ing and vibration of the boat would be reduced, ing to increase its life and diminish depreciation. f an accident to the engine, the battery would contain capable of propelling the boat for about one hour at l and for more than two hours at half speed, which long enough to tide over the repair of an ordinary re. Of course, the first cost and the complexity of such an equipment would be greater than that of the 1,500 h.p. engine and boilers, and its weight would probably be greater, but the losses in the generator, batteries, and motor would probably be more than made up in the increased economy of the engines and boilers, and the increased flexibility of the system might outweigh its disadvantages. The control of the propeller speed could also be effected to a nicety directly by the pilot instead of roughly through signals to another person, a consideration of no small moment in service requiring such frequent landings.

Disruptive Discharges in Air and Liquid Dielectrics.—Mr. T. W. Edmondson contributes a long article on the above subject to the *Physical Review*, in which he details the past experiments of others in the determination of spark-gaps in various media with different-shaped electrodes. The author has devoted special attention to the sparking distances between spherical electrodes immersed in different oils, such as are sometimes used in transformers. His results are plotted in curves and largely compared with those of other researches. The effect of the radius of the spheres used on the sparking distances in air with direct currents is expressed by the following: Radius, ·5cm.; dielectric strengths, 28·5 kilo-volts per centimetre. Radius 1cm., 30·6 kilo-volts; radius 2·0cm., 32·4 kilo-volts; and finally 3·0cm., 36 kilo-volts per centimetre. All these values are considerably higher than that obtained by Macfarlane for planes—*i.e.*, 23·8 kilo-volts per centimetre. It appears, then, that the potential necessary for a discharge when the spheres are close together is dependent to a great extent upon the size of the spheres as well as upon the nature of the electric field. The results of the insulating oils are by no means so uniform as those for air. In the cases of water-white distillate (a light oil resembling kerosene), mineral sperm oil, castor oil, and lard oil, the behaviour of the smallest spheres is somewhat anomalous. For the other spheres the results are of the same character as those obtained for air—that is, for small spark-lengths the dielectric is electrically strongest when the spherical electrodes are smallest. Whether the weakening of the dielectrics for small spheres when the spark-length increases takes place here also it is difficult to say, as it was impossible to obtain consistent readings for spark-lengths of more than 1·4mm. on account of the great disturbance of the liquid due to convection currents. There appear, however, to be some indications of such a change in several cases, notably in those of kerosene, water-white and export distillates, lard oil, and xylol, where the curves begin to converge. The following are the dielectric strengths in kilo-volts per centimetre for different oils as obtained by Mr. A. L. Clark: kerosene, 112; water-white distillate, 158; paraffin oil, 127; export distillate, 96; natural sperm oil, 60; mineral sperm oil, 69; raw linseed oil, 67; boiled linseed oil, 67; olive oil, 51; neatsfoot oil, 52; castor oil, 104; lard oil, 27; turpentine, 70; xylol, 49. It will be noticed that, with the exception of lard oil, all the above oils are dielectrically stronger than air. The results of the experiments with the alternating current were not very satisfactory, the measurements of spark-lengths showing remarkable departures from the evenness of the results obtained for the electrostatic discharge. The source of potential was a large induction coil from which the make-and-break attachment had been removed. Through the primary of this coil was passed an alternating current at an E.M.F. of 50 volts and frequency 125, which was obtained from the ordinary street service. It was found, however, that the dielectrics are electrically weaker for spheres of 3cm. diameter than for the smaller sizes of 1cm. and 2cm. diameter.

LORD KELVIN'S PATENTS.*

(*Continued from page 359.*)

PORTABLE OR MARINE VOLTMETERS AND AMPERE-METERS.

For the measurement of potential in connection with electric lighting or power installations on board ship, the mass of the moving part of the balance voltmeter and engine-room voltmeter is too great to be convenient for accurate use. The marine voltmeter now to be described is specially suitable for such a purpose, but it is also equally useful as a portable voltmeter for general use. The resistances to enable the instrument to be used as a voltmeter are wound anti-inductively on two brass cylinders, and the lower one of these may be arranged to serve as a convenient means of supporting the instrument on a table or shelf. When, as is most commonly the case, the mean potential to be measured is 100 volts, the platinoid resistance is adjusted to make up, along with the fine copper wire solenoid (of which the resistance is about 60 ohms), a total resistance of 1,000 ohms. Thus, the direct reading of potential on the scale is in volts.

In order to save time in taking readings a checker is provided. A brass arc, capable of moving in a vertical direction, is placed parallel to and slightly below the plane in which the pointer moves, and by means of a handle this arc may be brought gently and momentarily into contact with the pointer so as to quickly stop its oscillations.

FIG. 11.—Portable or Marine Voltmeter.

When the instrument is to be used for very accurate work, a means of observing and annulling any error due to residual magnetism in the oblate may be provided by a reversing key placed below the scale box, and two magnets screwing into the sheath. The current through the instrument is made in one direction when the handle of the reversing key is in the top position, and made in the opposite direction when the handle is in the bottom position. The current is broken when the handle is on either side. The residual effect in the instrument is very small, and it is found to be sufficiently accurate for all practical purposes without this adjustment.

The Marine Ampere-meter.—The marine ampere-meter is similar to the marine voltmeter as described above, with the exception that its solenoid is made from one or more turns of heavy copper conductor. Three ranges of the instrument are usually made—viz. (I.) 40 to 160; (II.) 60 to 270; (III.) 100 to 500.

The instrument consists of a small oblate of soft iron supported on a stretched wire in the centre of a solenoid of fine copper wire connected in series with platinoid resistances, variable according to the potential to be measured; and is founded on the principle that an oblate spheroid of soft iron, movable round a diameter, tends to turn its equatorial plane parallel to the lines of force in a uniform

* Abstract of paper read by Dr. Magnus Maclean to the Philosophical Society of Glasgow, Feb. 23.

magnetic field. The pointer is fixed relatively oblate in such a manner that, when the pointer is zero position of the scale, the equatorial plane of the is inclined about 45deg. to the lines of force of the so The suspending wire is stretched between th ends of a brass tube, being fixed at the botto and carried at the upper end by a torsion head, is secured by screwing down upon it the movable the top resistance coil. Portions of the tube are cut to permit of easy access to all parts of the instrume adjustment or inspection. In order to prevent dam the suspending wire or accidental disturbance of the t head, two brass cylinders, which also serve to carr resistance coils, are placed covering the two ends supporting tube, and are fixed by screws to the s The scale is graduated from zero to 140, but fo venience of observation the first marked division It is placed in a horizontal box with a glass fixed to the sheath, and the pointer shows by tion direct reading of currents of from 50 to milliamperes. The instrument is provided with a so that its scale can be read from a distance.

THE AMPERE AND VOLT GAUGES.

These instruments are intended for use on switchb where on account of the intense field of their sole and the fact that their movable magnetic system is

FIG. 12.—Ampere Gauge.

vertical, they are found to be free from effects of currents. The ranges of the different types of the ment usually made are:

I.	From	·25	to	5	amperes.
II.	„	1	„	20	„
III.	„	5	„	100	„
IV.	„	10	„	200	„
V.	„	25	„	500	„
VI.	„	50	„	1,000	„
VII.	„	200	„	2,000	„
VIII.	„	600	„	6,000	„

The instrument is of simple construction, hav vertical slate base-plate, to which are attached solenoid of special form, having a very intense (*b*) brass bearing plates supporting a balance which a soft-iron plunger on its one arm and a brass counte weight on the other; (*c*) a brass arc having a scale gra to give direct readings in amperes.

The solenoid is built up of copper plates with mic lation between them, and is fixed to the base-plate its core is vertical. The balance is supported on knife at such a distance below the solenoid that the top the plunger is slightly entered into the core. The p is made from a thin soft-iron wire about 20cm. lon is supported by a cross-bar with two hooks on it, pass over two knife-edge stirrups on the arm of the b It has a brass weight hung on its lower end in or

n a vertical position and prevent its being attracted he side of the solenoid. An indicating needle, or formed from a strip of platinoid, passes down from nion of the balance to the brass arc bearing the d scale. As the plunger is attracted upwards, this passes round the scale and indicates the strength of passing through the solenoid. A dash-pot containing ced below the plunger and renders the instrument eat" in its action. When the instrument is packed age, the plunger and pointer are removed and in a separate cardboard box. They should not be o place in the instrument till it is fitted in its position. The instrument should be secured to a means of its electrodes, so that the pointer is in e plane with the scale and stands at 0 when no is passing through the solenoid.

DARD DIRECT-READING ELECTRIC BALANCES.

instruments are founded on the mutual forces, d by Ampère, between movable and fixed portions ctric circuit. The shape chosen for the mutually-ng portions is circular, and each such part will be r brevity an ampere ring; or sometimes simply a ether it consists of only one turn or of any number of the conductor; or an arc when it consists of a whole turn. In each of the balance instru-xcept the kilo-ampere balance, each movable ring ed by two fixed rings—all three approximately l. There are two such groups of three rings—to 600 amperes, the main current through each circle, whether of one turn or of more than one turn, is carried by a wire rope of which each component wire is insulated by silk covering, or otherwise, from its neighbour, in order to prevent the inductive action from altering the distribution of the current across the transverse section of the conductor.

The balancing is performed by means of a weight which slides on an approximately horizontal graduated arm attached to the balance; and there is a trough fixed on the right-hand end of the balance into which a proper counter-poise weight is placed, according to the particular one of the sliding weights in use at any time. For the fine adjustment of the zero a small metal flag is provided, as in an ordinary chemical balance. This flag is actuated by a fork, having a handle below the case outside. To set the zero, the left-hand weight is placed with its pointer at the zero of the scale, and the flag is turned to one side or the other until it is found that, with no current going through the rings, the balance rests in its sighted position. To measure a current, the weight is slipped along the scale until the balance rests in its sighted position. The strength of the current is then read off approximately on the fixed scale (called the inspectional scale), with aid of the finely-divided scale for more minute accuracy, according to the explanations given below. Each number on the inspectional scale of the ampere balances is twice the square root of the corresponding number on the fine scale of equal divisions. In the watt balances the numbers on the inspectional

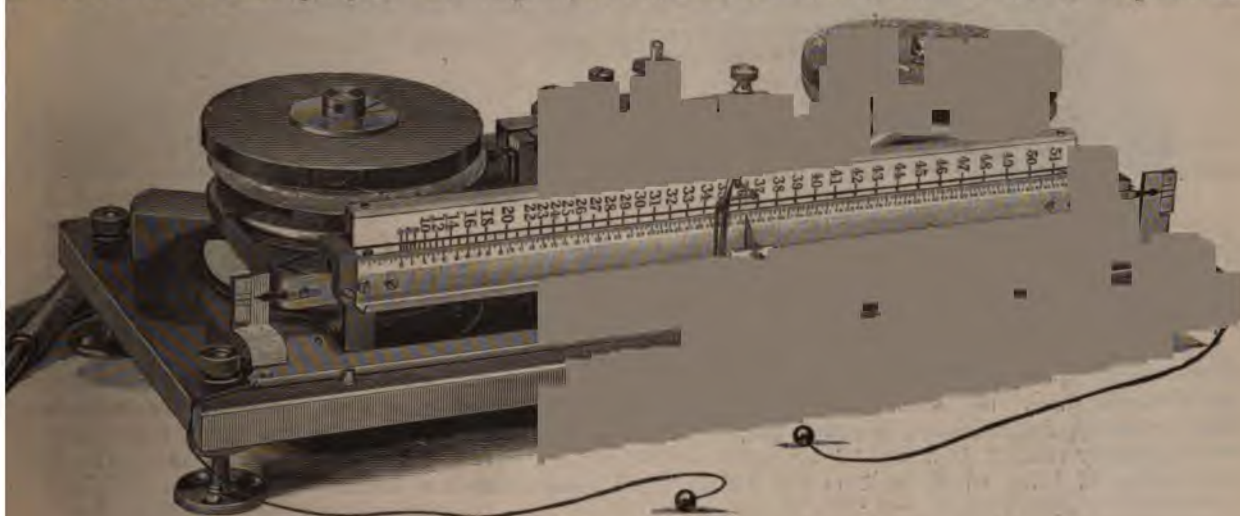


FIG. 13.—Standard Deka-Ampere Balance.

able rings attached to the two ends of a horizontal arm pulled, one of them up and the other down, r of fixed rings in its neighbourhood. The current posite directions through the two movable rings ically annul disturbance due to horizontal com-of terrestrial or local magnetic forces. In a kilo-balance the whole current passes through a single ng and divides through two halves of a movable ich are urged one up and the other down by the amperian force. In all the instruments the arm is supported by two trunnions, each hung by c ligament of fine wire, through which the current nto and out of the circuit of the movable rings or

l the balance instruments, in which the movable between two fixed rings, the mid-range position of vable ring is in the horizontal plane nearly midway n the two fixed rings which act on it. The current opposite directions through the two fixed rings, so e movable ring is attracted by one of the fixed rings elled by the other. The position of the movable quidistant from the two fixed rings is a position of um force, and the sighted position, for the sake of y, is above it at one end of the beam and below it other, in each case being nearer to the repelling the attracting ring by such an amount as to give per cent. more than the minimum force. In the instruments to measure alternate currents (which also used for direct currents) of from 1 ampere

scale correspond to those on the fine scale. The slipping of the weight into its proper position is performed by means of a self-releasing pendant, hanging from a hook carried by a sliding platform, which is pulled in the two directions by two silk threads passing through holes to the outside of the glass case. Four pairs of weights (sliding and counterpoise), of which the sledge and its counterpoise constitute the first pair, are supplied with each instrument. The weights are adjusted in the ratios of 1 : 4 : 16 : 64, so that each pair gives a round number of amperes, or half-amperes, or quarter-amperes, or of decimal sub-divisions or multiples of these magnitudes of current, on the inspectional scale. The useful range of each instrument is from 1 to 100 of the smallest current for which its sensibility suffices. The ranges of the different types of this instrument regularly made are—

I. Centi-ampere balance from 1 to 100 centi-amperes.
II. Deci-ampere " " 1 to 100 deci-amperes.
III. Deka-ampere " " 1 to 100 amperes.
IV. Hekto-ampere " " 6 to 600 amperes.
V. Kilo-ampere " " 25 to 2,500 amperes.
VI. Composite " " ·02 to 500 amperes. and from 100 to 50,000 watts (at 100 volts).
VII. Deci-watt balance, to suit currents from 0·1 to 20 amperes.
VIII. Deka-watt balance, to suit currents from 0·5 to 100 amperes.
IX. Hekto-watt balance, to suit currents from 5·0 to 500 amperes.
X. Kilowatt balance, to suit currents from 25 0 to 3,000 amperes.
XI. Kilowatt balance, to suit currents from 100 0 to 10,000 amperes.

N.B.—The ampere balances are designed to carry 75 per cent. of their maximum current continuously, and carry their maximum current long enough for all standard purposes.

The following table shows for each type of instrument the value per division of the inspectional scale corresponding to each of the four pairs of weights:

	I. Centi-amperes per division.	II. Deci-amperes per division.	III. Amperes per division.	IV. Amperes per division.
1st pair of weights	·25	·25	·25	1·5
2nd ,,	·50	·5	·5	3·0
3rd ,,	1·0	1·0	1·0	6·0
4th ,,	2·0	2·0	2·0	12·0

The fixed inspectional scale shows approximately enough for most purposes the strength of the current; the notches in the top of the aluminium scale show the precise position

FIG. 14.—Standard Kilo-Ampere Balance.

of the weight corresponding to each of the numbered divisions on the fixed scale, which practically annuls error of parallax due to the position of the eye. When the pointer is not exactly below one of the notches corresponding to integral divisions of the inspectional scale, the proportion of the space on each side, to the space between two divisions, may be estimated inspectionally with accuracy enough for almost all practical purposes. Thus we may readily read off 34·2 or 34·7 by estimation with little chance of being wrong by 1 in the decimal place.

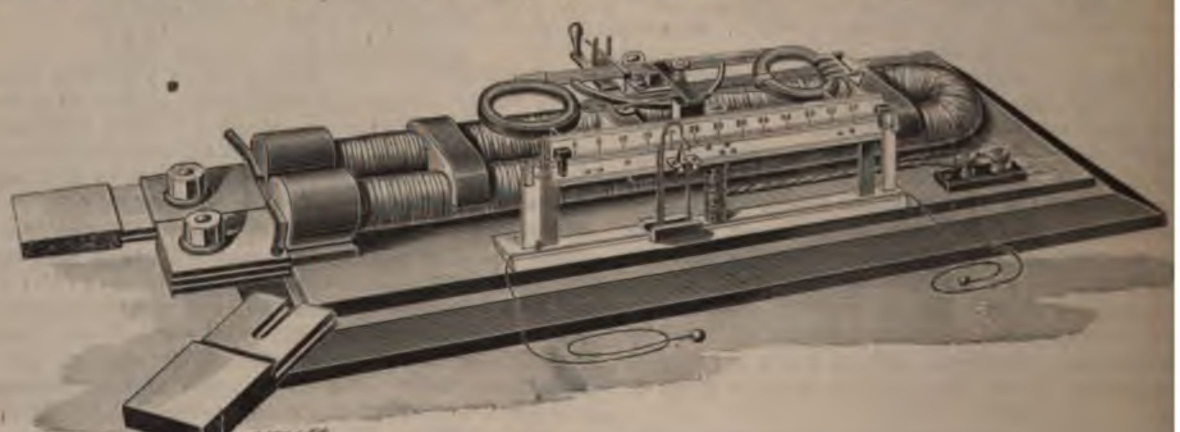


FIG. 15.—Alternate-Current Kilowatt Balance.

But when the utmost accuracy is required the reading on the fine scale of equal divisions must be taken, and the strength of current calculated by aid of a table of doubled square roots. Thus, for example, if the reading is 292 we find 34·18, or, say, 34·2 as the true scale reading for strength of current; or, again, if the balancing position of the pointer be 301 on the fine scale, we find 34·70 as the true reading of the inspectional scale.

The centi-ampere balance, with a thermometer to test the temperature of its ampere rings, and with platinoid resistances up to 1,600 ohms, serves to measure potentials of from 10 volts to 400 volts.

CONSTANT OF THE CENTI-AMPERE BALANCE WHEN USE[D AS A]
VOLTMETER.

Weight used.	Resistance in circuit.*	Volts per [division] of fixed [scale]
First pair of weights	400	
,,	800	
,,	1,200	
,,	1,600	

* Including resistance of the instrument, which is about

If the second pair of weights is used, the constants double of those noted above.

COMPOSITE BALANCE.

This instrument is similar in form to the cen deci-ampere balances, but the pair of fixed coils end of the beam are made of a rope of insulate similar to that used for the coils of the hekto- balance. Separate electrodes are provided for th coils, and for the fine-wire coils. A switch which the movable coils either to be included in the by themselves or in series with the fixed fine-wi is attached to the underside of the sole-plate instrument. When the handle of the switch is to "Watt," the movable coils alone are in the c but when the handle is turned to "Volt," bo movable and the fixed fine-wire coils are circuit. The composite balance can be used as ampere balance, or as a wattmeter, or as a voltme following the instructions given below. To enal composite balance to be used as a direct-reading wat or voltmeter, a separate anti-inductive resistance o noid wire, subdivided into four coils, is usually su The first coil is equal to the resistance of the fixe wire coils, and is intended to be included in the cir the movable coils when the instrument is used as meter. The second coil is arranged to make up 200 with the resistance of the fine-wire movable an

The third coil is 200 ohms and the fourth is 400 It is not advisable that the current through these ices should be allowed to exceed 0·5 ampere.

STANDARD WATT BALANCES.

main use of the watt balance is to measure the ergy developed in an inductive alternating-current The balances are, except those described below, in form to the standard ampere balances, but the e coils are, as in the case of the composite balance, with fine wire. These coils are of low resistance, e joined up in series with a large anti-inductive ice in a "potential circuit" across the mains, while d coils carry the whole current in the circuit to be ed, and are inserted in one main. The instruments vided with weights similar to those used with the alances, and a certificate is given stating the number s per division for each weight.

IC WATT BALANCE FOR THE MEASUREMENT OF CURRENTS UP TO 10,000 AMPERES.

e instruments were designed in the first instance to quirements for a standard balance to read up to amperes. For this purpose it was not considered le to use the ordinary idiostatic "Kelvin" balance unt of the necessarily enormous proportions which vable beam would have, and the consequent limita- range due to possible stiffness in the suspending t. The instrument was therefore designed on the ter plan, in which the main current passes through opper conductors, while a small current of measured is passed through two coils of fine wire at each a movable beam in every way similar to that centi-ampere balance. The main conductor is like a double rectangle, and the current is con- in by one electrode round three sides of the top le then down by a connecting piece round three the bottom rectangle and out by other electrode. am, with its movable fine-wire coils, is situated the two rectangles, and its terminals are brought binding screws. The action when the current is is the same as in the other electric balances—viz., it-hand coil on the beam is attracted and repelled he current passing through the fixed conductors nd below, and the left-hand coil is similarly repelled racted down, the resulting force being balanced by ling along of a weight on a graduated scale. The ing rectangles are each made of a thick copper vith a slot about 0·5cm. wide cut from the right- de up to within 9cm. of the left-hand end.

instrument is, of course, a self-contained wattmeter, en it is to be used as such extra resistances are pro- or the fine-wire circuit. The resistance of the fine- oils is about 10 ohms, and the extra resistances d are subdivided into coils of 400 ohms each so as nit of an adjustment of the instruments constant 0 to 2,000 watts per division of the scale. When strument is used as a standard ampere balance, rrent values can be obtained by dividing the readings by the E.M.F. if a reliable voltmeter ilable, but for very accurate working it is best sure the actual current passing through the fine- oils on an auxiliary instrument, such as a centi- balance. By this method great sensibility can ained, as currents up to one ampere can be used, the constant of the instrument can be varied asure from 0·1 ampere to 10 or 20 amperes per n of the scale, and thus a range of measurement 0·1 to 10,000 amperes is provided. The balance, cribed above, is intended for use with continuous it, and it is evident that an instrument of this if used with alternating current, would require ial constant to suit different periods of alternation.

ALTERNATE-CURRENT KILOWATT BALANCE.

suit cases where the testing is either on direct or ating systems, a different type of instrument with a led main conductor is made. The main conductor is shape, and passes under the movable coils. This ctor is made up of ropes of insulated copper wire, ed together so as to form a cable with a hollow core. In order to correct any effect due to the induction of one arm of the coil upon the other the twisting is done in a very careful manner, so that the strands of the cable which are inside on passing the left-hand movable coil on one side are outside on passing the right-hand movable coil on the same side, and are in the reverse direction on the other arm of the U. The core of the cable is, as mentioned above, hollow, and brass tubes are passed up each arm of the U as far as the bend. The main object of these tubes is to prevent any deformation in the cable, but they also serve as a means of blowing air through to keep the conductor cool, if it should ever be necessary to use it for much heavier currents than those for which the instrument is primarily intended.

(To be continued.)

NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

[*Copyright.*]

XCVI.

The compound obtained by Schönbein can be produced only by the action upon cotton or other forms of cellulin of the most anhydrous mixtures of nitric and sulphuric acid $\left(\text{such as } \left.\begin{matrix} 2HNO_3 \\ 2H_2SO_4 \end{matrix}\right\} + H_2O, \text{ or } \left.\begin{matrix} HNO_3 \\ H_2SO_4 \end{matrix}\right\} + H_2O.\right)$, or by repeated immersion a mixture of these acids not more hydrated than the following—viz.:

$$\left.\begin{matrix} 2H_2SO_4 \\ 2HNO_3 \end{matrix}\right\} + 3H_2O.$$

This is the pyroxylin compound designated A by Hadow, who assigned to it the following composition: $(A) = C_{18}H_{21},9NO_2,O_{15}$; or (dividing the given numbers by 3), $(A) = C_6H_7,3NO_2O_5$.

Cellulin being $C_6H_{10}O_5$, this compound (A) is now termed tri-nitro cellulin; the reaction by which it is formed being expressed by the following equation:

$$C_6H_{10}O_5 + 3HNO_3 = C_6 \left\{\begin{matrix} H_7 \\ 3NO_2 \end{matrix}\right. O_5 + 3H_2O.$$

Here we see that three atoms of H in cellulin have been replaced by three atoms of peroxide of nitrogen or *nitryl.*

Tri-nitro cellulin, as usually produced, is soluble in ethyl acetate $(C_2H_5,C_2H_3O_2)$, but quite insoluble in any mixture of alcohol (C_2H_6O) with ordinary vinic or "sulphuric" ether $[(C_2H_5)_2O]$. But if it be prepared with the sesqui-hydrated acid mixture given above, at a temperature of 122deg. or 130deg. F., it is found to be quite soluble in a mixture of 1 of alcohol and 8 of ordinary ether. The effect of similarly raising the temperature of more hydrated acid mixtures will be referred to below. Tri-nitro cellulin in a pure state is somewhat difficult to produce—slight differences in the strength of the acids producing a great difference in the result. Although a stable compound (when pure) it is dangerous from its violent explosive properties; and being, so far as I know, useless for purposes not involving battle, murder, and sudden death, it is best, from our point of view, to have nothing to do with it in practice. Compounds containing certain percentages of it, probably not in admixture but in combination, are, however, of great utility and value; and these cannot be neglected by the electro-chemist or ignored by manufacturers of storage batteries.

XCVII.

When cotton and other forms of cellulin are treated with a mixture of nitric and sulphuric acid having the following composition—viz.:

$$\left.\begin{matrix} 4H_2SO_4 \\ 4HNO_3 \end{matrix}\right\} + 7H_2O,$$

the compound termed by Hadow B (or β) and found by him to have the composition $C_{18}H_{22},8NO_2,O_{15}$ is produced. If we take the liberty of dividing the atoms and molecules—or, rather, the numbers expressing the atomic and molecular weights—the above acid mixture becomes

$$\left.\begin{matrix} H_2SO_4 \\ HNO_3 \end{matrix}\right\} + 1{\cdot}75H_2O;$$

and the compound becomes

$$(B) = C_6H_{7\cdot5},2\cdot6NO_2O_5.$$

Now the acid mixture in question is very conveniently produced by gradually adding 16 fluid ounces of sulphuric acid of specific gravity 1·833 (or thereabout) to 17½ fluid ounces of nitric acid of specific gravity 1·424, kept as cool as possible by water or ice *outside* the vessel containing it. The specific gravities specified are those of acids to be readily obtained in commerce, and which can be manipulated without much inconvenience. If we take weights instead of volumes, the mixture corresponds to

$$\begin{array}{r} H_2SO_4 + \cdot33H_2O \\ \text{and } \underline{HNO_3 + 1\cdot42H_2O} \\ = H_2SO_4 + HNO_3 + 1\cdot75H_2O. \end{array}$$

One part of finely carded cotton may be immersed in 15 parts, by weight, of the acid mixture.* The compound (B) produced is insoluble in glacial acetic acid, but unlike the compound (A) is perfectly soluble in ether-alcohol. It is very noteworthy that if the compound has been produced at ordinary temperatures—say, at 60deg. F.—the solution formed by dissolving it in the proportion of six grains to the ounce of solvent, is thick and glutinous, whereas, if the compound (B) has been produced by the action of the above-mentioned acid mixture at the temperature of 122deg. F to 130deg. F., the solution is perfectly fluid, and produces on drying films or sheets of great strength and toughness, well adapted for photographic, surgical, and many other purposes

This compound (B) is less explosive than (A), but is still dangerously so—*i.e.*, putting aside the burning and scorching effects, the atmospheric concussion is still violent by reason of the suddenness of the combustion. It appears to be, not a definite compound, but one intermediate between tri-nitro and di-nitro cellulin. The reaction by which the latter compound would be formed and its constitution are expressed in the following equation:

$$\left.\begin{matrix} C_6H_{10}O_5 \\ \text{(cellulin)} \end{matrix}\right\} + 2HNO_3 = C_6\left\{\begin{matrix} H_8 \\ 2NO_2 \end{matrix}\right. O_5 + 2H_2O$$

Di-nitro cellulin is thus .... $C_6H_82NO_2O_5$.

Adding the components of tri-nitro cellulin, and halving } $\dfrac{C_6H_73NO_2O_5}{2)C_{12}H_{15}5NO_2O_{10}}$.

we obtain .... $C_6H_{7\cdot5}2\cdot5NO_2O_5$,

which is an approximation to the compound (B).

XCVIII.

When cellulin is treated with an acid mixture having the following composition:

$$\left.\begin{matrix} H_2SO_4 \\ HNO_3 \end{matrix}\right\} + 2H_2O,$$

the pyroxylin compound designated (C) and having the composition $C_{18}H_{23},7NO_2,O_{15}$ is obtained: it has been termed Gladstone's *cotton-xyloidin.*

For purposes of comparison, we may divide by 3 the number of atoms and molecules. Thus,

$$(C) = C_6H_{7\cdot\dot{6}},2\cdot\dot{3}NO_2,O_5.$$

This compound is richer in nitric oxide than di-nitro cellulin, though poorer than the compound (B). It is freely soluble both in other and glacial acetic acid. It is highly combustible rather than explosive, and burns with a slow jet of flame when rammed into a tube and ignited.†

XCIX.

The weakest or most hydrated mixture of nitric and sulphuric acids that has been used for the treatment of cellulin to produce a substitution compound in which H is replaced by NO_2 is the following:

$$\left.\begin{matrix} 2H_2SO_4 \\ 2HNO_3 \end{matrix}\right\} + 5H_2O.$$

With this acid mixture Hadow produced the compound (D), having the composition $C_{18}H_{24},6NO_2,O_{15}$, or $C_6H_82NO_2O_5$. By the action of the above acid the texture of cotton is more or less destroyed; a resulting compound, quite insoluble in acetic acid, partially soluble in ether-alcohol—some apparent changed cotton remaining undissolved. It thus that the soluble portion is the lowest compound obt by the action of mixed acids on cotton. This com is very combustible, but not explosive; and it likely to be of considerable value commercially.

In theory, at least, there should be another cellulin—viz., the mono-nitro cellulin C_6H_9,NO_2,O duced by the following reaction:

$$\left.\begin{matrix} C_6H_{10}O_5 \\ \text{(cellulin)} \end{matrix}\right\} + HNO_3 = C_6\left\{\begin{matrix} H_9 \\ NO_2 \end{matrix}\right. O_5 + H_2O.$$

Watts and Tilden* have assigned to *xyloidin* the formula—viz., C_6H_9,NO_2,O_5—but I am not acquainte any nitro-cellulin containing so low a proportion of Muspratt, Miller, and other authorities double the tion, giving $C_6H_8,2NO_2,O_5$ as the constitution of xy which would thus be identical with the (D) compo Hadow. No doubt this discrepancy will be cleared enquiry in the right quarter.

Xyloïdin is produced by stirring dry and po starch—identical in chemical composition with cel into nitric acid of specific gravity 1·5—*i.e.*, acid con 91 per cent. of HNO_3. Muspratt directs that the should be boiled in the acid; but this is inconvenie I have not found it to be necessary. The starch gra dissolves in the acid at ordinary temperatures, and with it a transparent jelly. [But if the acid be hydrated than that above mentioned, it may decomposed, with evolution of copious red fumes When the jelly is thrown into a comparatively quantity of water, a white, curdy substance, in in that liquid, is obtained: this is xyloïdin. It di in most of the pyroxylin solvents, and is suscept many useful applications. Like the compound (D) it an opaque white film on the evaporation of the s but so do many other of the nitro-cellulin compound water is present.

C.

From the point of view of the electro-chemist with secondary cells, it is important to note that th cellulin and xyloïdin compounds may be reduced t original form of cellulin and starch by the action of re agents. Thus, although it may be impossible other distinguish between two films respectively obtaine Hadow's (D) compound and from xyloïdin, in th solvent, yet by digesting them in a solution of potassic sulphide (KHS) the compound (D) w reconverted into cellulin, and the xyloïdin w reconverted into starch, which, unlike the celluli yield a blue coloration with iodine. Although ments in this direction are wanting, there is no to suppose that the reducing action of K more energetic than that of hydrogen, when the h evolved in contact with nitro-cellulin compounds. other hand, the susceptibility of these compou the action of reducing agents may explai deterioration of celluloid in many cases this has been observed; and it further in that, although pyroxylin may be an excellent m with which to encase the peroxide elements accumulator, it may be very necessary to avoid its an envelope for the spongy-lead elements. Al "tons" of celluloid have been used in connectio accumulators, no investigation has been made, or likely to be made, in this direction, nor in many necessary directions, by those who should be most int in the questions at issue. *Tanta est stultitia!*

CI.

The known and tried solvents for nitro-celluli pounds, besides the well-known mixtures of "sul ether, and alcohol, and of glacial acetic acid w without alcohol, are: Ethyl acetate, or acetic ($C_2H_5,C_2H_3O_2$), with a boiling point a little over 165d acetone (C_3H_6O) boiling at 133deg.; amyl

* The proportion of cellulin may be increased when economy is to be studied, and the exact nature of the product is not of importance.

† Sheridan Muspratt.

* Watts's "Manual of Chemistry" (second edition), p. 211.

O_2) boiling at 271deg; methyl acetate $_2$) boiling at a little over 133deg.; and, as a ent, when volatility is objectionable, amylic $I_{12}O$) with a boiling point as high as 269·6deg. F. tion with one or more of these solvents, camphor to the extent of half the weight of the pyr- sed in the production of celluloid. By the aid lvents many beautiful and useful products may ained.

QUESTIONS AND ANSWERS.

his heading we insert questions and answers cal character relating to central-station work, ork, or construction work; and for each suit- ion offer *one shilling*, and for the best solu- y question we offer *ten shillings*. We also *illings* for every other answer we print. The any question should be sent within 10 days uestion has appeared, and should be written on the paper only. We would call the attention nding in answers to the fact that the neatness ches sent in is considered when marking the ues of these answers. Questions may be sent .

Questions.

e the advantages and disadvantages in using steam- in a central supply station?—F. M. M.

pply stations in adjoining districts use respectively 2,400 volts on their high-tension mains. Sketch t and most economical arrangement of booster ion to allow power to be transferred from one district ther.—P. T.

Answers.

. 45.—Assuming that no two different types of te-current transformers "bank" or parallel correctly r at all loads, at what point of the load is it most le to have them parallel correctly—*i.e.*, to give the oltage.

wer to No. 45 *(awarded* 10*s.).*—No two different nsformers have precisely the same characteristics. may be wound for a greater ohmic drop, the y of the iron stampings may be different, or tic leakage may be more than in a transformer make. Any one of these varying characteristics ly or indirectly affect the terminal secondary the transformer. For the perfect parallel transformers it is necessary that they should same size and design, in order that they will l secondary pressures at all loads. Consider nsformers working in parallel or "banked," and m being designed for a greater ohmic drop in gs than the others. On open secondary circuit load all the transformers would give the same t as the load is put on the "bank," the trans- h the greatest drop would be unable to take up f the work, and consequently the others would upon to do more than their fair proportion. eakage and variation in the permeability of the also indirectly cause a difference in the curve of M.F. in transformers.

ent types of transformers must be "banked" in s, it is very important that they should parallel t full load in order that each may be worked to acity. It might easily occur that if four 20-kw. rs were "banked," and giving out a load of ween them, one or more of them might be doing ly more than 20 kw. and the others less than ing to the drop being different in each. This g might result in the injury of the insulation of ormers, or, perhaps, blowing of the fuses, and ring all the load on to the remaining transformers, ho would be unable to bear the load, and con- the fuses of the whole bank of transformers r. At light loads it is not so essential that each r should be doing its proper share of work, as is plenty of margin on each.—J. P. B.

to No. 45 *(awarded* 5*s.).*—If the magnetic two transformers is negligible, and they each have a separate drop of 2 per cent. at full load, then they parallel correctly at all loads, whatever their relative sizes may be—that is, each takes its due share of the load, and at full load each is giving its maximum secondary current. In ordinary commercial transformers, however, the leakage of magnetic lines, although small, is always appreciable, and varies even in transformers of the same type and size. If we plot out the secondary volts of a transformer and the secondary watts, the curve is not quite a straight line, and the slope of the curve gets more rapid as we reach the maximum permissible drop of 2 per cent. These curves of secondary volts not being quite similar for different transformers, a little consideration will show that they will rarely work in parallel so that each takes its due share of the load, and so we have to consider how they divide the load between them at various loads.

There are two cases that arise and which we have to consider: (1) when an extra transformer is put in parallel with the house transformer owing to more current being wanted, and (2) when transformers are banked at a sub-station and automatically or otherwise switched into the circuit as the load on the sub-station increases.

1. Suppose that we have a 2-kw. and a 20-kw. transformer supplying a house circuit. In practice, an automatic switch would be used, which would switch in the large transformer when the house load exceeded 2 kw. Still, it is interesting to consider what would happen if they were connected permanently in parallel. We shall suppose that the secondaries each give exactly 100 volts at no load and 98 volts at full load, so that at full load the transformers would parallel correctly, for it is well known that the wave of secondary E.M.F. is exactly similar in shape to the wave of primary E.M.F. and almost exactly opposite to it in phase. At intermediate loads the transformer in which the magnetic leakage was greatest would take less than its fair share of the load, and the other transformer would consequently take more. If the transformer in which there was the greatest magnetic leakage had a slightly greater secondary E.M.F. at no load than the other one, then at some intermediate load the two transformers would divide the load fairly, but at full load the leaky transformer would be slightly overloaded. At no load also it would be always pumping current into the secondary of the other transformer, and practically this no-load local current might be very considerable, as the ohmic resistances of the secondaries are so small. It is therefore never advisable to have different voltages on the secondaries at no load.

2. At sub-stations where the transformers are switched in one after the other as the load increases, it is necessary that they all give the same voltage at full load. Since, practically, the efficiency of a closed iron circuit transformer is over 90 per cent. at one-tenth load, the effect of some of them working at lighter loads than the others will make very little difference to the average efficiency of a bank of transformers.

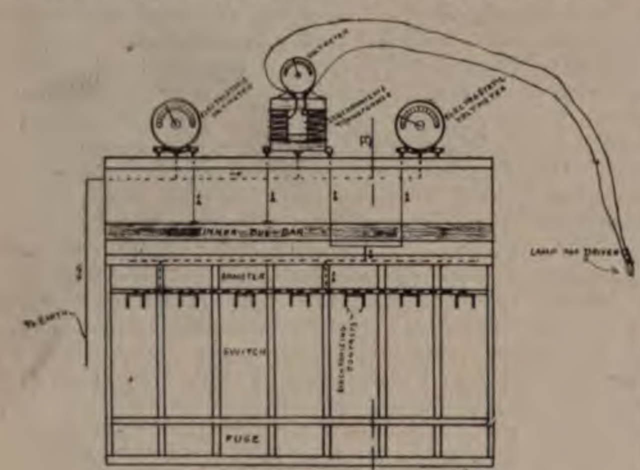
The answer to the question is, therefore, that the point of the load at which it is advisable for them to parallel correctly is at full load. Before putting two transformers in parallel we ought first to find their voltages on open circuit and at full load. If these are accurately the same, then they will work well in parallel, and at full load each will take its due share of the load.—J. C. R.

Question No. 46.—In the paralleling of two alternators, what do you consider the best apparatus to use to show when they are in synchronism? Explain the working of the same.

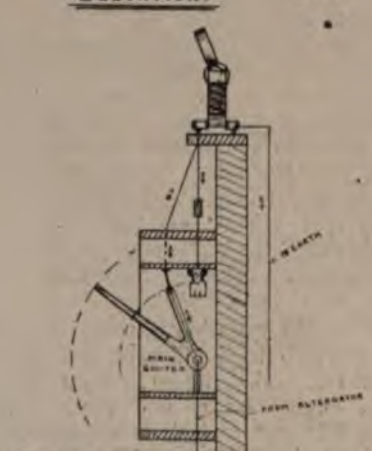
Best Answer to No. 46 (*awarded* 10*s.*).—The best synchronising gear, in my opinion, is that used by Mr. Ferranti on his switchboards. It consists of a small transformer of the shape shown in the sketch, the ratio of the primary to the secondary winding of which is as 20 to 1, so that if the 'bus-bar voltage were 2,000, the induced voltage on the secondary winding would be 100, which is indicated on a voltmeter mounted on the transformer, and forming part of the secondary circuit. The transformer is provided with three terminals: one outside terminal, which forms the end of the primary winding on one limb of the transformer, being permanently conducted through a high-tension fuse with the inner 'bus bar; while the other outside terminal, to which is joined the end of the

primary winding on the opposite limb of the transformer, is connected through a high-tension fuse to a synchronising contact in the main switch. The centre terminal, to which are attached the ends of the two primary windings, is connected to earth. It will be seen from the sketch that there are two electrostatic voltmeters on the switchboard, the left-hand one showing the difference of potential between the inner 'bus bar and earth, while the right-hand one is connected to the synchronising contacts, and shows the voltage on any machine which is being synchronised. From the terminals of the voltmeter on the transformer two leads are taken to an incandescent lamp placed in a convenient position for the engine-driver to see.

The Ferranti type of main high-tension switches are single-pole ones, and are so arranged that when the switch-handle is put in the intermediate position between open and closed, at half-cock, as it were, the switch engages with two springs, which are connected to the synchronising transformer and the right-hand electrostatic voltmeter, as mentioned above. Of course, there may be any number of switches, but the synchronising contacts in each are connected to the same rod, a fuse being interposed in case the springs should accidentally become connected with the inner 'bus bar, which, however, is a very rare occurrence.



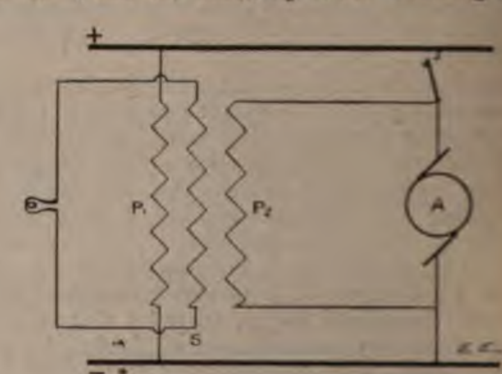
ELEVATION. E.E.



SECTION AT AB. E.E.
SHOWING POSITION OF SWITCH WHEN SYNCHRONISING

The action of this beautifully simple and efficient apparatus is as follows: Suppose that two or three alternators are running together on the 'bus bars, and it is desired to switch another alternator in parallel with them. Having run the engine up to speed and given the machine a certain amount of field current, the main switch is placed at half-cock, which allows a small current from the machine to flow through the primary winding on one limb of the transformer to earth, while at the same time the right-hand electrostatic voltmeter will indicate the voltage of the incoming machine. There are now two distinct currents flowing through the transformer, one from the inner 'bus bar round one limb to earth, and the other from the incoming machine round the opposite limb to earth; and as the secondary winding is equal on each limb, the current induced in it will depend on whether the primary currents coincide or not. If the machines are dead out of these currents will oppose each other, and induce secondary a very rapidly fluctuating current, causes the needle of the voltmeter to oscilla short quick jerks near the zero of the and at the same time the synchronising lamp flicker at the same rate. The engine-driver w this lamp, and adjusts the stop-valve or gov till the engine is driving the machine at as near possible the same rate as the other alternators on which is shown by the lamp dying right out and lighti again slowly. The switchman now adjusts the field o alternator till it is giving the same voltage as the machines on the 'bus bars, and then he watches the meter on the transformer until the pointer gives a slow, steady swing, and when this swing reaches its hi point he closes the switch with a quick jerk, and if h caught the phase at the right moment there will not b slightest flicker on the lights and no disturbance o ammeters of the other machines. This slow swin the voltmeter is caused by the two primary currents r the transformer coinciding, and so inducing the full cu in the secondary winding, and the primary currents coincide when the alternations per second on the inco machine are equal to those on the other alternators occur at the same time.—R. S.

Answer to No. 46 (awarded 5s.).—The operati paralleling alternators is an extremely delicate one, r ing much care, in order that the lights shall not "b at the moment of coupling the machines. Some ki indicator is required to show when the voltages deli from the machines are in the same direction or Two or three methods are in use. In one a small former has two primaries wound upon separate cores a common secondary, to which an 8-c.p. incandescent is connected. One primary, P_1, is connected to th bars + and −, and the other, P_2, to the incoming mac



If the current from this machine is flowing in the opp direction to that of the 'bus bars, there will be no cu induced in the secondary, S, of the transformer, therefore no light from the lamp. If the currents a the same direction, the lamp will be lighted. The o tion to this kind of synchroniser is that it is difficu detect the maximum amount of light from the lamp so find the moment when the two currents are in ex the same phase. Owing to the thermal storage of the filament, and the retention of the impressio the light on the retina of the eye, the variatio the strength of the light as the voltage alter not easily detected. The smaller the lamp, of c the smaller the thermal storage, the cross-sectio the filament being less. If the coupling switch be thrown in at the moment of maximum light, there wi a blink in the lights, because the phase has begun to ch It is better to put the switch in a moment before th moment too late. The accompanying diagram shows arrangement of this form of synchroniser. Very often 8-c.p. lamps are put in parallel with one another in case should cease to burn suddenly. Sometimes each pri has its own secondary, the two secondaries being in s with each other and a lamp.

Another arrangement, and one which is far better the foregoing, is to use a dead-beat voltmeter instead o lamp. The connections and general arrangements

The pointer of the voltmeter can be watched as ally rises to the maximum, and then the switch in. This can be done much more easily than when re used as the indicators. It is essential that the is should be dead beat in order to show any changes tely. A Cardew voltmeter may be used, or a c one with spring control. It is as necessary for gine-driver to see whether the machines are in nism as for the switchboard attendant, and, of he cannot read a voltmeter on the switch gallery position by the engine, so that the lamps should as well as the dead-beat instrument. These may d on the edge of the gallery, or in some prominent so that the engine-driver can see them as he t the engine stop-valve. Until synchronism takes hough steam only is admitted to the engines to voltage right; but as soon as the machine is in more steam must be gradually admitted, and the hare of load will be taken up. This is probably method of synchronising.

er plan is to have marks put on some revolving he alternators and illuminate them by means of s driven from the same alternators. When the n synchronism the marks appear stationary. This k well at night, but sometimes it is required to n the daytime when the sun's light would counter- from the arc lamps in too great a measure.—T. A.

PRACTICAL OPERATION OF MULTIPHASE CURRENTS.*

BY T. HAWKINS, MEMBER.

(Concluded from page 374.)

motors run at 360 revolutions per minute. The pumps ned to work at a crankshaft speed of 45 revolu- minute against a water pressure of 300lb. per square y are of American design, and were made by the mpany. Twelve triplex single-acting pumps, with 4½in. by 8in., of the same general design as the fore- upled direct by means of single-reduction gearing to otors, running at 360 revolutions per minute. These umps are also designed to work at a crankshaft speed evolutions per minute against a water pressure of r square inch. The main cable is triple concentric; ductor having a copper area of ·118 square inch. th of this main cable is 1,666 yards. The branch generators, running at 450 revolutions per minute; the voltage and periodicity being as described for the Vogelstruis Mine. There are three triplex pumps 6½in. by 8in., and eight pumps 4½in. by 8in., coupled direct by single reduction to 35-h.p. and 20-h.p. motors respectively. The length of the main triple concentric cable for this mine is 900 yards, each conductor having a copper area of ·145 square inch. The total length of the branch cables is 830 yards, each conductor having a copper area of 0·118 square inch. A plant exactly similar to the Knight Central has been sent to Witwatersrand Mine. The following is a complete list of the motors supplied to the above three mines:

No.	H.P.	Speed per minute.	Starting device.	How connected.
7	35	360	In rotor circuit	Geared to pumps.
3	35	360	,,	Belted to machinery.
28	20	360	,,	Geared to pumps.
1	10	870	Switched into circuit without resistance	Belted to machinery.
6	5	870	—	—

The generators for these three mines are all of the inductor type. At full load they give a commercial efficiency of 91 per

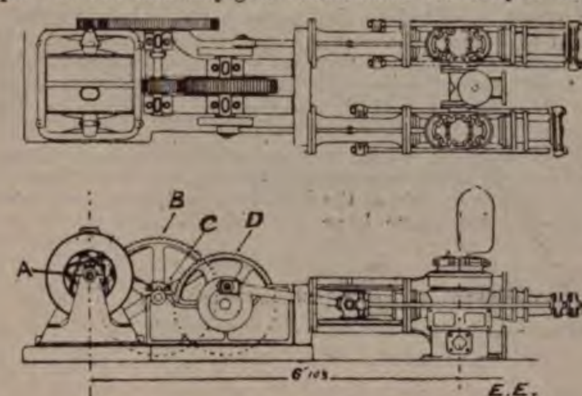


FIG. 5.—9-h.p. Motor coupled to 5in. by 9in. Duplex Pump.
A. Pinion 6in. dia., 18 teeth, 3in. face. C. Pinion 8in. dia., 20 teeth, 3½in. face.
B. Wheel 30in. dia., 60 teeth. D. Wheel 26in. dia., 65 teeth, 3½in. face.

cent., and the rise in temperature after long continuous runs is 25deg. C. The main switchboard is so arranged that the generators can be run in parallel. As these mines are very wet, the motors were designed with watertight and ventilated covers, as shown in Fig. 4. To enable the 20-h.p. and 35-h.p. motors to start up smoothly and gradually, they were supplied with starting resistances in the rotor. The 20-h.p. motors were

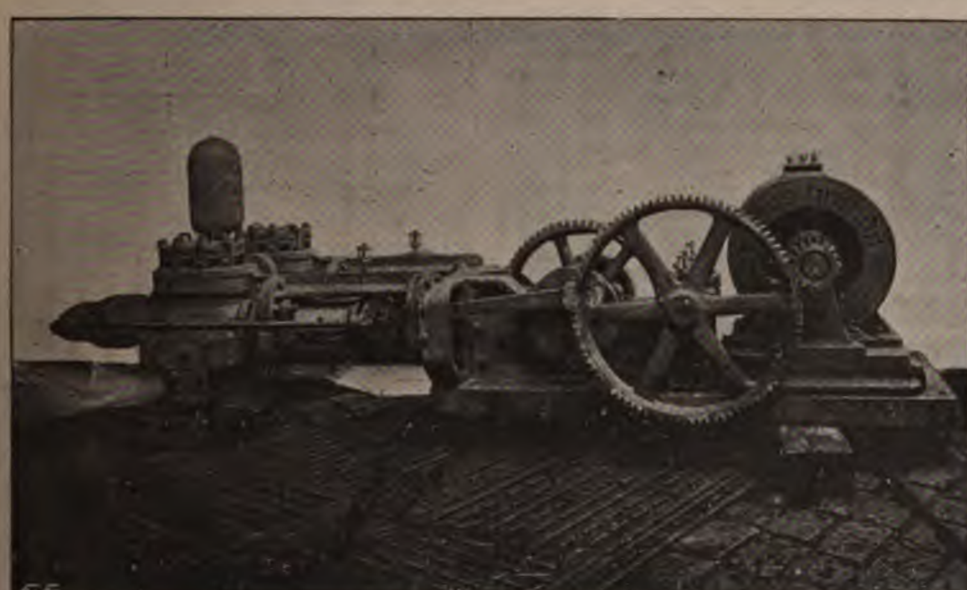


FIG. 6.—General View of the Pumping Plant.

are also triple concentric. There is one length of rds, the sectional area of each conductor being ·047 inch, and another length of 1,300 yards, with an area 24 square inch for each conductor. The above cables d covered and steel armoured. Another plant was sent Knight Central Mine, consisting of two 100-kilowatt made in Manchester, by the General Electric Company, Limited, and each machine was coupled to its pump, and tested separately at its full load for six hours, the rise of the temperature being 25deg. C. The York Gold Mining Company of South Africa have just installed a power plant, consisting of two belt-driven 50-h.p. three-phase inductor type generators, running at 750 revolutions per minute. These supply power to two 24-h.p. motors, the motors being coupled to Easton, Anderson, and Goolden belt-driven

* er read before the Northern Society of Electrical Engineers.

pumps. They have one 3-h.p. motor connected to a centrifugal pump and several small motors, which are belted to various kinds of machinery; and one 9-h.p. motor coupled direct to a continuous-current dynamo, the output of which is 15 volts, 300 amperes, used for cyanide work. The E.M.F. at the generators is 960 volts at 50 cycles; the length of the line being 835 yards. The power is transmitted through bare overhead conductors, supported on porcelain insulators. The station and line are fitted with Wurts's lightning arresters. Fig. 5 is a diagram of one of three horizontal 5in. by 9in. duplex pumps, made for the Consolidated Gold Fields of South Africa. Each pump is capable of raising 200 gallons 60ft. per minute, and is coupled to a 9-h.p. three-phase motor through double-reduction gearing. The speed of the motor is 1,150 revolutions per minute, with 60 cycles and 110 volts between two phases. Fig. 7 is a diagram of an electrically-driven coal-cutter, fitted with two 10-h.p. three-phase motors. The motors are wound for 500 volts, and are switched into circuit without any starting device. Their speed is 960 revolutions per minute, this being reduced to nine revolutions per minute at the cutter through treble-reduction gearing. The diameter of cutter wheel is 5ft. 8in. This machine has been constructed for Messrs. Pope and Pearson, Limited, for use in their colliery at Normanton. The distance between the generators and coal-cutters is about a mile.

The plants described in this paper have all been supplied within the last two years, and although, I am sorry to say, it is a very small amount when compared with what is being done in the United States, Germany, or Switzerland, it is some satisfaction to know that a little progress has been made in this country in the manufacture of this class of work. Even those who do not admit of any or sufficient superiority of the three-phase over the continuous-current system to induce them to take up the manufacture of the former for use in England, must acknowledge that many large and valuable orders for our

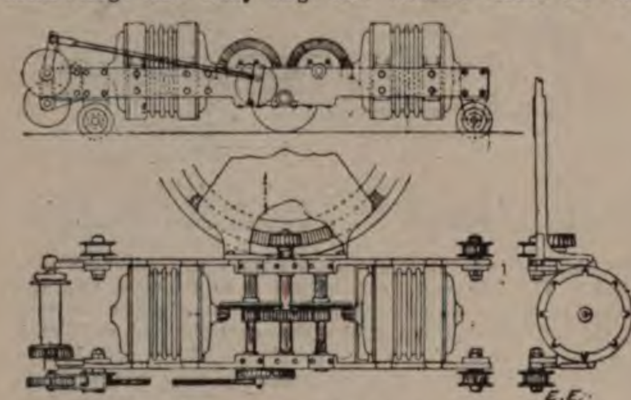


FIG. 7.—Two 10-h.p. Motors driving Coal-Cutter.

colonies and elsewhere are given to foreign firms which ought to be executed in this country, but unfortunately so little has been done here that so far we are not in a position to compete.

A number of questions were then asked the author.

Mr. Hawkins, in reply to Mr. Corlett, who stated he did not understand why the author advocated the use of the revolving armature in preference to the stationary armature, said he (the author) did not advocate it. What he said was, if a cheap machine were wanted, use the revolving armature, and he thought it would be quite satisfactory for low pressures. He distinctly stated that the best machine was made by using the inductor type. With regard to the slide rings, he certainly omitted to say so in his paper, but he pointed out in the photograph that the short-circuiting lever was thrown in before the brushes were lifted; after the resistance was cut out the slide rings would be still in use, and it would be necessary for the operator to throw in the short-circuiting arrangement, which was shown on the right-hand side of the motor. Of course it was possible to keep the three brushes always on the slide rings, and thereby do away with the necessity for the short-circuiting device, but his experience was that the short-circuiting arrangement gave no trouble, and that he preferred to use it and lift the brushes after the motor had attained its proper speed, thus doing away with the wearing of the rings and brushes. With regard to the continuous-current series-wound machine he (the author) had said that multiphase machines were specially adapted for installations where motors running at a constant speed were required. When he said constant speed he did not mean to say there would not be any drop at all, but he meant what was generally termed constant speed—viz., motors having a variation of not more than 5 per cent. between no load and full load. With multiphase motors the drop in speed at full load was less than that in continuous-current motors. Referring to the five-ton crane which Mr. Corlett mentioned, one could certainly put in starting resistances in the rotor circuit and so reduce the current when starting up, but in practice this crane started quite smoothly without such an arrangement; and as the generator in this particular installation was 100 h.p., the current taken by the crane was only a very small matter. Mr. Wordingham had said he

wished the author had spoken on some of the uses of
machinery for central stations. He (the author), in re
doubt much could be said in favour of its use for
work, and that he might have spoken about the cen
he had lately visited on the Continent and i
where multiphase machinery was extensively used,
Niagara; but as such plants had been described be
thought it better to speak only of the multiphase mach

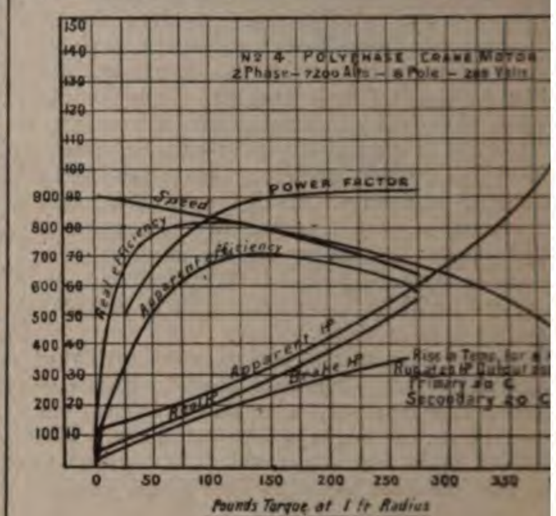


FIG. 8.

had been built under his own supervision. With reference
lation of the triple-concentric cables, samples of which
on the table, there was practically no difference in the
of the first and second conductors. As the test was
be one of 10,000 volts between the first and second con
8,000 between outer and earth, this accounted for the
round the outer conductor being less than round the
Mr. Wordingham had said he did not see how the p
could be ventilated and made watertight at the
The author said he should have stated that the
only protected from water falling in considerable
from above. If, however, the mine were flooded
rose from the bottom, it would get in through the
In reply to Mr. Cowan, it would be more correct to
rotor field, with very large currents, reacts on that of
and weakens the resultant field. Therefore, it would b
if the maximum torque is required, to put in resistance
circuit to such an extent as will give that particular
which maximum torque is obtained. Fig. 8, which the
on the screen, showed very clearly the amount of overlo
motor would give out. At 20 b.h.p. the speed was 800
at 75 per cent. overload the speed was about 680
It was hardly necessary, the author thought, to poi
any motor running on 75 per cent. overload woul
over-heated, and, therefore, the limit to output—at
up to 75 per cent. overload—was the heating of
On reference to Fig. 9, showing curves taken fr

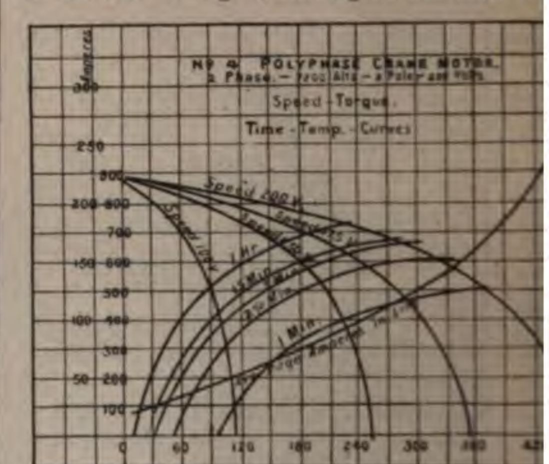


FIG. 9.

the same motor, a little consideration would show th
time the motor might safely be run at different torq
Fig. 8 could be found the brake horse-power corres
these torques. Fig. 8 gave the efficiency, power
speeds at the various loads, while Fig. 9 gave the vario
at different voltages across the stator terminals, an
current in the line. As these curves were taken from
crane motor in which the "slip" is allowed to be gre
would be for motors designed to run at an approximate
speed, the efficiency, owing to the increased slip, is
lower. The power factor should be kept as high as

: first, because the higher the power factor of 1e better the regulation of the system; secondly, igh power factor meant economy in copper in enerators, and transformers if the latter were used. r factor were equal to unity, and thus no lag it, there would be a saving of 25 per cent. of mains in a three-phase system as compared with the urrent plant, but if the power factor were as low as

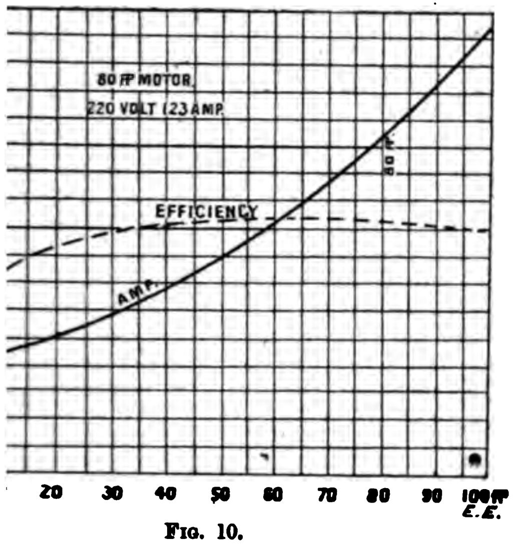


FIG. 10.

weight of copper in the two systems would be the same; however, in practice, the power factor id between ·75 and ·85, depending on whether the orbed by small motors or large ones. Comparing 1e two systems, it would, the author thought, be multiphase system could compete, and should the or generators and mains be slightly higher than for -current system, this would be amply compensated r cost in upkeep of the multiphase motors. embers of the Northern Society of Electrical Engi- prices of these machines during the discussion, the 1e following list:

E-PHASE MOTORS—50 CYCLES, 190 VOLTS.

eed.	Power factor.	Efficiency. Per cent.	Weight. Cwt.	Price.
425	·8	76	2	£20
425	·8	78	2¼	27
425	·8	79	3½	35
440	·8	82	4¾	45
960	·8	87	9½	72
960	·85	88	12¾	90
970	·85	90	16¾	120
970	·85	91	22¼	149
725	·90	92	24¾	215
725	·90	93	37½	240
490	·91	93	67¼	332

)N OF ELECTRICAL ENGINEERS, Mar. 24.

of Generation and Distribution of Electrical Energy.

BY ROBERT HAMMOND, MEMBER.

DISCUSSION.

ral Webber, in opening the discussion, said he had would have been called upon to start the discussion it a subject. There were some men on the face of m one always seemed to wish to know, and Mr. one of them. He had made his acquaintance that first time. There was a want of expression, he ose figures given in comparative tables. Thus the Company came fiftieth in order of merit in coal cost in total cost per unit sold. Other examples were that if the order of merit was taken by those figures, wide divergencies. They were nothing more than ad of little value except to station engineers and ed. He hoped Mr. Hammond would classify first l and then the calorific value of the coal. There oints in the paper he hoped would be taken up, of unaccounted loss. Proper classification of the be very useful. One company might use a large per and another a large amount of storage, and he he loss in one case pretty nearly balanced the loss

mpton said that every three years he read a paper subject, but it was fortunate that someone else had as he himself had not had the time to prepare one. hinted that the paper was a mere compilation, and ual. Statements like that made his blood boil, as difficulties which had to be met in obtaining the quired with which the writing of the paper was nothing. For about 11 years now he had been having such statistics made out for him by Mr. W. H. Miller, of the Kensington station. The publication of the Board of Trade returns had aroused the old English sporting instinct amongst the engineers in charge of central stations. He wanted to draw their attention to some items over which they had no control, such as rates, taxes, etc. In some London companies at present the taxes, etc., were two-thirds as large as the coal bill and would in time become no doubt considerably greater. In his former paper he took Welsh coal because of its well-known calorific value. In three London companies which competed very closely the weight of coal consumed was very similar, or about 6lb. per unit sold, and even going in some cases as low as 4lb. for short periods. Regarding reliability of plant, he thought that was even more important than the coal item. He should like to see more details among the figures given as to the number of breakdowns in the supply and as to the number of stations used. With only one station they would always be liable to a stoppage through accidents, and the whole district would be plunged into darkness. There should be at least two stations. It was not fair to compare the three London companies having several works with that at Brighton, which had only one station. The two or three smashes that had happened there tended to show the unreliability of high-voltage plants. As to "load factor," he, as the father of the expression, thought it was not a very good one. The most important thing of all was the engineer factor. The engineer had the making or marring of the undertaking. The most important thing was the man, and the man should be encouraged.

Mr. C. H. Wordingham said he also had to thank the author for bringing up so useful a subject. What greatly appealed to him was the accuracy of the paper in small details, as an instance of which the author had not forgotten that 1896 was a leap year. It was a mistake to leave the capital cost out of the tables. The term "total cost" was by no means a happy one. As regarded costs per unit in various towns, the lowest was found to be in Whitehaven; that was perhaps because the station was combined with a sewage outfall pumping station, and the cost not actually divided. With regard to "works costs," there was a danger of sacrificing everything to that. If a great many repairs had to be effected the cost should be charged to the revenue account, and not put down merely as works costs. As to the low price charged in Brighton for electricity, he had worked out their scale and found it agreed exactly with that of Manchester. At Brighton current was not supplied at 1½d. per unit for power, as was the case in Manchester.

Prof. Forbes said that the curves shown had great interest for him. They each found some little item in the paper with which they did not agree, but they would, he thought, acknowledge that that was the greatest effort that had ever been made to deal with a difficult subject. Going from left to right of the diagram shown, they found the cost diminished as the years advanced, and the number of units sold increased. The advance in economical practice with time was thus mixed up with the reduction caused by increased output. He felt that the information given would enable them to get at the facts of the case much better than before.

Mr. J. W. Grimshaw said that, referring to the figures given as to the cost of coal per unit, he thought there was no chance of reaching Mr. Crompton's ideal of 2·5lb. per unit. In the diagram he showed the cost of coal in the Westminster Company's three stations was given. The best annual average was 5·5lb. per unit. In some works with exceptionally good loads it dropped to 4·4lb. for a short time.

Prof. R. H. Smith said that in Table I. there were three columns giving the amount of coal per unit, price of coal, and cost per unit of the coal; he imagined that one result could be got from the other two. On trying that, however, he found very few of the cases given worked out correctly; in fact, out of the 48 instances, 30 did not agree. In Reading especially was this apparent. He thought, also, that leaving out the cost of initial outlay made the paper imperfect. By increasing the outlay it was possible to decrease the expenses, but it was a question how much it should be increased to obtain a warrantable decrease.

FORTHCOMING EVENTS.

FRIDAY, APRIL 1.

Institution of Junior Engineers. — At Westminster Palace Hotel, at 8 p.m., "Mechanical Refrigeration," by Mr. J. T. H. Burrell.

Royal Institution.—At 9 p.m., Prof. Dewar on "Liquid Air as an Analytic Agent."

SATURDAY, APRIL 2.

Institute of Junior Engineers.—At 11 a.m., Visit to the Thames Ironworks, Blackwall.

Chesterfield and Midland Counties Institution of Engineers.—At the Municipal Science College, Derby, at 3 p.m., "Electric Blasting" (Part III.), by Mr. W. Maurice. "Photographs of Electric Detonators," by Mr. L. W. de Grave. "Wagner's Portable Safety Dam for Mining Purposes," by Mr. Richard Cremer.

TUESDAY, APRIL 5.

Institution of Civil Engineers.—At 8 p.m., Discussion on "Extraordinary Floods in Southern India: Their Causes and Destructive Effects on Railway Works," by E. W. Stoney, M.E., M.Inst.C.E. And, time permitting, a paper on "The Electricity Supply of London," by A. H. Preece, Assoc.M.Inst.C.E., will be read.

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TO CORRESPONDENTS.

 Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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THE 1900 COMMISSION.

The activity displayed even at this early p the British Commission for the Paris Ex of 1900 will cause intending exhibitors to t consideration what they are going to sho have to assume that war is not going to put to all ideas of peaceful emulation, though ju moment the prospect of prolonged peace i as remote as the finding of the South Pol signs of the times all point to war. nation is preparing for it, showing that tion is but a name after all. Why this in America, in Africa, in Asia? The a of the English race to commence w a few thousand acres or square m Africa and elsewhere, has rather induce nations to presume upon their always giv rather than to respect them for human Still, these are not the columns wherein to di political troubles of the world; hence we t war clouds may pass away, and exhibitions a meetings bring nations more and more toge the very idea of strife other than peaceful e strife is rendered impossible. Whatever t in the womb of the future, let us go in preparing for the most important ex ever held on the face of the earth as if there no feuds to sunder, but only friendly feelings the nations. The nineteenth century, w history comes to be written, will be seen witnessed the birth, the waxing, and, in som the waning of many applications of science. in 1792, indeed, that Murdock succeeded in ing coal gas to light his house, but perhaps outside installation was that of 1798, w constructed the apparatus for lighting Bo Watts's works at Birmingham. From then installations were frequent in works and fact in 1807 one side of Pall-mall was lighted. may safely speak of gas lighting being the this century. That old-new country, Chi ever, in all probability had used natural gas just as she knew of gunpowder and the mag before Europe hit upon these discoveries gas has become since the birth of the we all know. There is no need to dis utility, but at the same time it may be s that another discovery of the century is to take the almost universal position for purposes it has held, and that gas will be r for use in fields it is better suited to serve. light, like gas, was born with the century, an gas, for three-fourths of the period lay pr dormant. Something more than the arc wa for commercial success, and, though Farad the clue, it was not till Gramme gave the r and Swan and Edison the incandescent la electric lighting became possible. How it has developed is well known to readers. It does not do to compare the s gas lighting with the spread of electric lightin former had, so to speak, a clear field, w latter found the field completely occupied in American centres. Of course, the streets of were lighted before 1807, but it was with o

from lighting—which certainly has been a able source of wealth to workers and investors g the century—to ordinary street traffic, ein electricity has as certainly shown its value. iackney coaches of the early part of the century ly disappeared, as did the stage coaches. rays swept away the latter; cabriolets, cabs, and s the former. It was not till about 1831 that s began to ply in the streets of London. ı later came the tramways, but all with the ays are of the century. What is the outlook › end of the century, and what may we expect e in large numbers in the 1900 exhibition self-propelled vehicles, to take the place of the 'buses, and trams of to-day? Again, though o rapidly nor so easily, electricity has shown ; showing that it will probably replace horses ılso largely the steam locomotive. The Paris ›ition of 1878 may be said to have inaugurated ectric era, though it was not till 1881 that the ;ude understood the possibilities of lighting; so nture to think the 1900 exhibition will be pro- 'e of revolutionary ideas among the multitude the propulsion of vehicles. We do not know ;land is going to wait, as it usually does, before ring for the business part, till other nations nade considerable studies and have exploited ountry to the detriment of our own factories. notto is gradually receding from "easily first" ıg last."

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

OZONE.

—It does not seem that the writer of the paragraph ne, published in last week's issue of the *Electrical* ıer, is well up in this subject. He ought to know ıe paper read before the Chemical Society on Feb. 17 ssrs. Shenstone and Evans, "On Observations on the nce of the Silent Discharge of Electricity on Atmo- c Air," is in no way a practical treatise on ozone. authority has he for saying that "other writers, and ɔs those who attack the problem commercially, have given to general statements rather than to exact '?

s is a very serious accusation. The problem of ozone n its cheap production—*i.e.*, in the construction of atuses which will work without interruption and give ı yield of ozone with the production of a minimum ıt of heat and of nitrous compounds.

mists and manufacturers are well aware of the rties of ozone, the most powerful oxidiser of nature, of. Dewar calls it; and Bunsen said that "there are ds of uses for ozone if only we can make it in large ities at a low price." Your contributor wonders at the ist of the applications of ozone which I gave; had he the paper delivered before the Royal Society in 1851 . electrician known by the name of Michael Faraday, uld have found in it a still longer list.

th very few exceptions I have successfully applied ı for many purposes, and especially to the drying of o the treatment of wines and spirits, deodorising fish manufacturing disinfectants, etc., and to beeswax, ı in a few hours can be decolourised and rendered tly white. Does your contributor wish to see it ! I am quite willing to bleach some beeswax in his se without the use of any chemicals, and therefore ut altering its constitution. It will not take more three hours. If he is desirous of seeing some water sterilised, I have not the slightest objection. Let him come with a bacteriologist, who will take some samples of water both before and after ozonisation, and who will decide whether the water has or has not been sterilised by the ozone passed through it.

For the first time since the discovery of ozone in 1841 by Schönbein, commercial ozonisers can be obtained now for use in various branches of industry; and when I called the attention of the technical Press to the circular announcing that the Electric Ozone Syndicate is prepared to supply my ozone generators capable of working in a continuous manner, and of producing ozone cheaply on a commercial scale at the rate of about 150 grm. per kilowatt-hour, I little suspected that there would be an electrician who, without seeing my apparatuses, although invited to see them at work, without knowing anything about ozone or of its production and its applications, would welcome the news of this unprecedented fact with discourteous remarks and sneers.

Even paragraphs of electrical papers ought to be written by men who have some knowledge of the question with which they are dealing.—Yours, etc., E. ANDREOLI.

[Mr. Andreoli finds sneers where none were intended, as we are well aware of the capabilities of ozone. What is wanted is rather definite information as to its commercial capabilities, not on laboratory experiments only. In such matters the question of cost is all-important. Thus diamonds, as pure carbon, are most excellent fuel for boilers, and yet not used in central-station working. It is for the experts to lead the manufacturers in new applications of ozone as stated in our note.—ED *E. E.*]

ELECTRIC POWER SUPPLY FROM CENTRAL STATIONS.

SIR,—I have read your editorial note to my letter of March 21. As your readers have not had an opportunity of seeing what I did actually say in my paper on this subject, I am at a considerable disadvantage. To make the matter perfectly clear, it would be necessary to quote at considerable length. In the first place, may I point out that your editorial note would lead readers to suppose that I had given £8. 10s. as the works cost of maintaining an indicated horse-power at full load for 8,000 h.p. per annum. This, however, is not the case, the figure referring only to the cost of coal, stoking, and taking away ashes. This was based on a consumption of 2¼lb of coal per indicated horse-power per hour, which even for coal giving only 12,000 heat units per pound is a very ample allowance. I have seen a calculation recently by a gentleman who is considered a great authority on this subject, in which with the best modern appliances and superheating he gives it as his opinion that for large powers an indicated horse-power could be obtained in practice for 40 per cent. less of the same coal than I have taken above. I was anxious, however, to allow a safe margin; this, of course, applies to power supplied continuously at full load. I then go on to say, as you quoted, that if the power is supplied to works operating only 54 hours per week, little more than one-third of the coal and stokers' wages will be needed, the other items remaining the same in both cases, or being similarly reduced. Now you contradict both these statements, and then go on in your note to say I have not allowed for power factor. It is obvious, as your contemporary the *Electrical Review* acknowledges in its last week's leading article, that, comparing water power with coal power, the capital and a large proportion of the other costs remain much the same whether the plant is used for 54 hours per week or for 168. Of course, this increases the cost *per indicated horse-power per hour*. As regards the cost of coal and stoking, only one shift of stokers would be required against three for the continuous load, while night work and Sunday labour would be dispensed with, both of which are more expensive. I put down the coal in this case at practically the quantity required for keeping the full load going for the whole time. As the full power would not be required all the time some saving of coal would be effected, which I consider would be about enough for starting or banking fires, so that the question of power factor is really

in my favour instead of against me, particularly if supply from a large central station is being considered, where there would be a number of engines working nearly always at their best economical load. Anyway, the cost of coal bears so small a proportion to the total costs in supplying a horse-power per annum, that it seems a pity to make a mountain of a slight difference in this point in discussing a great question.

In order to prevent misunderstanding, I may say that as the cost of coal at the prices ruling in South Staffordshire makes so little difference, an allowance in this respect has been made in the calculations of the Midland Electric Corporation so ample that no objection could be taken by the most conservative under this heading. Finally, may I say that my paper was evidently of a qualitative rather than a quantitative character.—Yours, etc.,

G. L. Addenbrooke.

Wolverhampton, March 30, 1898.

[We think Mr. Addenbrooke means 8,000 hours—not 8,000 h.p., as written. He distinctly says in his paper that the cost is reduced to "a little more than one-third of the coal and stoker's wages by using only 54 hours per week," instead of 8,000 hours per annum. How, then, can he allow the full 8,000 hours' supply of coal? Does Mr. Addenbrooke seriously contemplate working the Midland Electric Corporation's works with only one shift of stokers? Ed. *E. E.*]

THE JURIDIC SIDE OF THE MUNICIPALISATION OF TRAMWAYS.

BY GEORGE BEYNON-HARRIS.

(*Continued from page 51.*)

In our last statement we set out fully the various methods by which, under operation of law, a corporation may find themselves in possession of a tramway undertaking. Postulating now, therefore, our corporation by either of these methods to be in actual possession, and the owners of the tramway undertaking, our second point, as previously indicated, is: What can they do with it? What are their powers in relation to it?

In this connection it would avail us little to advance any arbitrary article of belief; speculation were vain, and dogmatic assumption both arrogant and useless. We must therefore take the law baldly as it stands in the principal Act (Tramways Act, 1870), and in the various provisional orders, and by the light of the inviolable rules for the construction of statutes, find the answer we seek. This, with some care, we shall have little difficulty in doing. And first let us endeavour to exhaust the principal Act. And here it must be borne in mind that it is only by virtue of the enabling powers of the principal Act that a provisional order can be applied for. The provisional order is the child of the principal Act. When a tramway, then, has been completed under the authority of a provisional order by a corporation, or where a corporation have under the provisions of the Act acquired possession of a tramway, the corporation may, with the consent of the Board of Trade, and subject to the provisions of the principal Act, by lease, to be approved by the Board of Trade, demise to any person or body of persons the right of user by such person or body of persons of the tramway, and of demanding and taking in respect thereof the tolls and charges authorised; or the corporation may leave such tramway open to be used by the public, and may, in respect of such user, demand and take the tolls and charges authorised: "*but nothing in this Act contained shall authorise any local authority to place or run carriages upon such tramway and to demand and take tolls and charges in respect of the use of such carriages.*"

The lease, however, must not exceed in the whole 21 years, though it may be made for a shorter term, and renewed from time to time, so that the several terms shall not in the aggregate exceed that number of years; and the corporation may upon the determination of the 21 years (if the Board of Trade consent) lease again for such further term or terms as may be approved by the Board of Trade; but not for longer, in any case, or altogether, than 21 years. But the lessees are not free to do as they like during the term; for it must be borne in mind that the corporation have the power, by implication (even though it may not be reserved by the lease) of re-entry, and of re-possessing the tramway, if the lessees at any time discontinue working the tramway or any part of it for the space of three calendar months, unless such discontinuance be occasioned by circumstances *beyond the control* of the lessees; *exempli gratia* (probably) a strike, some act of God or of the Queen's enemies, or some very refractory climatic influence.

It is, however, quite clear that the mere want of funds is not to be a circumstance beyond the lessees' control. Regarding the existence in the corporation of this implied power of re-entry, there is now not the slightest doubt; though for a period the spirit of uncertainty brooded over the question in the minds not only of corporations and tramway promoters, but also in the minds of the jurists.

So far, therefore, the powers and position of a corporation are well defined, and would have been refreshingly clear but for the peculiar wording of Section 43 of the principal Act. That section, it will be remembered, is the one which enables a corporation to purchase after 21 years and 6 months; and after providing that the corporation may purchase at that time, that section further provides that when any such sale has been made, "*all the rights, powers, and authorities of such promoters*"—*i.e.*, the persons or company from whom the corporation purchase—"*in respect of the undertaking sold . . . shall be transferred to, vested in, and may be exercised by the authority* to whom the same has been sold in like manner as if such tramway was constructed by such authority under the powers conferred upon them by a provisional order under this Act, and in reference to the same they shall be deemed to be the promoters."

At first this was taken to mean that when a corporation purchase the tramway, they become, *ipso facto*, placed in exactly the same position as the former owners—that is to say, that the corporation might exercise the rights of ownerships in just as plenary a manner as the parties from whom they bought could do. It must be confessed that it seems quite unnecessary that the Act should state, as the section does, that "all the rights, powers, and authorities" in respect of the tramway undertaking, hitherto exercised by the vendors of the tramway, shall be transferred to, and may be exercised by, the corporation, if, after all, they cannot be so exercised.

However, that the corporation, after purchase, do not become endowed with those rights, powers, and authorities, is quite clear—that is to say, a corporation by the mere exercise of the bare powers of purchase alone are not entitled to place or run carriages and to demand and take tolls and charges in respect thereof—for though the exact words of the section quoted may, at first sight, be calculated to invest the corporation with such full rights, powers, and authorities, yet the words which follow—namely, "in like manner as if such tramway was constructed by such authority under the powers conferred by a provisional order under this Act"—restrict the corporation to the powers of leasing as before explained; and then the corporation are faced by that strange yet irrefragable section of the principal Act: "*Nothing in this Act contained shall authorise any local authority to place or run carriages upon such tramway, and to demand and take tolls and charges in respect of the use of such carriages.*" Why it should not have been definitely stated in the Act that the powers of a local authority in possession of a tramway should be limited to the granting of a lease for a period not longer than 21 years will, probably, to a great many be wholly incomprehensible. But it is, nevertheless, clearly settled that a corporation will not possess the power to place and run carriages and demand and take tolls on a tramway by virtue of any provision in the principal Act.

So much, therefore, with regard to the powers of a corporation under the principal Act. Are the powers more comprehensive under the provisional orders or any of them?

By the provisional order the provisions of the Tramway Act, 1870, "are hereby incorporated with this order except where the same are expressly varied by this order, and further, "nothing in this order shall be deemed or construed to exempt the tramways from the provisions of any general Act relating to tramways now in force, or which may here-

ter pass during this or any future session of Parliament." It we must not confuse a mere variation with a fundaental alteration of the Act, which latter would at once ppen if full power were given by a provisional order to ork the tramways; and this would, moreover, exempt the incipal Act in its most vital particular, which would, of urse, violate the section just quoted.

It is therefore unquestionably settled that a corporation ave no power, either under the principal Act or under a ure provisional order, to place or run carriages upon a tramay, and to demand and take tolls and charges in respect the use of such carriages. Their power, therefore, being us limited to the extent stated, the only workable course pen to a corporation in possession of the tramways under ich circumstances, is to exercise the greatest care in granting lease of the tramways undertaking; so that the best ssible general terms shall be made, and that the yearly ead rent, reserved by their lease, shall be such a sum as, ter allowing for contingencies, interest, and sinking fund, hall leave such a net balance as will constitute a good return n the capital expended: in the one case on the purchaseoney of the tramways undertaking, and in the other, on e promotion of the provisional order and the construction f the tramways.

The corporation, therefore, being wholly destitute of the ower to run carriages and to take tolls, the question aturally arises: Is it possible for a corporation, by any ontortion of the principal Act, to obtain not only power o construct, but power also to work the tramways? The eply to this is that it is in the highest degree doubtful, in he face of opposition, whether this could be effectually ccomplished; notwithstanding that the Board of Trade lubiously hold themselves competent to authorise a corporation, by provisional order, to construct and work tramways *if the case is good on the merits.* Experience, however, as taught how much of nebulosity there is in phrases of his nature. If any of the essentials are wanting, the case would scarcely be considered by the Board of Trade to be good on the merits, and the Board would decline to take the esponsibility of contorting the principal Act to the extent f granting a provisional order embodying such a power. With that single possible qualification, therefore, whenever provisional order under the Tramways Act, 1870, to any xtent purports to enable a corporation to do more than the principal Act permits, it does to that extent violate the principal Act.

But, further, let us for a moment suppose that a case ufficiently good on the merits has been shown to satisfy the Board of Trade, and that the corporation have obtained a rovisional order with power to enable them to construct nd work a tramways, yet it must be fully borne in mind hat a provisional order, under the Tramways Act, is wholly noperative to confer power upon a corporation to purchase ompulsorily even the necessary land for the purpose of the ffective and profitable working of the tramway; and the Board of Trade is impotent to render any assistance in this respect.

The apocalypse of tramway legislation for nearly 30 years mpresses this lesson, that for a corporation the safe, comprehensive, and correct method of obtaining the full and omplete power to construct a tramway, to place and run arriages thereon, to demand and take tolls and charges in espect of the use of such carriages, and to purchase the ecessary land by compulsion for the effective working of ame, is either by promoting a special Bill in Parliament for his purpose, or by making the project one of the features f an omnibus Bill.

Having now treated both of (1) the means by which a orporation may find themselves in possession of the tramays, and of (2) the powers of a corporation when in ession, it now remains for us to enquire under what umstances a corporation can be said in strictness to have icipalised a tramway undertaking.

(To be continued.)

ictoria (Australia).—According to the *Victorian Contractors'* tte, the Government will shortly advertise for tenders for ly of electric light cables and fittings for the railway departt.

ALTERNATING-CURRENT MOTORS.*

BY E. E. TASKER.

In this paper which I have the honour to bring before you this evening there is not the slightest attempt made at literary style and a flowery display of the English language such as politicians delight in, but I have endeavoured to put the subject as plainly and explicitly as I can before you. I think myself that the majority of electrical engineers (or at least the student portion) have nearly all their time taken up keeping pace with the advance of electrical science, without struggling with the complexities of the English language.

It first devolves upon me to briefly go into the working of an alternating-current generator. Alternating generators are constructed in three different ways: they may have stationary fields with revolving armatures, or revolving fields and stationary armatures, or the fields and armatures may both be stationary, with rotating iron parts called inductors or keepers. The chief advantage of having stationary armatures is the great ease and precision with which the coils may be insulated, and this is exceedingly important where high voltages are in use. Another advantage is that the current can be immediately led away without any collectors or brushes intervening. In Fig. 1 the

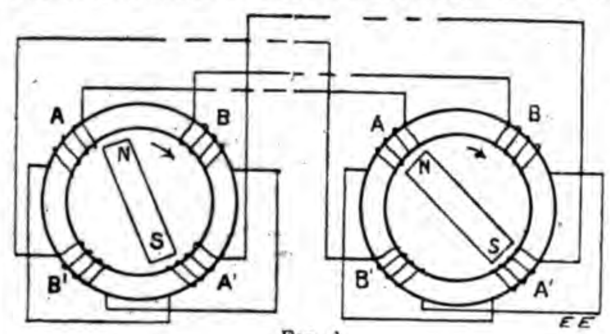


FIG. 1.

windings on the left-hand ring represent diagrammatically the armature of a two-phase generator with field magnet revolving. When the magnet is rotated by some mechanical means alternating currents are generated in the coils, A A[1], B B[1], and when the current in A A[1] is a maximum, that in B B[1] is zero, and *vice versâ*, the currents having then 90deg. difference of phase. By equally spacing six coils round the ring we obtain a three-phase generator, or a continuous coil may be wound on the ring and tapped off at three equidistant points.

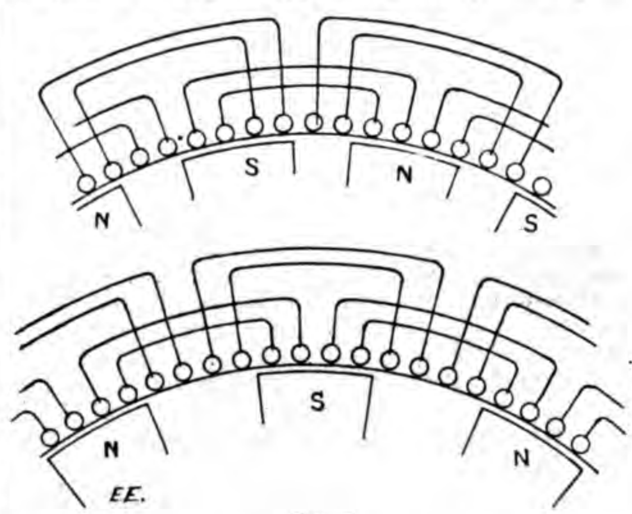


FIG 2.

Fig. 2 indicates the manner in which two and three phase generators are wound. It is necessary that the armature reactions should be small in dynamos from which motors are to be run, else the pressure will drop considerably when a motor is started; consequently the torque will be very much lessened, since it is proportional to the current and induction, which are both proportional to the impressed E.M.F.

Having got on speaking terms with the generator, we will now attack the motor. Supposing there are two electromagnets with a coil between them (as shown in Fig. 3), then directly the current is switched on the coil will take up such a position that the flux through it is a minimum, and will there stop; it has come to what is called a dead point. Now to produce continuous motion it is necessary to have another field, preferably at right angles to this one; then, if when the

* Paper read at the students' meeting of the Institution of Electrical Engineers, March 16, 1898.

coil has reached a vertical position (Fig. 4), the current round $P\,P^1$ is cut off and passed through windings round $Q\,Q^1$, the coil in the field will again assume a horizontal position; then this current is cut off and applied to $P\,P^1$, and so on. Instead of using direct current and cutting it off each time, alternating currents are applied, and automatically changes the poles and the direction of the field. Then, instead of getting a very strong field suddenly and then zero, as we should in the above case, we are enabled to produce a constant field, but which will rotate.

Fig. 3.

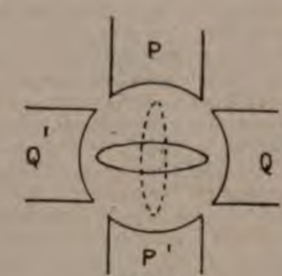


Fig. 4.

Returning to our diagram with the revolving magnet (Fig. 1), suppose the current is transferred to the motor, then when it reaches a maximum in the coils $A\,A^1$, the iron is magnetised, and the poles so formed will be directly under the coils $B\,B^1$, and when the current in $B\,B^1$ is at a maximum the poles will be directly under $A\,A^1$; at any intermediate values the poles will be between the coils. We may represent the strength or intensity of a magnetic field and also its direction by a vector, and if we have two of these at right angles to one another, as in the case of that produced by two currents differing in phase by 90 deg., their resultant, which represents them in direction and magnitude, may be found at any instant by completing the parallelogram and drawing the diagonal (Fig. 5)—that is, provided there are no eddy currents, etc., acting upon them, which would very much complicate matters. From a little study of Fig. 5

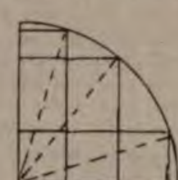


Fig. 5.

it will be seen that the resultant has the same magnitude during the whole of the time, but changes in direction—that is to say, we get a field of constant value, but which rotates. If the two fields are not of equal amplitude, or if they do not differ by exactly 90deg. in their phases, the result will be an elliptic rotating field. Again, if the alternation does not follow a sine curve, but is more pointed, we get a field like that shown in sketch (Fig. 6) whereas if the curve is flat topped, the field produced may be represented by the diagram (Fig. 7). We thus obtain the requisite revolving field produced by the alternating currents supplied by the generator. This revolving field induces currents in the rotor windings, which currents also produce a rotary field of their own, this trying all the time to catch up

Fig. 6.

Fig. 7.

the stator field. The difference between the speed of these fields is called the slip, and the greater the slip as the motor becomes loaded, the greater the current induced in the rotor windings; and this acting as the secondary of a transformer tends to lessen the self-induction of the stator, thereby allowing more current to flow as the machine becomes loaded up. The slip in these motors when unloaded is sufficient only to make up the losses due to eddy currents, hysteresis, leakage, etc., and at full load is seldom more than 5 per cent., unless designed for some special purpose, such as crane work, when this may be increased to 12 or 15 per cent. This motor will be found to start by itself and run up to speed; and this is where it has the pull over single-phase synchronous motors, which require a continuous current to excite their field magnets, and also to be run up to the speed of synchronism by some other source before the current is switched on. These

machines—*i.e.*, the single-phase synchronous motors—
another drawback, which is, that when much overloaded
stop dead.

Single-Phase Synchronous Motors.—Any alternating-cu
dynamo may be run as a motor; in fact, their tendency
so sometimes gives trouble in central stations where se
alternators are in parallel. It is necessary to bring the
to speed and have them in step before switching on
current, when they will run synchronously. This nece
running up to speed with a single-phase synchr
alternator is one of its drawbacks, whereas if
phase synchronous alternators are used they may
by themselves, but only when unloaded. There are se
ways in which the motor may be brought to the
of synchronism—viz. (1) alternator exciter may be ru
accumulators; (2) a small two-phase motor with suitable p
splitting device; (3) a small series motor with laminated f
In the first case the exciter is run by means of accumulat
bring the alternator to the speed of synchronism, and
accumulators are recharged whilst the motor is running.
of course, necessitates having an exciter larger than
requisite to excite the magnets only, because it has also
as a dynamo for the purpose of charging the accumulators;
is also the extra cost of the accumulators. In the second
a phase-splitting device is used with a two-phase motor.
a phase-splitter, as it is called, is a device introduced in
alternating circuit to produce in one branch of it either
or a lead, and is usually constructed as shown in Fig. 8 (
represents a phase-splitter commonly used for st
motors), where R is a non-inductive resistance intro
in series with one set of coils at starting, or for
resistance may be substituted a liquid condenser.
has the effect of causing the current in the two se
coils to have a different angle with regard to the E.
thereby producing a rotating field, which enables the mo

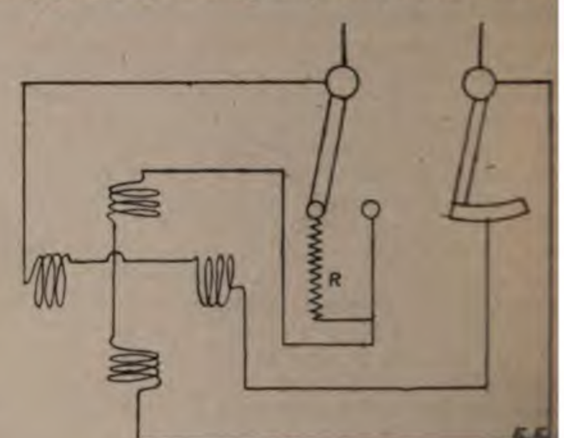


Fig. 8

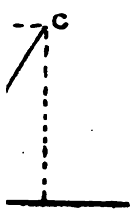
start as previously explained. In the second and third
an outlay is necessary for the extra motors and access
With the series motor the magnets have to be laminated,
the magnetism is reversed in the fields at the instant th
current in the armature reverses; these machines have,
ever, enormous self-induction, and are consequently una
exert very much torque.

Regulation of Excitation of a Synchronous Motor.—
the continuous-current motor, the alternating-current
gives rise to a back E.M.F., the difference betwee
impressed E.M.F. and the back E.M.F. at any instant
the necessary pressure to cause current to flow throug
armature. If the field is of such a strength that the
pressure exactly equals the impressed E.M.F., then
the motor is switched on the mains it will slightly l
phase, the amount of lag depending, of course, on the
induction of the armature, and will have such a value
the difference between the impressed and counter E.
will be sufficient to drive the necessary current th
the armature. When the motor is loaded this diffe
of phase angle increases, the current at the same time la
behind the resultant pressure, this, of course, being d
the self-induction of the armature. When there is any
difference between the E.M.F. and current (whether it
or lead) the current may be divided into its component
part (which is doing useful work) being in phase wit
E.M.F. and one at right angles to it, this latter being ter
wattless current. Let O E (Fig. 9) represent the E.M.
magnitude and direction, and O C the current lagging beh
by an angle Q, then the real watts absorbed by the m
O E . O C . cos Q, and the apparent watts is O E . O C : th
of these two quantities is called the power factor—th

$$\frac{OE \cdot OC \cdot \cos Q}{OE \cdot OC} = \cos Q \text{ (power factor). Then it is o}$$

that by properly exciting the field it will have such a st

current will be in exact phase with the E.M.F. in the s, and we shall be using a minimum exciting power for n armature current. If we plot armature current citation we get a curve as shown in Fig. 10, and his curve we see there are two excitation values ry value of the armature current, except at the point, p; the lower value, say, at A is when the is under-excited, and consequently the current lags,



a. 9.

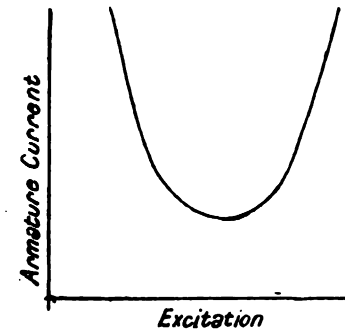


Fig. 10.

y shown; and the higher value (B) of the excitation is e current leads in phase—that is to say, the machine condenser. This peculiar quality of an over-excited ous alternator acting as a condenser was, I believe, first out by Prof. Silvanus Thompson. Now, if the armature self-induction, the curve will be broader at the bottom, have a greater range of regulation. In one or two a choking coil has actually been put in to produce this

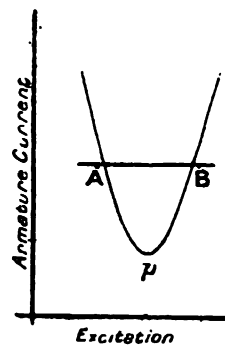


Fig. 11.

Fig. 11). If the armature has but small self-induc- curve is more pointed at the bottom, and the sides are er; or, again, if we come to a theoretical case where no self-induction and no armature reactions, the curve a vertical straight line—that is to say, we should get ed current with the same excitation.

Phase Asynchronous Motors.—In this type we have a oscillating field, which is resolved into two fields rotating ite directions. The two oppositely rotating fields will to form the amplitude of the alternating-current field, ese will be a maximum at a certain instant, and 90deg.

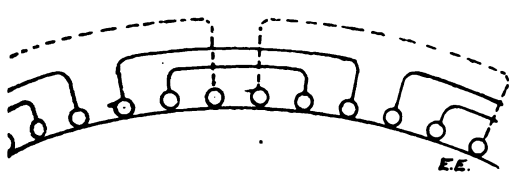


Fig. 12.

will be zero, from which we see that each of the fields of one-half the intensity of the alternating-current is necessary to upset the balance of these oppositely fields, for which purpose the motor is provided with winding called the starting winding, the two having a of phase produced, as already explained, by a phase- In the stator part of the machine, about two-thirds of are filled with what I will call the main winding, the winding having about an equivalent number of ampere- wire of which may be much smaller than the other, will only be used at starting, and will have to carry only for a short time. Fig. 12 shows diagrammatically of winding. The rotor consists of short-circuited bars. Some manufacturers connect the bars by German- strips at the ends, these offering a greater amount of to the current than copper connectors. The effect ing this resistance in is to increase the starting will be explained later. These strips being at the s a great cooling surface and free access to the air, and can, therefore, be made of smaller section than they could be if enclosed. This departure somewhat lowers the efficiency of the machine, but is counterbalanced by other considerations. When the motor is running, say, right-handedly, we still have a field rotating in the opposite direction to the rotor; and this acts inductively, causing losses due to currents of great frequency, since it equals twice the frequency of the simple alternating current, and these also tend to lessen the torque. Another method of starting these types of motors might be mentioned, which has lately been brought before our notice by Prof. Arno. He discards the auxiliary winding to get a phase displacement to produce the rotating field, but inserts in the armature such a resistance at starting that with any particular load the starting current is about double that which the motor takes when running under that same load—that is the usual rule followed in starting any induction motor when resistances are inserted in the armature circuit. The rotor is then given a small initial velocity (just turning by hand will do) in the same direction as it is required to be run, then as the motor gains speed the resistance is cut out in the usual way. Comparing this kind with the polyphase motor, it is

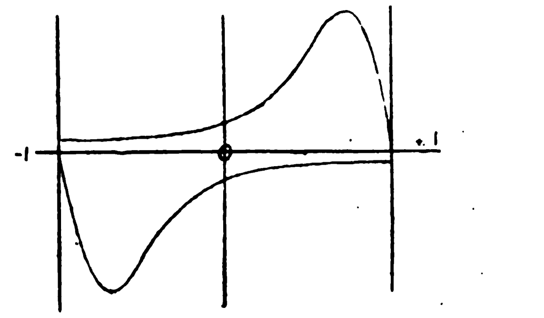


Fig. 13.

evident that a motor of the simple alternating-current type will require twice as strong a field as the polyphase one for the same amount of slip and the same power, but we cannot obviously work at a very much higher density in the iron, else the losses due to hysteresis, etc., will become enormous; the only practical thing that remains to be done is to increase the size of the motor; this gives us more winding space, and although the slip may be reduced the torque cannot be increased. Consequently, machines of this type will always be much larger than a polyphase machine for the same amount of power; besides which the hysteresis loss will be greater, as will also be the shifting of the phase. Small fan motors, made by the Westinghouse Company for running on 100-volt single-phase circuits, are not provided with a phase-splitting device as previously explained, but, instead, they have two sets of coils. The main fine-wire winding (Fig. 14) embraces two teeth (laminated), one

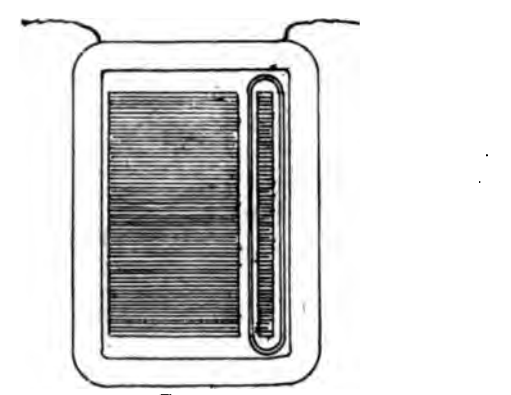


Fig. 14.

large and the other a very small tooth, which has a single turn of copper strip short-circuited on itself. This strip has currents induced in it, and gives rise to another field out of phase with the main field, thus supplying the necessary displacement to enable the motor to start. The rotor is of the ordinary squirrel-cage type.

It will be noticed in Fig. 1 that there is some waste space between the coils, and if we insert here another winding we obtain three currents differing in phase by 120deg. This in the motor gives a more even turning moment, analogous to an engine with three cranks 120deg. apart. In practice it is not usual to run separate mains for each set of coils, but in the case of a three-phase machine one end of each coil may be connected to a common junction as a star connection, as shown in M^1 (Fig. 15), or the coils may be connected in the form of a mesh, as in M^2. Instead, however, of winding the coils round the ring, as shown in the diagram, they are either wound in slots or else embedded in the iron in tunnels. This latter system is the invention of Mr. C. E. L. Brown. In induction motors of

the squirrel-cage type the rotor consisted of a laminated iron core keyed on the shaft, and outside this copper rods short-circuited at the ends by copper rings. This was the first of its kind, but they are now made with the windings embedded in the iron. The conductors or rods are threaded through the slots or holes, a tube being previously put in for insulating purposes. These tubes are made sometimes of compressed paper or canvas shellacked and wound on formers, the shape and thickness, of course, depending upon the coil and the voltage at which the machine is required to be worked. The rotating part, or rotor, as it is called, is wound in a similar manner to the stationary part, or stator, the stator and rotor having an uneven number of holes. By means of this construction the rotor may be made of almost the same size as the internal diameter of the stator, the only space being

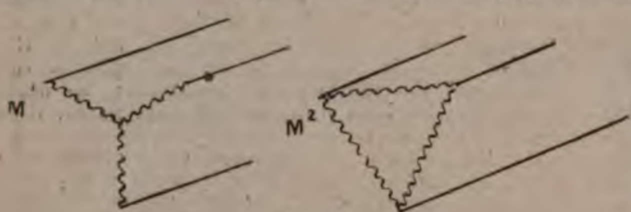


Fig. 15.

about 1-64in. for small machines—that is, just sufficient for mechanical clearance. We may here note that this does not allow of much wear in the bearings, but this disadvantage has been obviated by the manufacturers by making the bearings of phosphor-bronze and rather longer than usual. The conductors are very securely held in position in a good mechanical manner, binding wire being unnecessary. There are other advantages, the chief of which are absence of eddy currents in the copper, consequently it is not necessary to laminate the conductors; and there is no tangential drag upon the winding, but this comes on the iron part. The mechanical construction is exceedingly good, because the conductors are securely bedded and driven. Then centrifugal force does not displace them, and the clearance between the rotor and stator is reduced to a minimum, thereby in the case of tunnel or tooth wound dynamos greatly lessening the necessary exciting power.

In the fields of the motor the frequency of the magnetic cycles is obviously equal to the frequency of the alternating-current supply, whereas the number of times the magnetism is reversed in the armature depends upon the amount of slip which the motor has; and this being comparatively small, the hysteresis loss per pound of iron and losses due to eddy currents are considerably smaller in the armature than in the fields.

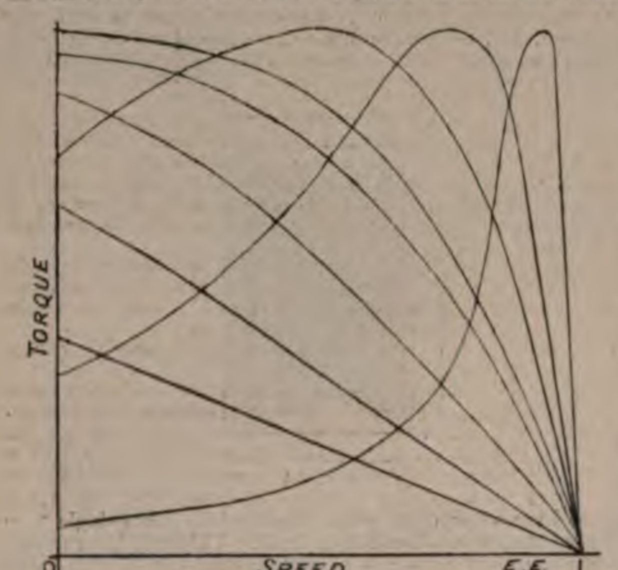


Fig. 16.

The tendency, then, is to have as little iron in the fields as possible, but this tends to a limit, since if this is decreased too much, we should get the induction very large, which is a thing to be avoided. Consequently, in large machines, it is usual to have the armature stationary, with a revolving internal field; this, of course, necessitates the use of brushes and slip rings, but this disadvantage is more than balanced by the saving of power in reducing the hysteresis losses. All these modern types of machines are provided with self-oiling bearings, and if used for working in flour mills or other dusty and often inaccessible positions, they may be very easily enclosed, and do not require such close attention as a direct-current motor, there being no commutator, etc. When the motors are to be used *in factories where there* is much dust of a gritty nature in the

air, such as in cement manufactories, the air-gap betwe
and stator is usually made larger at the bottom than at t
so that they will run for a lengthened period without a
the bearings. The shafts in these motors are usuall
hardened.

One may argue that the great drawback is the run
three wires, but is this more complicated than the thr
or five-wire system of direct-current distribution? thi
the principle of nearly all the direct-current plants th
been put in during the last few years. Of course, for th
voltage it is necessary to insulate better, since the alte
current will have a maximum pressure of about 141 volt
root mean square value is 100; hence we require a
insulation to withstand this maximum pressure. I
Fig. 16 we have a series of curves showing the
between the torque and speed of an induction motor
0 is the starting point and 1 equals the speed of synch
By the curve *a*, which is a straight line, you see the to
a maximum at starting and falls off as the speed increas
condition being fulfilled when we have a large resist
circuit and practically no self-induction. Now, if we ha
induction as well as resistance, the curve becomes bent
and the greater the self-induction becomes in propor
the resistance the more bent does the curve beco
shown in *c*, *d*, *e*, *f*, *g*, *h*. The designer is enab
construct machines which will follow almost any o
curves. It will be noticed what a good torque we get
case of *h* when near the speed of synchronism, but, on t
hand, how small the starting torque is. This difficulty

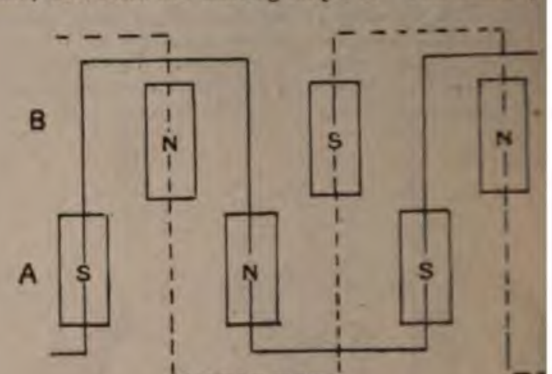


Fig. 17.

got over, however, by inserting resistance at starti
gradually cutting it out as the speed increases, be
starting the torque is proportional to the resistance of t
At starting the slip is very great, therefore, if the roto
very low resistance, as it naturally has from its const
enormous currents are generated in it, and would requ
large currents in the stator; the field of these being at
time opposed by the field due to the rotor currents, wo
a tremendous number of lines along paths outside of t
all of which tends to lessen the torque. Another loss,
considerable, would be that due to heating of the
Curves *c* and *d* show the effect we should get with
designed with a relatively high-resistance rotor; the
torque would be the maximum exerted by the machine
the speed increased the torque would become less. A
tion of this type, such as shown in curve *e*, would be
crane or any such work where a motor has to be starte
a heavy load, and where speed is of secondary imp
Up to about 5 h.p. or 6 h.p. the motors have usuall
circuited rotor windings, but above this output the
method is to provide a starting resistance, which is
as the speed increases, finally short-circuiting th
of course, this involves the use of slip rings and br
some equivalent device for cutting out the resistance.
illustrates a special type of motor with staggere
Essentially this is two single-phase machines side
their windings being connected to a two-phase sour
corresponding rotor is like two put together on the sa
the windings extending the whole length of the tw
When the coils are in the position shown, current is in
the dotted winding, and as this winding is directly u
poles of the B field a torque is produced proportion
current strength in the rotor and the strength of th
At the same time a current is induced in the rotor
shown in full, and these similarly produce a torque
A field. Now, when the rotor has revolved through a
equal to one quarter of the pole-pitch, it is acted up
by all the fields, and two torques are produced in
directions, and we have here a dead point; this may,
be annulled by properly disposing the winding. The
are usually provided with external resistances for
purposes.

Starting Devices.—There are several ways of starti
phase induction motors: (1) direct connected to m

in field; (3) resistance in armature; (4) variable er; (5) commutated armature. Small machines are rays connected, or switched direct on to the mains, undesirable for large machines, because they would an enormous current, besides which there is the y of the armature burning out. The Allgemeine of Berlin construct some of their machines with a w of windings in the rotor.

nce in the Field.—This is usually in the form of a liquid , and diminishes the current in the field, as a result the field is much weaker, and therefore the rotor has rrents induced in it, and is unable to exert a great t starting; this arrangement is good where we are o start the motor on a loose pulley, but is bad when ine has to be started under load. The same argu- is good in case (4), where a variable transformer is he effect of putting resistance in the rotor circuit ly been discussed, and is represented by the curves in In case (5)—viz., starting by commutating the arma- conductors are put in series at starting, and by some rangement are put in parallel when running. If we ls in parallel when running and put them all in series , then the current is $\frac{1}{n}$ of what it would be if started e coils in parallel; the field current, however, has the whichever method we employ, and the starting he same, because putting the conductors in series he resistance and reactance in the same proportion. everal ways of connecting the coils with or without to minimise the starting current and get a greater ich need not be entered into here.

n of Two to Three Phase, or vice versâ.—This converting alternating currents was first tackled it to a successful issue by Prof. Silvanus Thomp- scribed in a lecture given at the Royal Institution ring was used having 12 coils wound upon it, to ee-phase current was supplied, then by tapping off points, A A¹, D D¹ (Fig. 18), he obtained two-phase

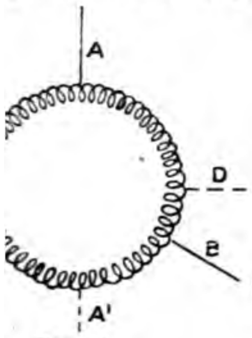


FIG. 18.

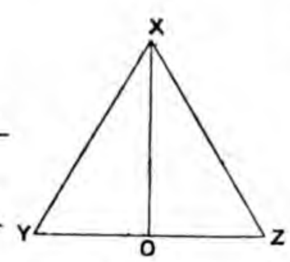


FIG. 20

by taking leads from the proper points could get phases. Mr. C. F. Scott shortly afterwards devised of converting two-phase currents into three-phase For this purpose he employs two transformers, as ammatically in Fig. 19, where G represents a two- ator, and T_1 and T_2 transformers. The secondary sformer T_1 is connected to the mid-point of the of T_2, their other ends being connected to the

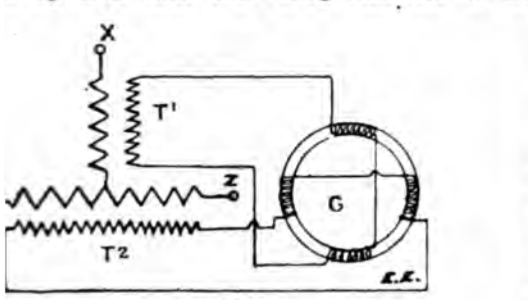


FIG. 19.

Y Z. The currents in the transformers differ in leg., and therefore the E.M.F.'s generated in the will also differ by 90deg. The resultant E.M.F.'s across the terminals may be represented by a 20), where O X is E.M.F. across T_1 secondary, M.F. across T_2 secondary, that between X and Z ultant of the full E.M.F. of the secondary of T_1, e E.M.F. of the secondary of T_2 represented O Z respectively. In the same way X Y repre- M.F. between X and Y, whilst X Z represents the secondary of T_2. Then it is obvious that by portioning the number of turns on the secondaries rrange matters that the E.M.F.'s between X Y, X Z, and Y Z are all equal, and they will have 120deg. difference of phase. This operation may also be reversed—that is to say, we can convert a three-phase current into a two-phase.

To be continued.)

PHYSICAL SOCIETY.

At the last ordinary meeting of this society, Mr. Shelford Bidwell president, in the chair,

Mr. A. A. Campbell Swinton read a paper and showed experiments upon **"The Circulation of Gaseous Matter in a Crookes Tube."** The stream-lines within a Crookes tube are investigated by observing the direction and speed of rotation of a mica radiometer mill mounted on a sliding rod, so that it can be moved along a line at right angles to the line joining the electrodes. The axis of the mill is at right angles to both these lines. If the mill is adjusted to a position between the flat plate and the cup electrodes, with its axis just sufficiently low to prevent equal and opposite simultaneous actions on the top and bottom vanes, it rotates, always in the direction indicating a stream from cathode to anode. The speed is greater when the flat plate is the cathode. If, however, the mill is now moved below this line, a point is reached at which rotation ceases, and below this neutral point the rotation is suddenly reversed. Reversal is only to be observed with high degrees of exhaustion. The rotation is never so rapid here as in the first position. The mill rotates, and the reversal may be observed whether cup or plate is made cathode, and the direction of rotation below the neutral point is always opposite to that in the position above it. A small Wimshurst machine is as effective as an induction coil in producing these effects. The experiments are intended to establish the existence, at high degrees of exhaustion, of a true anode stream—*i.e.*, a stream that travels from anode to cathode just in the same manner as the cathode stream flows from cathode to anode. This anode stream is charged positively; it is exterior to the cathode stream; its velocity is less than that of the cathode stream, but its velocity increases as the vacuum is improved. It seems probable that at high vacua some portion of the positive electricity passing through the tube is carried by the positively-charged atoms or particles that constitute the anode stream. At lower degrees of exhaustion the discharge passes through the tube chiefly by interchange of charges from molecule to molecule—a Grothüs chain. At very high vacua, however, when the mean free path is considerable, there may be to some extent a regular and complete circulation of positive and negative atoms, some of which pass from anode to cathode and *vice versâ*, and deliver up their charges, not by interchange, but by direct convection, to the electrodes of opposite sign.

Prof. Boys said he did not feel altogether convinced by the experiments that the rotation of the mill was due to simple mechanical motion of the particles of matter between the electrodes. The weight of air left in the tube at such high degrees of exhaustion was extremely small; it was difficult to realise that its impact could produce the sudden mechanical effect observed at the moment of the reversal of the rotation of the mill.

Mr. Wimshurst thought it important to keep in mind the existence of mercury vapour in the tube He also referred to some experiments in which a bar of metal was used to explore a focus tube, by observation of the changes of luminosity produced in different positions.

Dr. Chree said that if the rotations of the mill could be shown to indicate a velocity of the particles of the same order as that observed in Crookes's experiments, it was safe to assume the existence of a similar cause. This might be important in deciding as to the general truth of the bombardment theory of Crookes. He asked whether the rotation had been investigated within the dark space around the cathode.

Mr. Appleyard suggested that, in tracing the cause of the rotation, it would lead to simpler results if the vanes of the mill were made of some light conducting substance. Mica introduced difficulties owing to its retention of the charges.

Prof. Boys pointed out that this could be done by gilding the mica.

Mr. Campbell Swinton, in reply, said that the objection raised by Prof. Boys to the mechanical theory of the rotation would apply equally to the whole theory of electro-radiometry, including the case of the mill used originally by Crookes in the direct path of the cathode stream. But it must be remembered that, although the mass of matter present within the tube was very small, its velocity was proportionately great—it was of the order of 9,000 km. per second; hence the contained matter might be conceived as capable of producing the observed acceleration, and Crookes's bombardment theory might with safety be adopted as a safe working hypothesis. In the tubes used for these experiments the exhaustion was carried so high that the negative dark space appeared to fill the whole tube. He had, so far, only tried mica for the vanes, but he thought it would be important to observe the result with a substance that did not retain the charges.

Mr. A. Stansfield then read a paper on **"Thermo-Electric Pyrometers"** In obtaining photographic records of the readings of thermo-electric pyrometers, the range of measurement is limited by the size of the photographic plate. For long ranges of temperature, the sensitiveness of the galvanometer must therefore be small. When it is desired to examine the temperature changes in detail, as, for instance, at the melting points and freezing points of metals, it is necessary to employ some device for giving a more open scale for the short temperature ranges that include those particular points. For

this purpose two galvanometers are arranged in parallel, and so that they have their deflections recorded on the same photographic plate. The less sensitive galvanometer covers the entire range of temperature throughout an observation; the other is brought into use for magnifying special portions of the range. In this latter case, part of the E.M.F. of the thermo couple is compensated by an opposing E.M.F., applied at two points of the circuit, from a battery of Clark cells in series with a high resistance. The recording apparatus consists of a photographic plate mounted on a float that rises steadily when water is admitted into a cylinder. The source of light is an incandescent lamp, enclosed in a wooden box. A brass tube with a rectangular diaphragm at the end nearest the lamp cuts off all light except that from a selected piece of vertical filament. Light from this filament is reflected by the plane galvanometer mirror, and is focussed upon the photographic plate by a lens in front of the galvanometer; this method was suggested by Prof. Boys. The "cold" junctions of the thermo-couple are both inserted into a hypsometer. Very serious discrepancies exist between the indications of couples having nominally the same composi ion; they are too great to be attributed to accidental differences in the constitution of the alloys. Although with platinum alloys, coupled with platinum, 10 per cent. of iridium gives a more powerful couple than 10 per cent. of pure rhodium, the partial substitution of iridium for rhodium very considerably lowers its thermo-electric power. This result suggests that the change in the thermo-electric power of a metal depends upon the extent to which it is saturated with the alloying metal; thus 10 per cent. either of rhodium or iridium would, *per se*, more completely saturate the platinum than would 10 per cent. of a mixture of the two metals. The author discusses a series of curves derived from his experiments. He concludes that, thermo-electrically, there may be two classes of metals: (1) the ordinary metals, for which the curve representing the first differential of E.M.F. with respect to temperature is a straight line, and (2) the platinum metals, together with a few such as nickel and cobalt, for which the curve of that differential multiplied by the absolute temperature is a straight line.

Dr. Chree discussed the curves, and asked how far stirring affected the results. He was inclined to think that stirring was a mistake.

Mr. A. Campbell enquired whether the galvanometer kept its zero sufficiently well throughout the tests.

Mr. Stansfield, in reply, said he had also come to the conclusion that stirring was a mistake, and it was a mistake to use a large quantity of metal. The pyrometers were sensitive to about a tenth of a centigrade degree. He had experienced great difficulty with the zero of the galvanometer.

The **President** proposed votes of thanks to the authors, and the meeting adjourned until April 22.

ELECTRIC TRACTION IN HASTINGS.

The Council in committee have, in pursuance of the order made at the meeting of the Council held on Feb. 4 last in connection with certain tramway and light railway (electric) schemes, had under consideration the question as to what inland lines to the suburbs and outskirts of the borough should be constructed by the Corporation, and generally. At a meeting held on the 9th ult. the committee decided to refer the matter to the borough engineer to report as to (1) what inland lines are at present desirable, having regard to population of the neighbourhood, class of property, width of roadway, etc.; (2) the best route to be taken, including terminations, double or single lines, gauge, passings, etc.; (3) the best system to be adopted, power and other stations, requisite sites therefor, additional plant, etc.; (4) the probable cost per line or per mile thereof for construction, and the best mode of procedure; (5) the probable cost of working; (6) which lines should in his opinion be or shortly become remunerative, and generally thereon; and at a meeting held on the 16th the committee received the following report:

ELECTRIC TRAMWAYS.

To the Chairman and Members of the Council in Committee.

Gentlemen,—In accordance with your instructions I beg to report upon the question of electric tramways for Hastings as follows: It will perhaps be advisable in the first instance to give a brief outline of the various tramway systems in some of the principal towns on the Continent of Europe and in England, information which has in a large measure been obtained from the extremely useful reports made by the special committees of the Glasgow and Sheffield Town Councils and by the clerk to the Douglas Commissioners. The information which I am putting before you is obtained from the working of tramways in the following cities and towns: Brussels, Hanover, Hamburg, Berlin, Dresden, Budapest, Vienna, Milan, Genoa, Paris, Rouen, Elberfeld, Reimscheid, Liège, Blackpool, Bristol, Birmingham, Walsall, Wednesbury, Edinburgh, and from many cities on the continent of America. The information is of a very voluminous nature, and it will only I think be necessary to put before you the leading points whi
made me come to the conclusion that the overhead
trolley system is the one most suitable for tramways
town.

[We pass over this part of the report, as we have printed the Sheffield and Douglas reports.—Ed. *E. E.*]

The general conclusion to be arrived at on the qu
traction is that overhead electric traction is the syste
is most suitable to this town in almost every way.
also say that it could be worked in connection with a s
electric street-lighting.

After having given the whole question very seri
careful consideration, and bearing in mind that the pu
unmistakably expressed themselves against tramways a
part of the sea-front of Hastings, and considering
configuration of this town is so peculiar, I have com
conclusion that, as a beginning, the two routes which
desirable to be undertaken at the first are: (1) From th
hall at the bottom of Cambridge-road along Cambrid
Bohemia-road, through Silverhill, along the main Bat
and terminating opposite the road leading up to St.
Church, Hollington. The total length of this route is
1 furlong 7 chains. The steepest gradient is 1 in
distance of about 2½ chains. This route would serv
large population, and would unquestionably be very re
tive. The width of roadway in every part is ample. (
outside the cricket ground gates in Queen's-road, passi
Queen's-road, under the St. Andrew's Bridge, along
stone-road, Quarry-road, Mount Pleasant-road, Priory-r
London-road, and terminating a few yards on the Hasti
of the entrance to the borough cemetery. The total le
this route would be 2 miles 7 furlongs 7½ chains, and the
gradients would be 1 in 9 for the length of 3½ chains an
for a length of 12 chains. This line would also serv
populous and busy district, and at a future time a bra
might be constructed from Ore along the Fairlight-ro
as Down Lodge. This could be worked during sum
only, and would undoubtedly prove a great boon to th
of people who visit this town, and also a large numbe
dents who do now, and would more often, frequent the
district.

It would be advisable to adopt the principle of sin
with frequent passing places, and I should recomm
the gauge should be 3ft. 6in. In route No. 1, passin
would be constructed at the top of Cambridge-road,
the junction of Magdalen-road, St. Peter's Church,
with London-road, Sedlescombe-road, and opposite
nursery; and of course a short length of double lin
be necessary at both the commencement and termin
the line. With route No. 2, passing places would
structed at the junction of Stonefield-road, junction of
road, junction of St. George's-road with Mount Pleas
near the junction of Priory-road with Old Lond
opposite Christ Church, Ore, and opposite Coghu
Both these routes would, I am sure, be very rem
from the commencement, and one has only to instan
to be confirmed in this view. At Dover the total leng
main track is only about three miles, and with a smal
tion compared with that to which either of these
routes would serve, this line has very much more than
the expectations of its most sanguine advocates.

As I have previously stated, the best system to be
is the overhead trolley system, as it has from alm
point of view advantages over any other. It is ch
first cost, varying from £4,000 to £6,000 per mile
any conduit system. It is far less costly to work; an
opinion of many experts decidedly safer. Any le
defect in the overhead cables is at once detected a
remedied; and with the most modern appliances,
having switches fixed at certain of the columns so as
the cutting out of any particular section of the c
repairs are very quickly made. The system of daily
such as to render an accident from anything but
ordinary cause almost an impossibility. The questio
type of column to be adopted is more or less a m
detail, but it has been found in almost every instan
the columns erected possess any degree of artistic m
after a short time the public become so accustomed
as to look upon them more as an ornament than
figurement of the streets. It is true that in some to
are about as plain and ugly as they can be, but i
notably Bristol, they are of a most artistic design, a
confident that both residents and visitors would in a sh
become quite accustomed to their presence. The de
sent out by the three corporations to which I have al
their visits to Continental and English cities, pai
attention to this question; and in every instance it
that the public soon became accustomed to them, and
cases looked upon them as ornamental. I can har
that a public which will tolerate ugly plain black
poles, will look askance at a nice light ornamental ir
and bracket. Should, however, serious objection be

em entirely, a combination system—similar to that n a short length of line in Berlin—could be adopted; is a combination of the closed-conduit system and the trolley. The closed-conduit system could be adopted the busy part of the town—for instance, Queen's-road—his involves the use of a slot, I feel sure that very great n would be taken to it. The closed-conduit system l by Messrs. Siemens and Halske has one rail of the y type, and the other takes the form of a double rail, forming the space between the two. This slot varies in. in width on the straight portions to $1\frac{1}{2}$in. on the portions of the line. Under this rail is the conduit which is carried the electric cable. At frequent intervals dholes and at certain points manholes for cleaning out nduit box. This combination system is always much xpensive than the overhead system, and it is a question to decide as to whether it would be worth while to he combined system instead of having one throughout.

ing dealt with the system proposed to be adopted, the n of power is perhaps the next in importance; and I unhesitatingly recommend you to enlarge your station in rorks-road to accommodate the machinery which will be ry for working these tramways. Let me at the com-ment inform you that it is not practicable to work electric from alternating machinery; no mechanism or appliance been found for starting motors actuated by alternating ; and even if there were, it is doubtful whether the f Trade would consent to allow anything beyond the s to be passed through naked conductors.

I deal with the plant which will be necessary for these two routes, it will be advisable for me to give utline of the proposed working of these lines. In all nates which I have prepared I have worked on the on that you would adopt a 10-minute service—that is x cars leaving the commencement of each route every intervals of 10 minutes each. The cars which I commend you to adopt would be capable of seating ns inside and 22 outside. They would be of a most al and yet substantial character and design, and those which are in use at Hamburg and many of the cities. Each car would be fitted with a pair of otors. These motors would be of sufficient power to that a speed of eight miles per hour could be run up clines which were not steeper than 1 in 18, when the fully loaded. On gradients steeper than 1 in 18, would not be very much less. There would be ample r attaching a trailer at busy times in the summer The cars would be fitted with both electric and hand nd be lighted with incandescent lamps fed from the ires; and I should propose to use the fishing-rod s this has been proved from actual working to be ieter and more reliable than the bow trolley. There only three cars at a time on each route on the outward and three on the homeward journey; and it would be to provide about 230 h.p. for this work. This would ple margin for running about six additional cars if , or would be available for the extension of the lines. on which has recently been erected at Waterworks-d be so extended as to accommodate almost any amount for motive power or lighting, and the machinery uld be required would be two additional boilers similar which are already there, and three direct-current one of which would be a stand-by. The adoption of ams would be the means of considerably reducing the unit for any street-lighting which might be done from ion. It would enable you to work part of your plant e day as well as the night, and it has been proved ever a day load can be obtained, not necessarily for machinery, but for the same station, the cost of s greatly reduced.

gone closely into the question of erecting a destructor ighbourhood of Silverhill, and also the power to be from the existing one at Rock-a-Nore, but I have come nclusion that as only about 100 h.p. could be obtained destructor at Rock-a-Nore, and you could not hope to re than 120 h.p. from any destructor which you might he Silverhill district, it is not advisable to create small stations. It goes without saying that a certain staff ve to be kept to look after the electric plant, and there many disadvantages in adopting such a method. The ing undoubtedly is to have the power at one central nd the station at Waterworks-road is particularly well s being almost in the centre of the two proposed n connection with these two lines it would be necessary le car stations, and I propose that one car station to date two cars should be put up on land which is now rchased by the Corporation in Coghurst-road, Ore, n land which is already in the occupation of the Cor-at Silverhill waterworks, to accommodate six cars, and aterworks-road to accommodate four cars. The ques-e times at which the cars should commence and cease , of course, one of detail.

In my report presented to the Tramway Committee of the late Council, dated Sept. 20, 1897, I gave it as my opinion that the cost of a single-line system with passing places in Hastings might safely be taken at £8,000 per mile, including the cost of the track and equipment, which would include cars, machinery for the motive power, and all incidental expenses; and after having gone into the estimate in detail, I find that the cost would be £7,263 per mile. This sum includes an item of 10 per cent. for contingencies, and is based upon the work being done in a first-class manner as regards permanent way, equipment of the line, and machinery. I have had my figures verified by a London electrical engineer of recognised standing, who gives it as his opinion that my estimate is quite ample for carrying out first-class work. In constructing these lines I should propose to use rails of not less than 87lb. per yard in weight. The rails, which would be 6in. deep, would be laid upon a bed of concrete 9in. thick and 12in. in width. The intermediate space between the rails, and for a distance of 2ft. outside each rail, would be laid with hardwood blocks—either Jarrah or Karri wood—laid on a bed of cement concrete 8in. thick. The rails would be of the usual girder type, slotted for tie-bars, and drilled for fishbolts, and also drilled for electrical bonding. I may here mention that the groove in the rail would only be $\frac{5}{8}$in. in width and about $\frac{7}{8}$in. in depth.

The best method of proceeding with a scheme of this sort is unquestionably, to my mind, under the Light Railways Act; and in this case the doubt which exists as to whether the Act was really intended to sanction railways constructed in urban districts would scarcely apply, as the lines undoubtedly run into districts which are in some measure rural. There are many advantages in proceeding under this Act in preference to the Tramways Act—the powers are much more extended, and what is perhaps one of the greatest benefits is that a local enquiry is held, and the general public consequently have the opportunity of appearing either in favour or against the scheme. If the scheme is carried through, and it goes before the Light Railway Commissioners this May, consent would probably be given in the following month, the Corporation could as soon after as they chose commence the work, and, as I have before stated, the nature of the work is such that the whole of it could be contracted for and placed in the hands of respectable and well-known contractors. I do not think it would be necessary to apply to the Local Government Board for sanction to borrow the money; the powers of the Commissioners are such that after the Act has received the Royal assent no further Government tribunal, except the Board of Trade, would have to be consulted. The work would, of course, have to be carried out under the Board of Trade regulations and to their satisfaction, and it would be treated in all respects as a railway. The Board of Trade would have to minutely and thoroughly inspect the line and its equipment, machinery, etc., before it could be opened to the public.

The cost of working these two routes, including interest and sinking fund on the estimated amount of the proposed works (£37,350), would be about £6,356 per annum. In this sum 7 per cent. per annum is provided for the depreciation of machinery and cars, and amounts to £798 per annum. Very ample provision is made for working expenses, and if my suggestion is adopted of working motive power in connection with public lighting, the same staff at the power station would suffice for considerable extensions. I have, for the purpose of calculating the revenue to be derived from these two routes, calculated the cars to commence running from 7 a.m. to 11 p.m., as follows: 7 to 8 a.m., 20 minutes' service; 8 a.m. to 10 p.m., 10 minutes' service; 10 p.m. to 11 p.m., 20 minutes' service, and I have estimated that the very low number of 12 persons would be carried by each car every journey, this number including short as well as long distance passengers. I have taken the fares as 2d. for the outward journey or part of it, and 1d. for the inward journey or part of it—that is to say, the fare from the Memorial to the cemetery would be 2d. all the way and 1d. back, and from the Memorial to Hollington 2d. and 1d. back. The number of passengers which I have estimated as being carried is, I am sure, a very low estimate, as in summer time the cars on both routes would undoubtedly often be full, and it might be found necessary at times to attach a trailing car to the ordinary car. Taking the above figures, a revenue of £8,424 per annum would be obtained; this would leave a balance over expenditure of £2,068, equivalent to $5\frac{1}{2}$ per cent. profit clear of income tax, this being included in rates and taxes added to working expenses. It may be said that these fares are too low, but I cannot too strongly point out to you that cheap fares are found to answer best on all tramway systems, and in this case I am sure that these fares would induce thousands to ride who would not think of doing so if the fares were higher. If the Corporation thought proper, you could run cars both up and down at six in the morning for the convenience of working people at reduced fares. This would undoubtedly prove a great boon to hundreds, and would enable many working-men to live on the outskirts of the town who now have to live nearer the centre of the town in order to get as near as possible to the station or their work. I have

not taken this matter into consideration in forming my estimate of receipts, although I have provided in my estimate of working expenses for work to commence at the power station at 6 a.m.

I have proposed these two main tracks in the first instance, and I am strongly of opinion that these should be undertaken first, and not the one only. The staff at the power station would have to be the same if one track was undertaken as if the two were built, and the working expenses generally would be higher in proportion if only the one route was dealt with. Branch lines from the entrance to Alexandra Park to the Spa, from Christ Church, Ore, to Down Lodge, Fairlight-lane, and from the junction of Sedlescombe-road with London-road, running as far as the Silverhill Board School could be built afterwards as feeders to the main tracks. The branch line to Down Lodge could be worked in summer only, and would no doubt be highly remunerative. My estimate of the cost of working is, I feel confident, ample, and that of the revenue to be obtained is well within the mark. And it may be here remarked that in almost every case where a good properly constructed electric tramway has been constructed, the results have far exceeded the most sanguine of their supporters. As an instance, Dover may be quoted, where with only three miles of track a revenue is already being obtained equal to that I have estimated for in this scheme, and in this case a population quite double that served by the Dover trams could be reckoned upon. It has been proved over and over again that with a well-equipped track and cheap fares a very large traffic is created, and the districts served soon became more developed and thickly populated; and I feel sure that it would give a great impetus to the development of the outskirts of the borough, and be the means of causing many people to reside here who would not otherwise do so on account of the expense and difficulty in reaching some of the prettiest and most healthy parts of the borough. And I do not think that any fear need be entertained that this scheme, if carried out, would deter a single person who now uses a carriage from doing so, or drive away from the town those who do. The opinions obtained from almost every town where electric tramways are used go to support this view, and it must be distinctly borne in mind that they do not obstruct traffic to any appreciable extent; and if the work is properly carried out the objection of crossing over the rails with a carriage or vehicle is reduced to a vanishing point, and the prejudice which many people evince at the idea of a modern electric railway track is undoubtedly derived from the real objections to horse tram tracks, from which they differ.

In conclusion, I have no hesitation whatever in stating that, in my opinion, the scheme would be an entire success, and is one which the Corporation might safely adopt without the slightest risk of speculation or injury to the town as a first-class watering place. Owing to the short time I have had in which to prepare my report, there are probably points upon which I have not touched, and I am unable to place before you such drawings as I should like to have done, but these are more or less details which would be submitted at a further time if the Council decide to proceed with the scheme, and which are not necessary to the preliminary work and the obtaining of the order under the Light Railways Act. In putting this report before you I should like to say that for the past two years I have made tramways, and electric and other modes of traction, a special study. I have, moreover, travelled over a good many tramway systems, both in this country and on the Continent, and made myself thoroughly conversant with their working; and I am, I believe, consequently in a position to fully advise you upon this matter.—I am, gentlemen, yours obediently,

P. H. PALMER, M.I.C.E., Borough Engineer.

The committee, having carefully considered the report, recommend that, subject to any variations as to details deemed necessary in connection with the entire scheme, the various suggestions made therein as to the construction and working by the Corporation of the two main lines be adopted; that power be also sought to construct and work the branch lines suggested; that the overhead electric system of traction be used throughout, and that a special committee of seven members be appointed to determine and carry out the details of the scheme.

The committee instructed the town clerk to forthwith give the requisite notice, under the provisions of the Light Railways Act, 1896, for a special meeting of the Council to be held on April 20 next and of the resolution to be proposed thereat approving of the making of the necessary application to the Light Railway Commissioners, under the provisions of the said Act, for an order authorising the construction and working by the Council of the suggested lines; and authorised the town clerk and borough engineer to take all necessary steps for enabling the application for the order to be forthwith made to the Commissioners in the event of the formal resolution being duly passed.

LEGAL INTELLIGENCE.

ELECTRICAL SANITATION PATENTS.

Mr. Registrar Brougham has granted an immediate
discharge to Paterson and Cooper, electrical engine
contractors, of Dalston, Westminster, Manchester, Glas
Dundee.

The **Official Receiver** reported that when the applica
set down for hearing, so far back as January, 1897, he wa
to submit that the assets were not of sufficient value to
in the £ on the ranking liabilities. The hearing had been
from time to time to allow of the assets to be realised, an
trustee now stated that 10s. in the £ would be real
would withdraw the allegation of insufficiency of assets.

His **Honour** said there being a clean sheet, he could
unconditional order of discharge to the debtors.—*Financi*

COMPANIES' MEETINGS AND REPOR

METROPOLITAN ELECTRIC SUPPLY COMPANY, LI

The eleventh ordinary general meeting of shareholder
Company was held at Winchester House on the 29th
Eyre M. Shaw, K.C.B. (chairman), presiding.

The **Chairman** said, in moving the adoption of the re
accounts, that the only capital raised during the year h
£62,500, the balance of the £125,000 new capital, w
issued in 1896, and from June 30, 1897, became part of
nary share capital of the Company. The expenditure on
account during the year was £93,795. 16s. 10d., with a gra
of £850,831. 10s. 9d., and a balance of £29,597. 18s. 10
was practically expended. The principal items of
ture were: extensions of mains, £38,869. 12s. 5d.; tran
and meters (6,000) with their connections, £15,823. 4s. 2d.
new site for generating works at Willesden, £12,891.
buildings, £9,445. 18s. 11d.; and machinery, £15,367.
The income from current was steadily increasing, giving
revenue of £138,267. 14s. 6d., as against £116,459. 4s., an
of about £22,000, or 19 per cent. The expenditure to
larger income also showed, as would be expected, an incr
not to so great an extent, being for cost of generation
against £52,619, an increase of £5,985, or 11½ per cent., pr
due to the increased consumption of coal and oil; and
revenue expenditure of £79,546, against £70,267 in 1896,
total increase of £9,279, or 13 per cent., as compared with
cent. increased income, as already stated. The increases
distribution had arisen from the extensions of mains and
ments of the system of low-pressure distribution, while th
of management expenses had been caused partly by
additions to the Company's staff in order to cope with the
increasing work and partly by the larger amount of the
fees. With regard to those fees he thought it right to rem
that some years ago the directors agreed among themselve
a very considerably reduced remuneration from that all
the articles of association until the Company should be
substantial dividends, and that even at the present time
amount allowed by the articles was not drawn. Believin
be truly a success the electric light must be regarded
luxury and more as a necessity, they had after the mos
consideration decided to make a substantial reduction
rates of charge from the commencement of the pres
That continual increase, while it was extremely satisf
pointing to the continued growth of their business, invol
in the obligation of making adequate provision for th
requirements. On the site at Willesden it was intende
large generating works. By gradually extending these
occasion might arise (and there was ample space at their
for doing that), they could place no limit to the amount
which could be produced. Intimately connected with th
sions, as affecting their cost of manufacture and dis
which it was their earnest desire to reduce to the lowes
figures, was the development which they had now in pr
changing their system of supply in those portions of th
where the lamp density warranted the laying down
pressure mains. With regard to their recent ne
with the holders of the founders' shares, the direc
prepared a scheme which had as its basis an allotme
new ordinary shares at par in exchange for each found
A committee was appointed by the holders of the founde
to report on that offer. They unanimously determined
offer was inadequate, and should be declined. The
stated they were confirmed in that opinion by comparing
with those accorded to founder shareholders in othe
electric supply companies, and that they had ascerta
holders of a considerable number of founders' shares pr
remain as they were, and would not entertain any offer l
able than the allotment of 300 ordinary shares at par
result of another attempt to effect an arrangement, the
had lately received a further letter from the founders'
suggesting that the founders might accept an allotme
ordinary shares; but the directors were still of opinion
terms were far too high, and unless within a very short
were able to come to terms with the founders, they would
issue a large portion of the new capital to the existing sh
at par, though it was their intention to postpone div
those shares until the new works could fairly be expec

ıeir proper proportion of revenue. The Chairman then e following resolution: "That the report and accounts l in our last issue) for the year ended Dec. 31, 1897, to this meeting be, and are hereby, approved and and that, in addition to the interim dividend of 5s. per l on Oct. 15, 1897, a further dividend of 7s. per share on of the original ordinary shares and of 6s. per share on shares of the Company be, and the same is hereby, such dividends to be payable on March 30, 1898, to all ı the Company's registers on March 19, 1898"

ıl Hay seconded the motion.

ell moved that the accounts be rejected in order to test r of founders' shares.

ldwin seconded the amendment.

pps (a director) said he was the largest holder both of lers' and ordinary shares. He thought that when they sted their differences the concern would be one of the essful in the country.

ıairman said the amendment was a simple negative to n.

tion was put, and carried by a large majority.

ditors having been re-elected, the meeting concluded with thanks to the Board and secretary and staff.

WILLANS AND ROBINSON, LIMITED.

dinary general meeting of shareholders in Willans and ı was held on the 30th ult., at the Cannon-street Hotel, chair being occupied by Mr. Mark Robinson.

ıairman said, in moving the adoption of the report and , that although the great strike had not interfered with ions between the Company and its own workpeople, yet th many firms upon whom they depended for assistance, rm of stores, or of finished engine parts, or of tools for rks. Tools which they had ordered over a year ago were elivered, and thus a part of the capital had been idle for lrawing interest while producing no engines. However, re gradually surmounting the many troubles entailed by e and by the strike, and no doubt the balance-sheet n more satisfactory as the outcome of a difficult time it represented a period when all went well. The engines of their make had increased. Already an to indicate up to 1,500 h.p. was under construction for work, and designs for an engine of 2 500 h.p. were being l. At Rugby they were in a position where extensions, cessary, could be made rapidly and economically. They ituted since the close of the strike a system of long-service which would give their men a strong inducement to vith them, and the offer of which had been received with ion.

fred Holland seconded the motion, which was carried.

motion of the **Chairman**, a further resolution was carried ng the declaration of the dividend for the half-year ended 1897, at the rate of 6 per cent. per annum on the preference nd at the rate of 8 per cent. per annum on the ordinary

tiring directors, Mr. Mark Heaton Robinson and Captain were re-elected, and the auditors, Messrs. Cooper Bros. reappointed. The proceedings terminated with a vote of the chairman.

BROCKIE-PELL ARC LAMP, LIMITED.

ljourned second ordinary general meeting of the share- f the Brockie-Pell Arc Lamp, Limited, was held on the , at Winchester House, Old Broad-street, E.C., the Right d Suffield (chairman of the Company) presiding.

ıairman said that the profit and loss account extended eriod of 17 months, and then went into details over the items of expenditure as follows: advertisements, £326. agency and travelling expenses, £177. 8s. 10d.; bad 2. 1s. 8d.; bank charges, £17. 3s. 11d.; directors' fees, 6s. 3d.; legal expenses, £139. 5s.; patent fees, £188. printing, stationery, and postages, £389. 9s. 7d.; rent, nd taxes, £1,038. 6s. 3d.; repairs, £25. 1s. 3d.; salaries, 0s. 6d.; and trade and office expenses, £500. 2s. 7d. The nounted to £7,737. 0s. 11d. On the credit side of the there was manufacturing gross profit, £2,085. 1s. 5d., ting the gross profit on the sale of lamps and other goods. ped in their next account to show a very much larger sum his head. A sum of £985. 0s. 7d. had been paid as royalties e firm who formerly made their patented lamps. The fees amounted to £76. 18s. 6d. The premiums on issue 0 shares amounted to £1,250, less preliminary expenses 14s., depreciation on furniture account £206. 13s. 9d., and ation on tools £59. 12s. 3d.—total, £1,250. The chairman ssed on to the balance-sheet. The capital of the Company 0,000 in shares of £1 each. Of these 75,000 had been fully nd 12s. 6d. had been paid on 5,000, making £78,125, less , of which nearly all had since been paid. Dealing with agraphs in the report, he said the reason for the result of ling not being more satisfactory was that after considerable they had been able to secure suitable workshops in cle-street, Finsbury, but they did not get possession of ding until the end of the year 1896. Most of the leading houses being full of orders there was difficulty in obtaining y, and it was not until March that the machinery was g order and work commenced, principally upon the special tools. At the end of July last the first 100 lamps were completed by their own men, thus leaving practically only five or six months in which to make any manufacturing profit. The strike had caused them a great amount of inconvenience, owing to their not being able to obtain prompt delivery of raw material and other things required in the manufacture of their lamps. The purchase of the French and Belgian patents was to be completed by July 19. The new patents granted to Mr. Brockie last year included some important improvements in the construction of arc lamps and accessories in connection with them, which they fully believed would add to their business, and practically extend the time of their monopoly. The value of unexecuted orders amounted to between £8,000 and £9 000, although they had not yet reached the end of the first quarter of the year. He then moved the adoption of the report.

Sir F. D. Dixon-Hartland seconded the motion.

Mr. Skipworth moved as an amendment: "That the directors' report be received, but that the same be not adopted, pending the report of a committee of investigation to be now appointed by the shareholders."

Mr. Waugh said he had confidence in the directors, who held nearly two-thirds of the shares, and he failed to see why a committee should be appointed.

Sir F. D. Dixon-Hartland, in reply, said that the patents were examined by an eminent firm of patent agents, and, therefore, it must be presumed that they were perfectly good. The factory was leased for 21 years. With regard to the foreign patents, they were offered £3,000 for the patents for France and Belgium, and one-fourth of the shares of the companies to be floated for the development of the same. The Board hoped to double and even quadruple their output, and then the working expenses would drop in proportion, and there would be a chance of making profits. The directors were quite willing to draw only two-thirds of their fees until the Company proved a success. If at the end of another 12 months satisfactory results could not be shown, other men might be elected on the Board.

Mr. Skipworth withdrew his amendment, and the motion for the adoption of the report was then agreed to.

The retiring director, Mr. H. W. Maynard, was re-elected; the auditors, Messrs. Mellors, Basden, and Co., were reappointed; and the proceedings terminated with a vote of thanks to the chairman.

EASTBOURNE ELECTRIC LIGHT COMPANY.

The directors state in their report to be presented to the shareholders at the annual meeting on April 4 that the gross profit realised on the working for the year 1897 was £3,619. 7s. 11d., and that the net amount available for reserve and dividend, after allowing for the interim dividend paid to June, 1897, and £400 carried to the depreciation fund, is £1,838. 9s. 9d. They propose that £412 be placed to reserve, and that out of the balance left of £1,426. 9s. 9d. a dividend at the rate of £10 per cent. for the half-year, making, with the interim dividend paid in June, £7. 10s. per cent. for the year, free of income tax, be paid upon all the share capital of the Company. This, after allowing for the interim dividend, will absorb £974 15s., and leave £451. 14s. 9d. to be carried forward to next year's account. The depreciation fund stands at £3,025, and if the proposal of carrying £412 to the reserve fund is adopted, the reserve will stand at £3,250, making a total reserve of £6 275. The capital account shows a considerable outlay in the past year for main extensions and for additional machinery and plant, bringing up the deficit on this account to £5,553. 1s. 1d.; and the directors have to provide for a prospective outlay for the next two years of at least £4,000, making a total further capital required of £9,953. 1s. 1d. The directors have had under serious consideration the desirability of placing the depreciation and reserve funds upon a more solid basis. The aggregate of these funds, as stated above, is £6,275, but the money is actually in use in the Company's business, and is not represented by separate cash. It is proposed that the amounts standing to the credit of both these funds be placed aside in cash and invested in reliable securities at remunerative interest. To carry this proposal into effect, and to provide sufficient working capital, the directors suggest that, in pursuance of the powers given by the memorandum of association of the Company, an issue of £1,500 preference shares of £10 each, carrying interest at £4. 10s. per cent. per annum, be authorised and to be called up as required. This would have very little effect upon the ordinary shares, as against the dividends upon the preferred capital thus raised bank interest would be saved, and the interest upon the investments of the reserve could be appropriated to revenue account. The sanction of the shareholders to the course thus proposed is looked for with confidence. The lamps in circuit, reckoned upon an average of 8 c.p. per lamp, number 19,288, against 16,690 at the close of 1896, an increase of 2,598 lamps for the year. The net increase of customers for 1897 was 56.

GUILDFORD ELECTRICITY SUPPLY COMPANY, LIMITED.

Directors: Dr. F. R. Russell, Guildford (chairman); A. F. Asher, Esq., Guildford; J. M. V. Money-Kent, Esq., Twickenham; Leonard Ashby Ellis, Esq., Guildford; Charles James Scott, Esq., Guildford. Secretary: W. J. Perkins, Esq., Guildford.

The directors in their seventh annual report state that the number of installations connected with the Company's mains is increasing and now amounts to 52. The directors are well satisfied with the result of the first complete year's working, and are gratified to think that the stage of remunerative business has now been reached, the revenue account for the quarter ending Dec. 31,

1897, showing a profit of £67. 6s. The subscribed ordinary capital has now reached £7,670; but, as it has been decided to increase the plant and extend the mains at once, further subscriptions for ordinary shares, to be paid in full on allotment, are invited from the existing shareholders. Shareholders are reminded that the ordinary shares are entitled to the first profits in each year to an extent sufficient to pay a dividend of 6 per cent. thereon, before the founders' shares receive anything. The ordinary shares take also three-fourths of any surplus profits over 6 per cent., the founders' shares being entitled to the remaining fourth. Also that the Company holds a provisional order, granted by the Board of Trade and confirmed by Act of Parliament (57 and 58 Vict., c. cxv), for supplying electricity in the municipal borough of Guildford, and that under this order the Company has a practical monopoly in the town for 35 years from July, 1894. The directors have elected Mr. C. J. Scott as a director in the place of Mr. Sandall. The retiring directors are Mr. Sidney Sharp and Dr. Russell, of whom Dr. Russell offers himself for re-election.

REVENUE ACCOUNT, YEAR ENDED DEC. 31, 1897.

Dr.	£	s.	d.
Fuel, including cartage	148	12	2
Oils, waste, water, etc.	31	19	0
Wages	260	0	7
Rents payable	50	0	0
Rates and taxes	14	5	1
Salaries	84	3	0
Stationery and printing	12	4	2
General establishment charges	15	9	3
Insurances	5	10	6
Interest	1	4	4
Law expenses	49	17	2
Repairs and maintenance	6	15	4
Renewals and sundry small disbursements	3	10	10
Reserve account against outstanding book debts	10	0	0
Bad debt	0	8	8
Auditor (Board of Trade)	7	16	6
Auditors of Company	10	10	0
Repairs, maintenance, and renewals of apparatus at distributing station	2	8	10
Repairs, maintenance, etc., on consumers' premises	0	13	2
	£715	8	7
Balance brought down	120	3	0
Loss at Dec. 31, 1896	167	7	1
As disclosed in balance-sheet	£287	10	1

Cr.	£	s.	d.
Sale of current	512	15	7
Rental of meters on consumers' premises	36	17	11
Rents receivable	30	0	0
Fees	0	16	0
Income (miscellaneous)	12	16	1
Shares cancelled	2	0	0
Balance, being loss on year carried down	120	3	0
	£715	8	7

GENERAL BALANCE-SHEET, DEC. 31, 1897.

Liabilities.		£	s.	d.
Capital account—amount received		7,730	0	0
Sundry creditors—viz.:				
On construction of plant and machinery, and for fuel, stores, wages, salaries, etc.	£142 18 9			
On open accounts, including deposits against house connections in progress	84 12 10			
		227	11	7
Reserve account		10	0	0
		£7,967	11	7

Assets.	£	s.	d.
Capital account—amount expended	7,043	13	7
Oils, waste, etc., and fuel in stock	6	10	0
Preliminary expenses	278	0	3
Sundry debtors	333	12	11
Cash at office	18	4	9
Revenue account—balance	287	10	0
	£7,967	11	7

BRIGHTON AND ROTTINGDEAN SEASHORE ELECTRIC TRAMROAD COMPANY.

At the annual meeting held last week at the offices on the Madeira-road, Mr. E. O. Bleackley, the chairman of directors, presided.

The report stated that the car had continued steadily at work (short spells of bad weather excepted) since it started on July 20 last, and that the traffic had been most satisfactory, and seemed likely to fully bear out the estimates made as to the probable earnings, the receipts shown in these accounts covering only a period of less than five months During this time the car travelled a distance of 2,601 miles. There being only one car, the earnings during the busy time are limited to its capacity. It is, however, thought advisable to gain experience by the working of the present car before building another. The new jetty and landing-stage at Greenways, to accommodate the village of Ovingdean, is now completed, and will be opened at Easter. The Corporation of B[illegible] having reduced the price for electric current, the direct[illegible] arranged to take the necessary power from the Corporation which would result in improving the speed of the car, and [illegible] ing increased power at a less cost than at present.

Mr. J. J. Clark seconded, and the report was carried.

Mr. Magnus Volk was re-elected a director, and Mr. E[illegible] and Mr. F. G. Clark were appointed auditors.

DIRECT SPANISH TELEGRAPH COMPANY.

The ordinary general meeting of this Company was held 29th ult., at the offices, Winchester House.

The **Marquis of Tweeddale**, who presided, said that the fund amounted now to £12,975, and after adding £5,00[illegible] same the Board proposed the declaration of a dividend of cent. on the preference shares and 4 per cent. on the [illegible] shares, absorbing £5,486. Half of that sum was distrib[illegible] October last in the shape of an interim dividend.

The report was adopted, and the dividends recommended were approved.

OXFORD ELECTRIC COMPANY.

The seventh ordinary general meeting of the sharehol[illegible] this Company was held on the 18th ult. at the Randolph the chairman of the directors, Sir Henry C. Mance, C.I.E. chair.

The report recommending a dividend of 5 per cent. was a[illegible] The profit for 1897 was £3,996. 17s. 5d., of which £2,2[illegible] available for the payment of the dividend, the balance applied to the payment of debenture and loan inter[illegible] expenses attending the issue of debenture capital, etc.

BOURNEMOUTH AND POOLE ELECTRICITY S[illegible] COMPANY, LIMITED.

The statutory general meeting of this Company was held 28th ult. at Winchester House. Lord Rathmore presided. [illegible] was no special business to transact, and no resolution submitted.

CONTRACTS FOR ELECTRICAL SUPPLIE[S]

CONTRACTS OPEN.

Zafra (Spain).—Tenders are required for electric lighting town. Apply to the Mayor of Zafra (Badajos), Spain.

Plymouth.—Tenders are required for alterations to tr[illegible] For conditions apply Corporation Tramways Office, Plymo[illegible]

Warschau.—Tenders will be called shortly for electric i[illegible] tion for light and power. Particulars may be obtained f[illegible] Mayor of the town.

Ashton-under-Lyne.—The Corporation invite tenders [illegible] free wiring of premises in the borough. Tenders by April [illegible]

Derby.—The Derby School Board are prepared to receive for the electric wiring of their Traffic-street Board School, Tenders by April 11. For particulars refer to our adv[illegible] columns.

Bucharest.—Tenders are invited for the supply of double-petticoat porcelain insulators and 30,000 porcelain [illegible] Tenders, addressed to Post and Telegraph Department, Bu[illegible] by April 11.

Manchester.—The Corporation invite tenders for the and delivery of about 500 tons of steel tramrails. Drawi[illegible] specification may be seen at the City Surveyor's Office Hall, Manchester. Tenders by April 11.

Accrington.—The Corporation invite tenders for the su[illegible] fixing of various articles and engineering appliances in con[illegible] with their electricity works. Full particulars appear advertising columns. Tenders by April 19

Valderas (Leon).—Tenders are invited for the electric [illegible] of the town. The provisional deposit required is 1,000 [illegible] Specifications, etc., are to be obtained from, and tenders ad[illegible] to, the Administrator of the Province at Valderas by April

Ocana (Toledo).—Tenders are invited for a public electri[illegible] ing installation. The provisional deposit required is 6,250 [illegible] Specifications, etc., are to be obtained from, and tenders ad[illegible] to, the Administrator of the Province at Ocana, Spain, by A[illegible]

Madras.—The Secretary of State for India in Council an[illegible] that the time allowed for the receipt of tenders by th[illegible] Engineer for Irrigation, Madras, for the utilisation o[illegible] power of the Periyar Lake has been extended from Oct. 3[illegible] to July 1, 1898.

Bournemouth.—The Town Council invite tenders for el[illegible] installation at the pier and pleasure grounds. Full par[illegible] can be obtained of the borough engineer, Mr. F. W. La[illegible] vided the sum of £1. 1s. has been previously deposited office. Tenders by April 4.

Derby.—Tenders are invited by the Corporation for wiring of their Ford-street yard and premises. Specif[illegible] etc., may be obtained from the Engineer and Manager Electric Lighting Works, Sowter's-road, Derby, on prepay[illegible] £1. 1s., which will be returned on receipt of a bona fide Tenders to be addressed to Mr. H. F. Gadsby by April 12.

a, E.C.—The Shoreditch Vestry invite tenders for the nd erection of arc lamps and accessories, also for electric Specifications, etc., can be obtained from Mr. C. Newton chief electrical engineer, Electricity Supply Department, street, Shoreditch, on payment of a fee of £1. 1s., which be returned on receipt of a bona fide tender. Tenders 12.

ester.—Tenders are invited by the Lancashire and York- lway Company for the supply of various articles during e ending April 30, 1899, including signal and telegraph signal telegraph, and electric light wires. Particulars btained at the Stores Department, Osborne-street, Man- The sample-room will be open for the purpose of inspec- l April 2, between 10 a.m. and 4 p.m., Saturday 10 a.m oon. Tenders by April 4.

mouth.—Tenders are required for motor vehicles for the of house refuse, street scavenging, and conveyance of terials. Specification, etc., accompanied by drawings, e delivered at the office of Mr. F. W. Lacey, M.I.C.E., engineer and surveyor, Municipal Offices, Bournemouth, r marked "Tender for Motor Vans," by April 4. Out- fication and form of tender can be obtained on applica- e Borough Engineer's Office.

a, S.W.—The Secretary of State for War is prepared to ffers in writing, accompanied by competitive designs and ions, for the supply of portable electric search-light s. General particulars as to requirements can be obtained ation, either by letter or personally, to A. Major, director contracts, War Office, Pall-mall, S.W. The offers and must be delivered at the War Office, Pall-mall, London, April 27, addressed to the Director of Army Contracts, ted on the outside "Designs for Search-Light Apparatus"

pool.—The Corporation invite tenders for the supply and at the Corporation electricity works during year ending , 1899, of machine bearing and petroleum oils. Specifica- ., may be obtained from Mr. Robt. C. Quin, borough l and tramway engineer, Blackpool, on prepayment of of 10s. 6d., which will be returned on receipt of a bona ler. Samples, under a nom de plume only, to be sub- r test to the Borough Electrical and Tramway Engineer fore April 4. Tenders to be delivered by 10 a.m. on

a.—The Council invite tenders for the supply and erection) two dynamos, one continuous-current balancing trans- (2) two gas-engines and connections; (4) switchboards. tions to be obtained from Mr. H. Collings Bishop, the l engineer, Cathall-road, Leytonstone, on and after l, on payment of £2. 2s. for each copy, which sum will be upon the receipt of a bona fide tender. Tenders, accom- y a £10 Bank of England note to be enclosed with the d to be forfeited if the tender is withdrawn before the is signed, must be received at the Town Hall, Leyton, y April 4.

urgh.—The Mid-Lothian and Peebles Lunacy Board nders for the installation of electric light in their asylum lynlee, near Edinburgh, including generating plant, ttings, lamps, etc. Plans, etc., may be seen at the office Baily Heriot-Watt College, Chambers-street, Edinburgh. tions etc., can be obtained from Prof Baily or from Mr. son Smith, clerk and treasurer, 19, Heriot-row, Edin- n payment of £1. 1s., which will be returned after receipt uine tender. Separate tenders may be accepted for (1) rating plant, including accumulators, switchboard, etc., wiring, fittings, lamps, etc. Tenders by April 23.

n (Australia).—Tenders are invited by the Council of of Hawthorn for the supply and erection, or for the ly, of: (Section A) buildings only; (B) boilers, water- pumps; (C) engines, dynamos, switchboard, mains, sub- transformers, meters, arc lamps, insulators, testing nts; (D) supply of poles and their erection; running of t for three years. Specifications and forms of tender can ed at the office of the Agent-General for Victoria, Lieut.- Sir Andrew Clarke, G.C.C.M., Victoria Office 15, street, Westminster, London, S.W., on payment of which will be returned on receipt of a bona fide tender. nders, endorsed "Tender for Electric Lighting," and d to the Mayor of Hawthorn, Victoria, Australia, on at 5 p.m.

RESULTS OF TENDERS.

-The Electricity Committee have accepted the tender of lalder, at £263 for switchboard extensions.

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ster.—Mr. Hammond attended before the Electricity Committee at its last meeting and submitted a plan how he proposed to arrange the electricity and dust- r works upon part of the Beanland estate, and conferred committee as to the various kinds of dust destructors. mittee approved of the plan submitted by Mr. Hammond, o any modifications that may be found necessary in se the details. Mr. Hammond was instructed to invite ing firms to submit plans and estimates for four dust- r cells: Messrs. Beaman and Deas; Goddard, Massey, er; Manlove, Alliott, and Co.; the Horsfall Syndicate, The foregoing was approved at a meeting of the City n Tuesday.

BUSINESS NOTES.

Appointments Vacant.—We refer our readers to our advertising columns for particulars of various vacancies.

Glossop.—A special meeting of the Town Council is to be held shortly to consider the proposed electric lighting scheme.

Blackpool.—We understand that the report of the deputation which lately visited the Continent will be unanimous in recommending the overhead system.

Globe Telegraph and Trust Company, Limited.—The Board of the Globe Telegraph and Trust Company, Limited, announce an interim dividend of 2s. 6d. per share on the ordinary shares.

Grimsby.—The directors of the Provincial Tramways Company have decided upon the draft proposals providing for the working of the line by electricity, which will be submitted to the Council shortly.

Islington.—At the last meeting of the Vestry a communication was read from residents in Highbury New-park expressing a hope that the Vestry would soon place the electric light along that roadway.

New Catalogue.—We have received from Messrs. John Davis and Co., of All Saints' Works, Derby, their new and well-illustrated list of mining, surveying, engineering, and mathematical instruments.

The Gibbs Motor-Starting Switch.—In our article describing the above switch in our last issue we omitted to state that the same had been patented, and hence is protected against infringement of design.

Downie and Adams.—We are informed that the fire which occurred on Saturday last, and which destroyed a portion of the premises of Messrs. Downie and Adams, has not in any way interfered with the business of the firm.

Leigh.—The District Council have instructed the gas manager to prepare detailed plans and estimates for the erection of an electricity supply station at the gasworks, and the laying down of an installation on the lines proposed in his report, at a capital outlay of £10,000.

Mexborough.—At a meeting on the 30th ult. in support of the candidature of Mr. J. H. Watson, C.C., for the Urban District Council, the candidate said he was in favour of a public library, and he believed that in the near future the adoption of electric lighting would be practicable in Mexborough.

Willenhall.—The Urban District Council have agreed to approve of the Bill promoted by the Midland Electric Corporation for Power Distribution, Limited, in which a proviso was set forth as to the price to be paid if the town thought fit to avail itself of having the electricity for public lighting.

Lewisham.—The District Board of Works in committee have recommended that the Board, in response to the request of the Board of Trade for information, should pledge themselves to next year again ask for the issue of a provisional order for the electric lighting of the parish. This recommendation has been adopted.

Blackburn.—The laying of electric cables is being proceeded with rapidly. Electric traction will be used for the trams from Billinge End to Witton. The whole of the route will be lighted by electricity. A double track has yet to be laid from Sudell Cross to Montague-street, but it is expected that the cars will be running about July.

Personal.—Mr. Louis J. Steele, who was Mr. Gisbert Kapp's assistant at Messrs. Johnson and Phillips, and who has since acted as chief designer to them, is severing his connection with this firm after eight years to take up the appointment of chief electrician to the well-known firm of Messrs. Veritys, Limited, at their works, Aston, Warwickshire.

Direct United States Cable Company, Limited.—The directors of the Direct United States Cable Company, Limited, have resolved upon the payment of an interim dividend of 3s. per share, free of income tax, being at the rate of 3 per cent. per annum, for the quarter ended March 31, 1898, such dividend to be payable on and after April 26 next.

Electric Supply Company of Western Australia, Limited.—This Company has been registered with a share capital of £100,000, and has been formed to take over the Westralian Electric Lighting and Supply Company, Limited, and to carry on and develop the existing system of electric supply now working in the town of Coolgardie (W.A.). The purchase price has been fixed at £70,000.

Monmouth.—At a special meeting of the Town Council, attention was called to the fact that more than a year ago the Corporation had paid £1,000 for machinery for generating electric light, and now they were told that the turbines were not yet ready. The Deputy-Mayor promised to call on the engineers during his visit to London with the deputation, and see what could be done to get the work pushed forward.

British Electric Traction Company.—The directors' report for the period from Oct. 26, 1896, to Dec. 31 last states that the gross profits amount to £14,422, and, after deducting the proportion of general expenses chargeable to revenue, and expenses incurred in connection with schemes not proceeded with, there remains a net profit of £9,804, which the directors propose should be carried forward to next account.

Fulham.—The Lighting and Dust Destructor Committee of the Vestry have come to the conclusion, after having considered the report of the conference held with the Hammersmith Vestry with reference to supply Argyll-mansions with electric light, to recommend that no action be taken, and that a letter be sent to the

Hammersmith Vestry courteously declining to enter into any negotiations on the lines suggested by them.

Bradford.—At the last meeting of the City Council, the Mayor stated that on the first half of the present financial year the profit on the supply of electricity was £3,000. The gas and electricity undertakings are under the management of the same committee, and it is said that the rapid extension of the use of electric light has not diminished the increasing profits from gas.

Greenock.—The Electric Lighting Committee of the Police Board have appointed a deputation to meet the Board of Trade in conference on the question of the introduction of electric light into the borough. It is stated that the Port-Glasgow Town Council, Gourock Commission, and the North British Electricity Company have also been asked to be represented at the conference, which will be held in London towards the end of April.

Charing Cross and Strand Electricity Supply Company, Limited.—We understand that the eight water-tube boilers supplied by Messrs. R. Hornsby and Sons for the new station erected by the above Company on the south side of the river have given such satisfaction that six more of a similar size and type have been ordered. These boilers are of 300 h.p., and generate steam at a pressure of 160lb. per square inch. They are fitted with superheaters.

Edinburgh—At a meeting of the Electric Lighting Committee of the Edinburgh Town Council on the 29th ult., it was resolved to recommend that the charge for electric energy as from May 15 next should be at the rate of 3½d. per unit, with the ordinary discounts; that the charge for each public lamp should be £14 per annum, and the charge for motor power 1½d. per unit. The present price, we believe, for electric energy is 4d. per unit, and for the public lamps £16.

Shipley.—A short time ago an inspection was made of the Baildon Bridge Mills with the object of considering their suitability as a station for the generation of electricity, the mills being run by water power. The special committee appointed to deal with the matter have now reported that in their opinion the price quoted for the mills was far beyond their estimate of the value of the premises to the Council, and that they could not recommend the purchase of the mills.

Nottingham.—The Special Tramways Committee of the City Council have drawn up a report for submission to the Council on Monday next. They recommend that the whole system be reconstructed with heavier and better-set rails; that certain important extensions be made; and that the system of electric overhead traction be adopted. The total cost, including the equipment of power station, cars, car sheds, etc., is estimated at £425,000. The ultimate extensions contemplated will bring the mileage of the system up to about 50.

Bedford.—The deputation appointed by a meeting of electric light consumers have interviewed the Electric Light Committee of the Town Council, with the result that the committee unanimously decided, in view of a probable considerable reduction in the working expenses and increase in the demand, to reduce the price of the current to 4½d. per unit from July 1 next. The ways and means of improving the street-lighting have also been discussed, and steps will be taken to considerably increase the illuminating power of the lamps in the principal streets.

Bath.—At the last meeting of the Electric Light Committee it was resolved to insure the works for £20,000 at 5s. per cent. Mr. Hammond reported that good progress had been made at the works. He also reported as to the modified contract with the Electric Construction Company. The total sum was now £3,091. 4s., as against £2 939 formerly agreed upon. It was explained that the additional amount included the cost of six extra lamp-posts, besides having to do with the proposed brackets, and it was approved.

Brighouse.—The Town Council have decided to take over the electric lighting plant belonging to Mr Brook on condition that Mr. Brook grants permission to the Corporation to attach any additional overhead wires to the present overhead cables without any increase in the rent of £100, the Corporation to give up tenancy of the overhead wires on six months' notice, terminating at the end of the year of tenancy; that the Corporation valuer attend to see if the plant is in equal condition as it was when it was purchased (ordinary wear and tear excepted); and that Mr. Brook pays the rent of the premises for the past six months he has been in occupation.

Leeds.—The more adequate service of electric cars on the Roundhay-Kirkstall section of the Leeds tramway has not proved an altogether unmixed blessing. Formerly a considerable number of wagonettes were plying in opposition. Since the Corporation put on the full number of electric cars, and gave a five minutes' service along the more populous portion of the route, the competing vehicles are no longer able to ply profitably, and all but two or three have now left the road. Also the 'buses between Briggate and Roundhay Park, and between Briggate and Gathorne-terrace on Roundhay road, have suffered seriously from the competition of the cars, and the service will now be stopped, and the vehicles and horses sold by auction.

Mutual Telephone Company.—The Mutual Telephone Company has, the prospectus states, been formed in Manchester with a share capital of £250,000, in £5 shares, divided into 20,000 5 per cent. cumulative preference and 30,000 ordinary, of which the present issue is 8,000 of the preference and 12,000 of the ordinary (£100,000). The New Mutual Telephone Syndicate, which has taken the necessary preliminary steps to carry out the object of the Company, has received promises to apply for more than 2,000 telephones and upwards of £50,000 of shares, but it is p
that before any new service can be started it is necessary
a license from the Post Office, which is to be applied
sufficient capital at least £80,000—is subscribed.

Aberdeen.—The Churches Committee's recommend
electric lighting be introduced in the West Parish Chur
understanding that the kirk session agree to pay half
expense of £160, has been adopted by the Town Counci
meeting it was suggested that in introducing the lig
West Church, the Council should provide for having it
the East Church, too, because they would, no doubt,
application soon from the East Church. Electric li
a church would soon save its own cost in painting and d

Folkestone Electricity Supply Company, Limited.—
pany has been formed, with a share capital of £50,00
into 10,000 ordinary shares of £5 each. The directors
man Spurgen (chairman), and Messrs. D. Baker, F. E
W. B. Hopkins, S. Penfold (the Mayor of Folkestone),
Pursey; Mr. Frederic Hall being the solicitor and secret
Company is formed to supply Folkestone with electricit
Corporation have the right to purchase at the end
22, or 29 years, on the terms stated in the prospectus.
of the works is a little to the west of Shorncliffe Stati
northern side of the railway, and special sidings have
vided by the railway company for detraining materi
expected that the works will be ready to commence supp
next.

Southwark.—At the last meeting of the Vestry of
a letter was received from the Board of Trade in re
sent by this Vestry, expressing regret that any misapp
should have taken place respecting the proposed electr
order for this parish. At the interview with the Vestry
tion in January last, there was not any pledge given by
that the Vestry's order would be granted, but that th
tion would be considered. To revoke the order granted
the County of London and Brush Provincial Electric
Company, now that they were preparing to carry o
visions, would press very heavily upon them, and caus
the consumers; nor would it be equitable to revoke
Should the company, however, fail to carry out such
Board would fully consider any application received
Vestry. The matter was referred to committee.

Parliament.—The Unopposed Bill Committee of th
Commons have passed the Charing Cross, Euston, and H
Railway Bill, promoted by the Charing Cross, Euston,
stead Railway Company, which was incorporated in 1
purpose of constructing an underground electric railw
the points named. By this Bill the company are au
extend their Charing Cross terminus from the Charing
to a point under Craven street, Strand. The Bill also e
time for constructing the authorised lines until August
authorises agreements with the South-Eastern Railway
and the London and North-Western Railway Comp
following Bills have been read a second time in the
Lords: General Power Distributing Company, Centr
Supply, Chelsea Electricity Supply, Metropolitan Elect
The following has been read a third time and passed
Corporation (Tramways).

The Brooks System of Underground Cable
Johnson and Phillips have sent us a pamphlet concer
Brooks semi-solid system of laying underground ca
information about the method itself is not new, as we
its introduction many years ago. What is new in the p
the long list of testimonials from users of the oil-
cable to show that no deterioration whatever takes
time, but that the insulation improves with keepi
remember rightly, objection was taken to it at th
account of the low insulation resistance compared w
cables. There was a craze at the time for hi
rather than durability, and it is in this latter respec
Brooks system excels. As will be remembered by o
the wires used are covered with fibrous material, and t
the pipe system filled with thick oil with a specific grav
than water. An hydraulic head is kept on this oil to
pipes emptying should leakage occur.

Waterloo Bridge.—In July last the London Coun
accepted a proposal of the Charing Cross and Strand
Supply Corporation to supply light to Waterloo Br
pattern of design to be adopted for the lamps to be ere
granite parapets and the abutments of the bridge
to that in use in the City, which has been found to
rays of light satisfactorily, and to obscure the ligh
river, which may be desired by the Thames Conse
the convenience of navigation. The estimated cost o
the existing columns and supplying new ones is £300
of the work has been provided for in next year's estim
London County Council, and it is proposed that the
mitted for the lamps to be erected on Waterloo
approved; that the Bridges Committee be authorise
tenders for the supply of the same, and that the sanc
Council be given to an expenditure of £300 to be incu
nection with supplying and fixing the lamps.

Crossness Outfall Lighting.—At the last meeting of
County Council the Main Drainage Committee subm
report, and recommended that the estimate of £5,500
by the Finance Committee be approved, and that the
agree to the installation of electric light at the Crossn
in accordance with the drawings presented to the Mai

a, at an estimated cost of £7,000; and also that tenders l for the supply and fixing complete of the dynamos, witchboard, and principal mains, and also for the supply g of the service mains, wiring, and fittings. This was . It is estimated that the total cost of the electric light n will not exceed £7,000. Of this amount it is prorharge to maintenance account the sum of £1,500, being timate original cost of the gas plant which will be superbalance of £5,500 being charged to capital (short period) The engineer has certified that the proposed installation sse the value of the buildings, machinery, etc., for he outfall works by £5,500 beyond their original cost.

Tramways.—Mr. Reginald P. Wilson's report to the ncil of Dudley on the traction question was presented . Mr. Wilson estimates that an expenditure of £5,399 necessary to put the present track to Hart's-hill in he cost of the reconstruction of the track, with 4ft. 8½in. the supposition that the old rails were used again, would If new rails, 6in. deep, were used, the cost would be nd £13,150 if the rails were 7in. deep, less £700 in each sale of the old rails. The length of the track from oss to Bishton's Bridge was 2¼ miles. He estimated cost of constructing the track from Queen's Cross rough boundary beyond Bishton's Bridge would be th rails 6in. deep, and £11,452 with rails 7in. deep. His f the cost of electrically equipping the two lines was 's considered the present service on the Dudley and tramway insufficient, and that the Corporation would start with a 15 minute service on each of the proposed suming that the Corporation determined to carry ole of the work themselves, the total capital expenld amount to £49,402. He estimated the annual at £9,516, made up as follows: £5,250, traffic rages, and power at 6d. per car mile, including current at 2½d. per unit; £1,053, maintenance of head wires, poles, etc., being at the rate of 2½ per outlay of £42,152; £650, maintenance of cars and tame at the rate of 10 per cent. on £6,500; £2,562 sinking fund at the rate of 5¼ per cent. on a loan of 'he traffic receipts at 1s. 3d. per car mile he estimated This would leave a net profit of £3 908 after allowance made for interest and sinking fund. He did not the Corporation should have any hesitation in take over the tramways and work them themng that, apart from the question of profit resultse undertaking, the interests of the inhabitants of the surrounding districts would be better served. h Electric Traction Company were to construct a line Heath, the Corporation could insist on supplying them al energy, seeing that they had a provisional order the right to the monopoly of that commodity within He should, therefore, advise the Corporation to oppose of the Light Railway Commissioners before the Board the ground that the Corporation were themselves about the line in question. The report, together with the tions on it by the committee, were carried unanimously. orporation of Dudley are going to oppose the applicaBritish Electric Traction Company, and also intend to tric lighting and traction.

lways.—The Board of Trade has, after modifications, se order made by the Light Railway Commissioners the construction of light railways between Flaml Bridlington in the East Riding. The work will be shortly. Messrs. Siemens Bros. and Co. and Messrs. Bros. are the contractors for the electrical plant and k, the civil engineer being Mr. Myers-Beswick and al engineer Mr. Bernard Drake. Apart from the affic, which is considerable in the season, the introhis line is expected to have an important bearing on dustry of the North, for it is stated that frequently cannot enter Grimsby will deliver their fish under the amborough Head as soon as facilities for transport Light Railway Commissioners have submitted to the ade for confirmation, under the Light Railways Act, r made by them for the construction of a light railFountainhall and Lauder, in the counties of MidBerwick. The capital of the company is to be ,800 shares of £10 each. Towards this the North ray Company have agreed to subscribe £15,000, the cil of Berwickshire £15,000, and the Town Council burgh of Lauder, £3,000. The first directors of the to be the Marquis of Tweeddale, the Earl of Laudesr. George Dalziel. The North British Railway d the County Council of Berwickshire are each to director. The line will be 10 miles 1 furlong, or a length, and is to be constructed on a gauge of is to commence in the parish of Stow, in Mida junction with the Hawick branch of the North ay, and to terminate at Waterloo-place, Lauder.— r County Council have passed a resolution to the ey are of opinion that the electric line from Garth to ould be on the sea or south side of the Menai-road, nsel retained to appear before the Light Railway s be instructed to apply that the line should be rdingly.—The Board of Trade has also confirmed the construction of a line from Congresbury to Blagdon, dre.—The Light Railway Commissioners, the Earl of K.G., and Colonel Boughey, R.E., C.S.I., held an he 30th ult. into the application by the British Electric Traction Company, Limited, for an order to lay a light railway or tramway through the main streets of Airdrie and Coatbridge in terms of the Light Railways Act. It is proposed to have a gauge of 3ft. 6in., and to work the line by electrical energy on the overhead system. It would be a single line with passing places. The Chairman said that apparently the scheme was much desired in the district and by both the local authorities, and the Commissioners would be happy to report to the Board of Trade in favour of the order, although the settlement of two or three points would have to come on for consideration. It was arranged that a clause similar to that in the Dudley order would be put in in the interests of the gas and water companies' pipes.

PROVISIONAL PATENTS, 1898.

MARCH 21.

6773. **Improvements in and relating to street lanterns for the reception of incandescent electric lamps.** John Edwin Stewart, Imperial-chambers, Albert-street, Derby.

6831. **Improvements in electric miners' lamps.** William Outterson Wood, 77, Chancery-lane, London. (Complete specification.)

6834. **Improvements in safety devices for use in connection with high-tension electric conductors.** Charles H. Wordingham, 26, Victoria-street, Westminster, London.

6865. **Improvements in electric conductors and in appliances for making connections with same.** Joseph Devonport Finney Andrews, 45, Fulham-park-gardens, Fulham, London.

MARCH 22.

6902. **Improved details of electric tramways and railways.** William Aldred and George Carr, 5, Brightside Bank, Brightside, Sheffield.

6903. **Improvements in electric plug connectors.** Albert Edgar Tanner and George William Lowcock, 78, King-street, Manchester.

6923. **Improvements in phonographs.** George Volentine Gress, 111, Hatton-garden, London. (Complete specification.)

6944. **A method of and furnace for the continuous melting of glass by electricity.** Franz Heinrich Becker and Ludwig Schreyer, 70, Wellington-street, Glasgow. (Complete specification.)

6954. **Improved holders for electric lamps.** John Crake Vaughan, 70, Chancery-lane, London.

6989. **Improvements in electrical measuring instruments.** Edward Weston, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

6990. **Improvements in electrical measuring instruments.** Edward Weston, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

6991. **Improvements in electrical measuring instruments.** Edward Weston, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

6992. **Improvements in electrometers.** Edward Weston, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

7016. **Improvements in telephone transmitters.** George Fiegle Payne, 65, Chancery-lane, London. (Complete specification.)

MARCH 23.

7027. **Improvements in dynamo-electric generators and motors.** Sidney George Brown, 1, St. John's-road, Chelmsford.

7057. **Improvements relating to plug switches and plug connections for the control and distribution of electric currents.** Harold Faraday Proctor and John Rutherford Blaikie, 13, Burlington-road, Redland, Bristol.

7058. **An approved method of preventing the corrosion of electric battery connections.** Walter Robert Underhill and Percy Wilbraham Northey, 28, Victoria-street, Westminster, London.

MARCH 24.

7129. **An improved means of generating electrical energy.** Thomas Holmes, Albion Holmes, and George Sockett Holmes, 10, St. George's-crescent, Liverpool.

7150. **An electric locomotive.** Herbert Luzerne Todd and Ernest Harker, 53, Elmore-street, Essex-road, Islington, London.

7164. **Improvement in apparatus for electric signalling and adjuncts thereto.** Felix Benedict Herzog, 1,123, Broadway, New York.

7170. **Improvements in or in the construction of electrical storage batteries.** Francis Fane Yeatman and Walter Donovan, 31, Southampton-buildings, Chancery-lane, London.

7179. **Improvements in telephone posts or stations.** Pierre Germain, 60, Queen Victoria-street, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Sept. 1, 1897, being date of application in France.)

7193. **Improvements in or relating to primary electrical batteries.** Alfred Julius Boult, 111, Hatton-garden, London. (Jules Cerpaux and Amédée Wilbaux, Belgium.) (Complete specification.)

7199. Improved wall socket and plug for electrical fittings. Leonard George Tate, 18, Buckingham-street, Strand, London.

MARCH 25.

7222. A spring power appliance for taking the place of steam, electricity, and horse power. Richard Lewis, 56, Station-road, Llanelly, Carmarthenshire.

7236. An apparatus or improved manner of means for determining or ascertaining the velocity of air currents in coal mines and other situations by novel electrical and other means. Joseph Thompson, 19, Glamorgan-street, Canton, Cardiff.

7283. Improvements in miners' lamps and apparatus for electrically lighting the same. Samuel Harrison, 6, Lord-street, Liverpool.

7296. Differential electric transformation apparatus. Henry Harington Leigh, 22 Southampton-buildings, Chancery-lane, London. (Paul Lemaire, France.)

7305. Improvements in and relating to electrical accumulators. Joseph Tabrar and William Waller, 306, High Holborn, London.

7306. Improvements in electrical bull's-eye lanterns. Joseph Tabrar and William Waller, 306, High Holborn, London.

MARCH 26.

7310. A divided cylinder dynamo. William Doherty, 9, Venus-street, Liverpool.

7333. Improvements in the construction of plates for electrical accumulators or storage batteries. Ernest Mérian, 57, Barton-arcade, Manchester.

7367. Improvements in or relating to electric indicators or annunciators. Alfred Julius Boult, 111, Hatton-garden, London. (The Antwerp Telephone and Electrical Works, Belgium.) (Complete specification.)

7384. System of lever drawbridges with overhead conductors for electric railways. Alfred Clements, 83, Cannon-street, London. (Union Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

SPECIFICATIONS PUBLISHED.

1896.

27188. Electro-mechanical indicating and recording apparatus. Vernon and Ross.

1897.

2272. Electric batteries. Dobell.

5360. Method of and apparatus for utilising electric energy. Cox.

6251 Combination watch-stand accumulator or storage battery and electric lantern. Walling.

6929. Apparatus for electrolysing sodium, chloride, or other salts. Taylor, Cooke, and Montgomery.

7027. Secondary batteries or accumulators and manufacture thereof. Marquand.

7373. Apparatus for controlling the action of electric motors at a distance. Smith and Elphinstone.

8115. Means for conducting electricity along railway trains for the purpose of communication and lighting. Taylor and Duckworth.

8295. Electric traction and apparatus employed therein. Vedovelli.

8602. Electric lampholders and connectors. Verity's, Limited, and Cotterell.

10411. Supports for incandescent and other electric lamps. Keep.

11017. Telegraph cables or the like. Hall.

11155. Electric arc lamps. Boult. (Pellet and Déjardin.)

16764. Electromagnetic cut-in and cut-out. Lühne.

17609. Electric furnaces. Roberts. (Date applied for under International Convention, Dec. 29, 1896.)

18718. Electric railways and tramways with overhead conductors. Short.

24111. Electric conductor wire connectors. Shultes.

26919. Application of electrodes in electrolytic processes. Strecker and Strecker.

26921. Process for preparing insoluble or hardly soluble salts from metallic anodes by electrolysis of aqueous solutions containing two salts. Strecker and Strecker.

26923. Production of protoxides and oxides or of hydroprotoxides and hydroxides from metallic anodes by electrolysis of alkaline salt solutions. Strecker and Strecker.

27208. Ceiling roses and similar fittings for electric light service. Tanner.

29244. Apparatus for freeing, lighting and extinguishing gas burners at a distance by means of electricity. Guyenot.

1898.

2770. Holders for incandescent electric lamps. Jaeger and Bender.

2891. Announcing and recording apparatus applicable to telephones. Grünert.

TRAFFIC RECEIPTS.

Dover Tramways.—The traffic receipts for the wee[k] March 26 were £111. 9s. 8d. The total receipts for 1898 are £1,277. 18s. 7d. The mileage open at present is

Bristol Tramways.—The traffic returns for the wee[k] March 25 were £2,379. 14s. 7d., compared with £2,207 for the corresponding period of last year, being an in[crease of] £171. 15s. 2d.

Birmingham Tramways.—The traffic receipts for t[he week] ending March 26 were £3,369. 10s. 5d., as compar[ed with] £3,529. 19s. 0d. in the corresponding week in 1897, decrease of £160. 8s. 7d.

Liverpool Overhead Railway.—The traffic receipts railway for the week ended March 27 amounted to £1 compared with £1,336 in the corresponding week of the year, being a decrease of £33.

City and South London Railway.—The returns for ended March 27 were £1,066, compared with £974 for th[e corre]sponding period of last year, being an increase of £92. T[he] receipts for the half-year amount to £13,891, compar[ed with] £13,791 for the corresponding period last year, being an of £100.

South Staffordshire Tramways.—The traffic returns week ending March 25 were £562. 11s. 8d., as compar[ed with] £605. 14s. 11d. in the corresponding week of the previo[us year]. The aggregate receipts for the year are £6,904. 11s. against £6,875. 3s. 8d. in the corresponding period previous year.

Dublin S.D. Tramways.—The traffic receipts for t[he week] ending March 25 were £414. 11s. 4d., as compar[ed with] £476. 19s. 10d. in the corresponding week in the previo[us year], being a decrease of £62. 8s. 9d. The number of pa[ssengers] carried was 69,266 in 1898 and 72,768 in 1897. The a[ggregate] returns up to date are £4,793. 9s. 0d., as compar[ed with] £5,146. 13s. 8d. last year, being a decrease of £353. 4s. mileage open is the same as last year—viz., 8 miles.

COMPANIES' STOCK AND SHARE LIST

Name.	Paid.
Birmingham Electric Supply Company	5
Brush Company, Ordinary	3
—— Non. Cum., 6 per cent. Pref.	2
—— 4½ per cent. Debenture Stock	100
—— 4½ per cent. 2nd Debenture Stock	100
Callender's Cable Company, Debentures	100
—— Ordinary	5
Central London Railway, Ordinary	10
—— "	6
—— Pref. Half-Shares	1
—— " "	5
Charing Cross and Strand	5
—— 4½ per cent. Cum. Pref.	5
Chelsea Electricity Company	5
—— 4½ per cent. Debentures	100
City of London, Ordinary	10
—— Prov. Cert. 90,001-100,000	2
—— 6 per cent. Cumulative Pref.	10
—— 5 per cent. Debenture Stock	100
City and South London Railway, Consolidated Ordinary	100
—— 4 per cent. Debenture Stock	100
—— 5 per cent. Pref. Shares	10
—— " " " '96	10
County of London and Brush Provincial Co., Ordinary	10
—— " " "	4
—— 6 per cent. Cum. Pref.	10
Crompton and Co., 7 per cent. Cum. Pref. Shares	5
—— 5 per cent. Debentures	—
Edison and Swan United Ordinary	3
—— 5 per cent. Debentures	5
—— 4 per cent. Deb. Stock, Red.	100
Electric Construction, Limited	2
—— 7 per cent. Cumulative Pref.	2
—— 4 per cent. Perp. 1st Mort. Deb.	100
Elmore's Copper Depositing	1
Elmore's Wire Company	2
W. T. Henley's Telegraph Works, Ordinary	10
—— 7 per cent. Preference	10
—— 4½ per cent. Debentures	100
House-to-House Company, Ordinary	5
—— 7 per cent. Preference	5
India Rubber and Gutta Percha Works	10
—— 4½ per cent. Debentures	100
Kensington and Knightsbridge Ordinary	5
—— 6 per cent. Pref.	5
London Electric Supply, Ordinary	5
Metropolitan Electric Supply, Limited, Ord. No. 101-50,000	10
—— " " " 50,001-82,500	10
—— 4½ per cent. First Mortgage Debenture stock	100
National Telephone, Ordinary	5
—— 6 per cent. Cum. First Pref.	10
—— 6 per cent. Cum. Second Pref.	10
—— 5 per cent. Non. Cum. Third Pref.	5
—— 3½ per cent. Deb. Stock, Red.	100
Notting Hill Company	10
Oriental, Limited, £1 shares	1
—— £5 Shares	5
—— £4½ shares	4½
Oriental Telephone and Electric Company	1
Royal Electrical Company of Montreal	—
—— 4½ per cent. First Shares Mortgage Debentures	100
South London Electric Supply, Ordinary	2
St. James's and Pall Mall, Limited, Ordinary	5
—— 7 per cent. Pref.	5
—— 4 per cent. Deb. Stock, Red.	100
Telegraph Construction and Maintenance	12
—— 5 per cent. Bonds	100
Waterloo and City Railway, Ordinary	100
Westminster Electric Supply, Ordinary	5
Yorkshire House-to-House	5

NOTES.

sonal.—Mr. Arthur Wright, the electrical engineer Brighton Corporation, has accepted the post of con- ; electrical manager of the British Thomson-Houston any, Limited. By the recent arrangement made the Brighton Corporation, Mr. Wright will hold both ntments at the same time.

amways in Great Britain.—It appears from a mentary return issued on Friday by the Board of that the total capital expended on tramways in the d Kingdom till June 30 last was £14,782,700, as red with £4,207,350 in 1878. The total length of pen was 1,031 miles; the number of horses employed ?,342; the number of locomotive engines belonging nway companies was 492—a smaller number than in ree preceding years; while the total number of gers carried was 788,000,000, being the highest rd. The net profits were £1,037,149. Of the miles of tramways open, 367 belonged to local ties.

tric Riveting.—The opening meeting of the thirty- ssion of the Institution of Naval Architects was st week in the hall of the Society of Arts, John- Adelphi. The president, the Earl of Hopetoun, the chair. A paper by Herr F. Von Kodolitsch, ng a new electrical riveter devised by himself, was, bsence of the author, read by the secretary. The tated that for the last two years the author had perimenting on electric riveting machines and had ucceeded in bringing out a type of machine quite of superseding the two systems already existing— draulic and pneumatic riveting. There was no e in the quality of the work done, but the quantity electric system was considerably superior. The machine closed 12,000 rivets in a day of 10 hours labour of three men and a boy.

nway Legislation. — Our contemporary the *ilway Review* sums up the reasons for our deficient r system as follows: "The municipalities (in) have, in fact, been so afraid they would in some out-bargained that they have, as a rule, fairly over- themselves; and now, after a lapse of 20 years, naturally served by undeveloped lines, with anti- ppliances, simply because they made it the distinct of the companies operating those lines to provide better. Human ingenuity does not seem as yet devised any tenure under which men, much less ions, will develop a business with the same degree prise when they are working for the ultimate advan- others as when they are working for themselves." temporary might add that the Light Railway Act he path of the tramway engineer much easier. The Railway Commissioners are most indefatigable in the work on, and we hear that during one week erent local enquiries were held by them. Childish ns which before the Parliament bar are used to waste e promptly disallowed by the Commissioners, and sinesslike procedure saves much time and expense ncerned.

ction Telegraphy.—It will be remembered that experiments were made by Mr. W. H. Preece and Gavey in induction signalling between Laver- int and the Flat Holm. Now a permanent system lling by means of magnetic induction has been ed between these points. Permanent lines of pper wire have been erected parallel with each e being on the Flat Holm and the other on the mainland, and the effects produced by electromagnetic induction are such that Morse working from point to point can be carried on with the greatest ease. Not only has a great improvement been effected by the use of very large copper wire on the line, but the instruments employed have been altered so as to embody several important desiderata. The passing of the current from the electric motor used in signalling produces through space a humming sound in the receiver at the distant end, and the words, which are transmitted from a Morse key in the usual way, are read off with the greatest ease. As many as 40 words a minute have been transmitted without any necessity having arisen for obtaining a single repetition. The experiments have again been conducted by Mr. Gavey. The communication with the Flat Holm has now been in operation for several days, and the working so far has been uniformly excellent.

Water-Tube Boilers.—The efficiency of the water-tube boiler needs no further proof now, but the coal consumption trials which have lately been carried out on the new cruiser "Diadem" are worthy of note because of the size of the boiler installation and the high economy realised. The "Diadem" is a smaller edition of the "Powerful," which was of 14,000 tons displacement and 26,000 h.p., the displacement in the present case being 11,000 tons and the horse-power 16,000. Like the "Powerful" she is furnished with the Belleville water-tube boiler, and carries such improvements in the way of economisers for heating the feed water and higher steam pressures as were suggested by the memorable boiler tests on the older ship. The best results were obtained on a 30-hour test at 12,500 h.p.—three-fourths of the full power—when the coal consumption worked out at 1·59lb. per indicated horse-power per hour. It is doubtful if this low rate is ever realised in the navy with the cylindrical boiler, and it is rarely reached with the same type in the mercantile marine. The "Powerful" using the same boiler burned 1·83lb. on a ¾-h.p. trial and the "Terrible" 1·71lb. The steam pressure on the "Diadem" was 280lb. at the boilers and 245lb. at the engines, and these pressures were maintained with little variation throughout the trial.

What We Are.—Three associations, dealing respectively with street railways, gas, and electric light, recently held a convention in Laredo. The Mayor welcomed the members in the following glowing terms: "The city of Laredo bids me greet the stranger within our gate, not as a foreigner, but as a guest and friend, for whom nothing that we have is too good, and never was a behest more gratefully obeyed. When I say 'Welcome!' I would wish you to understand it in that generous hospitality that it bears in our own south land. We shall endeavour to bear substantial testimony to the fact that we are not unmindful of the compliment and honour bestowed upon us in the selection of our city for your convention. These words, my friends, are not addressed to you as lip tricks, and in no spirit of time-serving or apology. The marvels of your electric currents outrival all the magic of necromancer and alchemist. You are compelling nature to reveal the secrets which she has so artfully concealed. Your science is the magnet of our times. It woos the thinker and the worker alike; it opens careers and pays rewards of dazzling brilliancy. Ever since Edison has made our life almost automatic and your science so alluring, devotees have been flocking to it by the thousands. The marvellous triumphs of electricity have been as beneficent as they are great. You have in myriads of ways ministered to our comfort. You are the benefactors of our race, and the civilised world is gazing with amazement upon the wonders of your inven

l gas. Replying, Mr. de Grave said that he would ain the result of firing a detonator in coal gas. He ather afraid it would ignite the gas.

aaks in Electrical Tramway Work.—Mr. C. L. eld Dallas read a paper on the above subject before agres in Laredo, Texas, from which we cull the ring ideas as to cranks. Chaff of this kind is aps the best method of preventing erroneous ideas crystallising. Thus we learn from the author that re are engineers and engineers. We have those who a certain kind of oil and a certain kind of waste that a only oil and the only waste they can work with. have engineers who have made up their minds that e people who naturally come under their authority e only people who can do the work—frequently they atives and social friends. A great many of our ers are totally unwilling to try anything new; other hand, we have them just as bad in the direction, in that they are always trying something nd spending their time, which is the company's , in experimenting upon paths never heretofore Dynamo tenders, as a rule, are fairly progressive, rm of crankiness being that they are always patch- l never willing to get new parts, or that they always ew parts, and are never willing to make use of the new shapes and new combinations. Linemen tly get an idea that they own the earth and the above, particularly the latter, and that they have t right to drop wire, insulators, monkey wrenches, er tools that have a considerable attraction towards th upon the heads of innocent passers-by, thus g on damage suits that by our laws are not only of heavy results against the corporation, but are stimulative to that end. We now come to the ry or auditor, whose crankiness, if developed, is he line generally of spending 10dol. to save one cent. , next in importance to the fireman we have the l manager president, the executive head of the con- ho too often has no knowledge, either theoretical or l, of the business in which he is engaged, and in a es has not discovered this fact. It is lamentable only the first condition exists, but where the first ond conditions are found in combination it leaves apany 'poor indeed.'"

king Concert.—A grand Bohemian concert, given combined staffs of the City of London, Metro- , and London Electric Lighting Companies, was held 31st ult. at the Freemasons' Tavern, Great street, W.C. Mr. F. Bailey acted as chairman and Cecil Bull as vice chairman. The committee d Messrs. J. L. Dyson, F. B. Aspinall, D. Wilson, kington, R. A. Chattock (hon. treasurer), A. W. on (hon. secretary), F. Dew, C. E. Davies, etc. A ong programme was opened by the orchestra with Bohemian Girl" overture. A quartette, entitled swear to be Good," was then given by the Opera a "The Promise of Life" and "Nobody Else" excellently rendered by Madame Belle Cole, the song receiving an encore. Songs from well-known were well in evidence, Miss Gaston Murray giving ittle Bit of String" ("Circus Girl") and "A Monkey Stick" ("The Geisha"). Miss Jessie Hotine also "Be Wise in Time" ("Dorothy") and "The Jewel a" ("Geisha"), and sang with Mr. Black a duet the "Yeoman of the Guard" A ventriloquial was given by Mr. F. Russell, and Mr. W. ker greatly amused the audience by a silent tion of a political meeting. Musical sketches were by Mr. C. Conyers, and were much appreciated. Duets were well rendered by Mr. W. Page and Mr. B. Black, and Miss Gaston Murray and Mr. Black, the latter, entitled "Irish Courtship," being very amusing. The ever-fresh dances from "Henry VIII.," and also a selection from the "Shop Girl," were given by the orchestra. In replying to a vote of thanks, the Chairman said that he was pleased to notice so many representatives of the low-pressure companies there. There had been a time when relations were not quite so cordial between the high and low pressure companies as they now were, and he thought that by the presence there of those gentlemen it showed that any little jealousy which had existed in the past had been entirely eradicated. He jokingly referred to Mr. Partridge's recent production in the musical line, about the London Electric Company helping the Metropolitan, and added that when the latter company was of service to its competitors it did not commemorate the event in rhyme.

The Steam Dynamo.—We use this term to mean the combination of a steam-engine and dynamo on the same bed-plate and directly coupled together. Mr. Charles T. Child contributes an article to the *Engineering Magazine* on the evolution of such coupled sets, and yet confines his attention to American practice only. This is like looking for the footsteps in the evolution without first collecting the facts, and is specially noticeable in an English edition of the above magazine. The fact of the matter is that, in direct coupling of high-speed engines to dynamos, our English engines have led the way. The Willans and the Brotherhood engines were the first to be used, and the makers of these made their first attempts at direct coupling as far back as 1881. The author of the above carefully avoids any reference to our practice, and, after tracing the effect of direct coupling in tending to give multipolar designs, goes on to speak of steam turbines. Apparently he only knows of the Laval type, and he adds: "Hitherto no attempt has been made to design a dynamo for direct operation at the speed of the turbine, but the effect has been to reduce the speed either by gearing or directly to that of the present types of dynamos. The analogy of the case of dynamo and reciprocating engines 20 years ago, seems to the author to point to some compromising method. Certainly, gearing will never be tolerated so long as there is the least hope of directly reducing the speed of the steam turbine. There appears to be good grounds for thinking that compounding offers a solution of the difficulty, and that speeds as low as 2,500 revolutions per minute may be had directly from a multiple-wheel, multiple-expansion turbine. It is not, therefore, beyond the bounds of possibility that our future central stations will contain no reciprocating machinery larger than a boiler feed pump." So much for the author's prophecy. He might, if he had troubled to look up his subject, have said: There have been steam turbines direct coupled to dynamos since 1886 in England, where there are several stations worked entirely by steam turbines. He might also have added that, in spite of multipolar dynamos, the American engineer stuck to rope and belt driving until about two years ago, and that even now stations are being laid down in the States with both belting and countershafts. In fact, the article is to the English reader an absurdity.

The Schlicht Method of Combustion.—The inventor of this method, Mr. P. J. Schlicht, has written an article to our New York contemporary explaining the details of his invention. The article is accompanied by a drawing which appears to us to represent an impossibility. The author places at the top of the chimney a sleeve which extends for a short distance above and below the chimney structure proper. The hot gases pass out through the centre of the sleeve, while the air is drawn in between the

inner wall of the chimney and the sleeve. The author then shows in his drawing that cold air drawn in does not mix with the hot gases, but passes right down the chimney to the fire. He adds that the ashpit doors are kept constantly closed or nearly closed, and that all air necessary for combustion comes down through the chimney and the flues. In the sketch this air for combustion is shown as impinging on the top of the fire, and not passing through it at all. The author proceeds to detail the advantages of the system, many of which would be real if the first point as to the two opposing currents of air in the chimney and flues were accepted. This acceptance means that the two currents keep separate without a dividing screen or partition, and that heat is transferred from one to the other without diffusing or mixing taking place. Perhaps the author's sketch is at fault, as he proceeds to quote different authorities who have tested his method, and who found a coal-saving of from 20 to 30 per cent. in fuel. Perhaps the author's claims will be of interest. They are as follows: (1) A saving is made by heating the air by contact with products of combustion after they have passed the sphere of useful work, instead of heating the air at the expense of the fuel. (2) A saving is made by feeding air heated by the products of combustion on top of the fire in automatically regulated quantities. (3) A saving is made by excluding the large amount of surplus air fed through the grate bars in ordinary practice. (4) Hydro-carbons and other combustible gases, which frequently escape before they are consumed for lack of oxygen, are wholly consumed in the combustion chamber. The author adds that various experiments carried on demonstrated the fact that this system of combustion produced more heat than could be converted into useful work by the boilers. The system is not unique in this respect. He also says that with certain types of boilers deflectors are required at the bends of the flues to keep the two currents separated.

Competition in Electric Lighting.—The question of competition between electric lighting companies in London is coming rapidly to the fore. For some years certain districts have been served by two different companies, much to the advantage of the consumer, who has thus the threat of a change over to fall back on if reasonable terms are not given. A correspondent in the *Financial News* is very despondent about the effects of this competition, and especially as concerning the Metropolitan Company. We do not for a moment suppose that the directors will echo his fears, but are sure that they will hold their own and pay good dividends, in spite of the opposition. The gentleman in question says: "The Metropolitan Company supplies, or has power to supply, the large and important districts of St. Giles and Holborn, part of St. Martin's-in-the-Fields, and the entire parishes of Marylebone and Paddington. Promoters of rival companies are seeking power from the Board of Trade to supply in competition with them throughout the whole area except Paddington, and if the competition sanctioned by the Board of Trade is finally confirmed by Parliament, it is not likely that the company will long escape it in Paddington. The whole of the eastern portion of the area is about to be handed over to the Charing Cross Company and the County of London and Brush Company. These companies, coming in with the benefit of experience and being admitted to districts where the Metropolitan Company has already developed the business by heavy capital expenditure, will be able to compete on terms ruinous to the old company. In Marylebone matters will be even worse, if, as is stated, the application of the Marylebone Vestry is really granted. It seems most unfair that the Vestry should now be allowed to come and establish competitive works out of mo[ney] borrowed on the rates. Of course, whatever price the c[om]pany charges it can be underbid by the Vestry, which [has] the rates to fall back upon. This is a matter of mo[ment] not only to shareholders in the Metropolitan Comp[any] whom it primarily concerns, but to electric lighting s[hare]holders generally, who, unless this new developme[nt of] competition can be stopped, will find an era of con[tro]versy all over London. The present good prospects of [the] business will be entirely dissipated, and prices reduced [to] a ruinous level. Nor will the consumer, in the long r[un] profit." This latter point we doubt, as well as the cor[re]spondent's conclusion as to the effects of the competitio[n]. There is no indication whatever as yet that the increase [in] the demand for electric light is falling off, and there [is] every reason for assuming that lower prices and larg[er] outputs will pay even better than the present.

Wireless Telegraphy.—Captain Kennedy's lectu[re] before the United Service Institution last week was w[ell] attended, and the well-prepared lecture was worthy of [the] audience. General Sir Richard Harrison presided. T[he] lecturer, who elaborately illustrated his remarks, c[om]menced by saying that communication could be ma[in]tained between two or more stations without the aid [of] wire, in two ways—namely, by Mr. Preece's Post O[ffice] system, and by Mr. Marconi's method. He then [pro]ceeded to describe both systems, paying more attenti[on], however, to the latter, which, he said, offered gre[at] possibilities from a service point of view. Having tra[ced] the discovery of electromagnetic waves and describ[ed] their powers, the lecturer described experiments with [the] Marconi system. These, it was explained, were taken [in] hand by the General Post Office a year ago, but, a comp[any] being formed for his invention, progress was interrup[ted] by financial interests. Nevertheless, experiments had b[een] further carried on by Captain Brett, R.E., at Devonp[ort], by Captain Jackson, R.N., and also by Mr. Marconi. T[he] following were the lengths used in various trials: Card[iff], 5,500 yards, height of wire 37 yards; Cardiff, 15,3[..] yards, wire 66 yards; Spezia, 7,700 yards, wire 37 yar[ds]; Rangsdorff, 23,000 yards, wire 330 yards; and Isle [of] Wight, 21,900 yards, wire 29 yards. There was a mark[ed] difference in the distance obtained over land and over s[ea]. The results of these experiments had led to a very c[on]siderable simplification of the apparatus, and it w[as] considered that the greatest service would be in naval aff[airs]. One important feature was that an incoming ship co[uld] signal her approach. Others were that lighthouses c[ould] guide ships in thick and foggy weather. In time of w[ar] information could be sent from long distances, ships a[nd] forts could correspond out of range of gun shots, and [the] means of communication being the free atmosphere, [it] could not be dredged up or cut by an enemy as a ca[ble] across a river's mouth could be. The vessels of a fl[eet] could be manœuvred at sea, and instructions given [in] cypher which could only be read by instruments timed [in] unison. All this could be done without any visible indi[ca]tion of the whereabouts of transmission or reception. T[he] efficiency of the heliograph depended entirely on [the] weather; but this Marconi system was unaffected [by] weather, and it would seem that communication co[uld] even be maintained between the general's staff and [the] fighting line. In the discussion which followed, M[r]. W. H. Preece said he could not yet do altogether witho[ut] wires. He was glad to say, however, that by Easter [he] hoped a perfect system of communication between Lavern[ock] and Flat Holm would be handed over to the War Office. [He] wished Mr. Marconi (who was present) every succe[ss], although his system was different from his own.

LORD KELVIN'S PATENTS.*

(*Continued from page 393.*)

SPECIAL STANDARD BALANCES.

ı very great accuracy and permanency is required, ıe case of balances used as ultimate standards of in laboratory work, a modification is made in the ʳ ampere balances. The scale and sliding weights m away, and the beam is made specially strong, a pointer at each end, situated at the middle of A scale pan is hung at each end of the beam, distance from coil to coil is greater than in the balance. An arrangement of screws is also proʳ which the beam can be raised to its original should the ligaments from any cause have been

ıethod of making an observation is as follows: of fixed amount is placed on the left-hand scale the beam is balanced with no current through the ı weight is then lifted to the right-hand scale pan, urrent is made. The amount of current passing

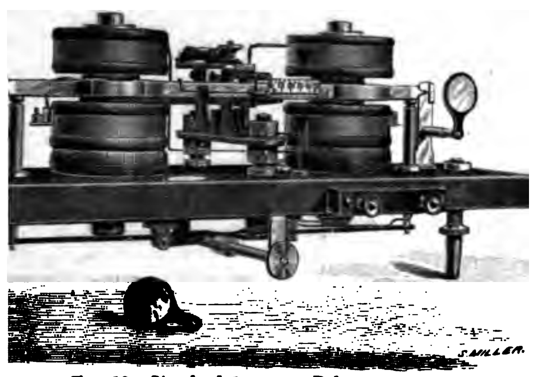


FIG. 16.—Standard 1-ampere Balance.

ɔd till the beam again balances, and according to : of the weight used, the strength of current is ithin a very small percentage of accuracy. A re standard balance of the type supplied to the Trade is shown in Fig. 16.

NEW ENGINE-ROOM WATTMETER.

ɜw engine-room wattmeter has a main circuit : a double rectangle of copper rod having sufficient arry 200 amperes, and a shunt circuit with two coils astatically arranged. The main coil is on a slate back so that the rectangles are l. The shunt coils are mounted on a light but uminium frame. One end of this frame has a nife-edged hole fixed to it, and the other end has ; knife-edge. These two knife-edges rest on two ·bronze hooks attached by insulating supports to le ends of the double rectangle. By this method sion complete freedom from friction is obtained, ı movable system is kept in a definite position end guides. Each fine-wire coil has about 1,000 ısulated wire, and its resistance is about 100 ohms. ent is conducted in and out from the movable y two flat palladium spiral springs, which also e restoring force for governing the sensibility of ment. Not more than one-twentieth of an ampere l to pass through the fine-wire circuit, and in order ɛe this, a large non-inductive resistance is rolled ıe of the instrument, which offers a large cooling The scale has nearly uniform divisions, and is l to read directly in watts or kilowatts as required.

ɔORDING VOLTMETER AND AMPERE-METER.

strument (Fig. 17) is of simple construction, and conlong solenoid, giving a very intense field, into which : end of a long soft-iron plunger is entered. The ı suspended on a set of spiral springs, and carries ɾer end a pen of special construction. A drum, hich a record paper is fixed by a metal band, is by means of a clock inside it, making one revolu- ɫ or 24 hours. The pen rests against the paper with a small component of its own weight, and as there are no pivots or other multiplying gear, the instrument is free from frictional error. Owing to the fact that the magnetic field of its own coil is very intense, the instrument is found to be free from the effects of board currents or other stray field. In changing the paper, the whole drum can be lifted out, allowing the changing to be done with ease, and at the same time the pen can be easily got at for renewing the ink. The scale is a wide-division one at the working part, and is divided in volt divisions. When ordering, the working voltage should be stated, and if for

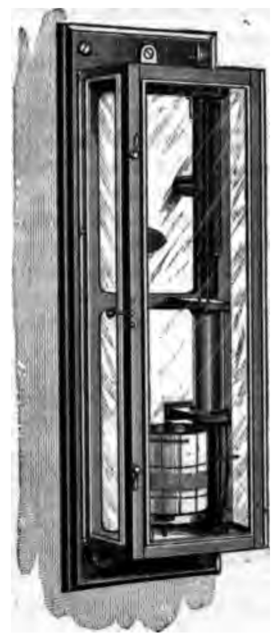


FIG. 17.—Recording Voltmeter.

alternating currents, the periodicity. The calibration of the instrument is quite permanent. Ampere-meters are made on the same plan and have equal division scales from 0 to maximum.

TESTING SET FOR MEASUREMENT OF INSULATION RESISTANCE.

The testing set (Fig. 18) consists of (1) a very sensitive galvanometer whose deflections are directly proportional to

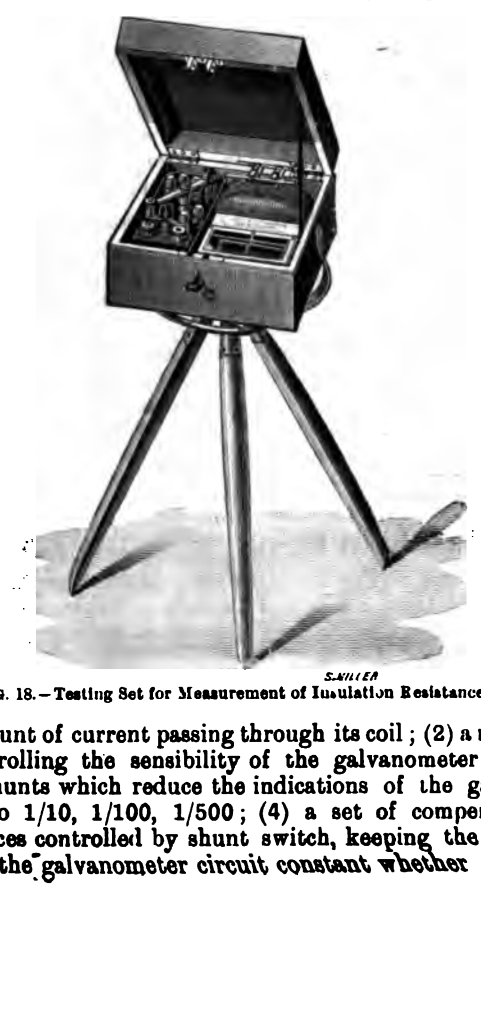


FIG. 18.—Testing Set for Measurement of Insulation Resistance.

the amount of current passing through its coil; (2) a magnet for controlling the sensibility of the galvanometer: (3) a set of shunts which reduce the indications of the galvanometer to 1/10, 1/100, 1/500; (4) a set of compensating resistances controlled by shunt switch, keeping the resistance of the galvanometer circuit constant whether shunted

* ...ct of paper read by Dr. Magnus Maclean to the ...al Society of Glasgow, Feb. 23.

or not; (5) a switch enabling deflection to be taken through the galvanometer alone for standardising, or through the galvanometer and unknown resistance when making test. The main advantages of the instrument are: (1) great sensibility; (2) long range of measurement; (3) it is simple to use, and with it rapid tests can be made; (4) can be used with a separate battery or with potential of lighting circuit whose insulation is under test; (5) no plugs to get lost; (6) all connections marked on vulcanite base; (7) great portability.

Improved Rheostat.

The object of the rheostat, invented over 40 years ago by Wheatstone, is to provide an electric resistance which can be varied continuously. The original instrument, although admirable in conception, and commonly shown on the lecture table, has been but little used on account of practical defects. The new instrument (Fig. 19) is an improved form of Wheatstone's rheostat, in which the wire is guided from one cylinder to the other by a fork carried along through the requisite range by a nut travelling on a long screwshaft. This screw-shaft carries a toothed wheel, which turns the two cylinders by means of toothed wheels attached to their shafts. A watch-spring, as in Jolin's improvement of Wheatstone's rheostat, keeps the wire always tightened to the proper degree. A leather buffer

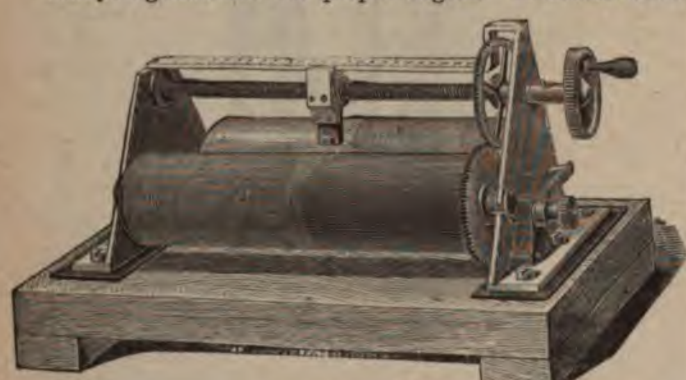


Fig. 19.—Improved Rheostat.

at each end of the range of the nut acts as a guard against overwinding in either direction.

High-Resistance Rheostat.

The conducting cylinder and the wire are both of platinoid, a metallic alloy having properties which make it specially suitable for the purpose. It has very high electric resistance, very small temperature variation of resistance, and its surface remains almost or altogether untarnished in the air. On account of the last-named property, the contact between the wire and the conducting cylinder, and continuity in action, which was a great difficulty in the old form of apparatus, is very complete.

Low-Resistance Rheostat.

The conducting cylinder in this instrument is made of brass, nickel-plated so as to avoid tarnishing, and the wire used is copper, also nickel-plated. The rheostat can be supplied to carry currents as high as 30 amperes. Five different types of the instrument are made—viz.:

	Wire.	Approximate resistance.	Maximum current.
Type I.	Platinoid	600 ohms	0·2 amperes
,, II.	,,	100 ,,	1·0 ,,
,, III.	,,	100 ,,	2·0 ,,
,, IV.	,,	10 ,,	5·0 ,,
,, V.	Copper	0·5 ,,	30 ,,

Electricity Supply Meter, 1898 Pattern.

This meter (Fig. 20) is the same in principle as that introduced in 1892, which was then described by Mr. Meikle in his paper read before the Philosophical Society of Glasgow in November of that year. Since then many improvements, the result of experience in actual use, have been introduced. In the new meter the driving mechanism, or clock, if it may be so called, is of the simplest possible form. It consists of a drum and scape wheel, both fixed rigidly to the same spindle; also on that spindle is an arm free to move round it, having pivoted eccentrically on its other end a sector of steel bearing against the drum on its outer edge and arranged to lock with and drive the drum round pulled up, but free to run in the opposite di without carrying the drum round with it. At

Fig. 20.—Electricity Supply Meter.

to the end of this lever, and passing ov drum, is a band of flexible material (an o

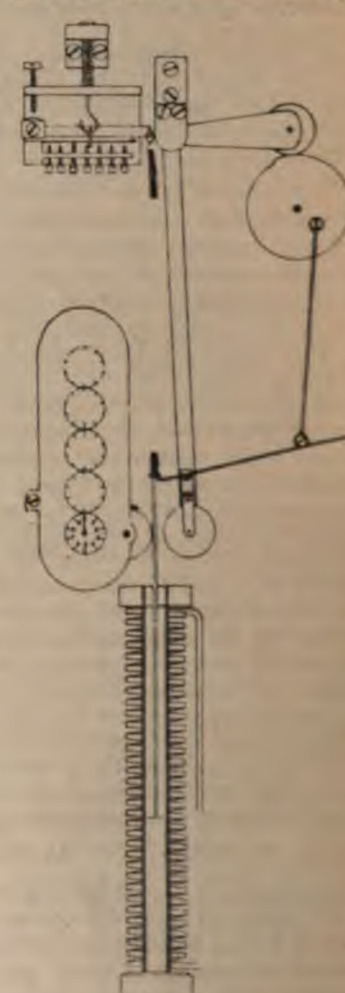


Fig. 21.

mohair bootlace) connected at the other end with rod about 12cm. long and 0·8cm. diameter, which the driving weight. This weight is arranged to

4cm., and when it has fallen that distance a disc ing fibre on its lower end presses down a light ler and makes a contact between two pieces of , sending a current of a tenth of an ampere round d, into which the upper end of the iron driving entered. The weight is immediately sucked up p of its range, the arm carrying the steel eccentric c on the drum, and the fibre disc catches the small slide at the top and breaks the current passing le solenoid, allowing the weight to start on its ownwards, carrying the drum round. The whole kes place in the fraction of a second; the energy herefore very small. To prevent sparking at the a shunt of very high resistance is fitted in with the winding solenoid, the current reduced ing passing round this, instead of jumping across k of the contact. The contact is a sliding one, ld the circuit not be completed at the usual point, rough wear, the intervention of dust, or any other will be pushed on further till a contact is made, ng cleaning the platinum surfaces and keeping them order. The speed of the clock is controlled by

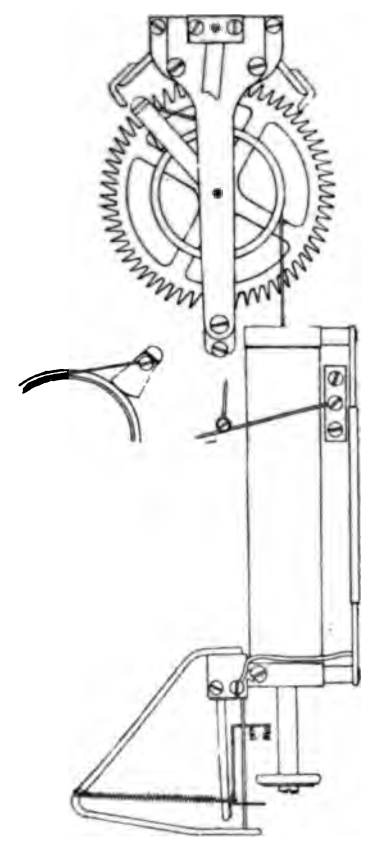


FIG. 22.

f a pendulum, and it is found to keep time with an r well within ½ per cent., whether running idle or e meter has full load on. The clock is self-starting, uld the current be switched off from the shunt the driving weight will run to the bottom of its d make the contact before the clock stops. Imme- the current is switched on the weight is drawn up, scape-wheel teeth; and the pallets being so designed e latter is given an impulse, the clock starts off. 21 the electrical part of the meter is shown. A lenoid of wire, sufficient to carry the maximum for which the meter is intended, has its ends con- to the main terminals. This solenoid has entered a soft-iron plunger, 16cm. long and 1·2mm. diameter, led from a spiral spring of phosphor-bronze wire. ring is in turn supported on the end of a small arm, the action of this being partly controlled by and partly by means of a small flat spring adjusted required position by screws below it. The action combined suspension is to allow the plunger to be into the solenoid by an amount exactly proportional current passing in the solenoid, or so that the displace- s, say, one-half ampere is exactly a twentieth of that amperes. At the lower parts of the scale, before the iron plunger has reached saturation, the small beam acts alone, controlled by gravity; next, it touches the small flat spring, this being so regulated by means of the adjusting screw below it that the deflections are proportional to the current, a shorter length of spring coming into use as the beam is pressed down, till with a current sufficient to saturate the iron the beam comes on a stop screw, and the spiral spring is alone in use. So that these vertical displacements may be recorded, the plunger passes between two rollers, one of these being geared to the counter and the other carried on the end of a crank lever (Fig. 22). At periodic intervals of about one minute, the cam, driven at a uniform rate by the clock, causes the plunger to be gripped between the two rollers. Immediately following this motion the lifter begins to rise, lifting the plunger to the zero position, and making a record corresponding to the vertical displacement of the plunger, this in turn being in proportion to the current passing in the main solenoid. The zero position is adjusted that the lifting bar touches the stop and cannot raise the plunger above the zero mark. To allow the plunger to take up its next position, the cam now raises the end of the crank lever resting on it, throwing out the lower end carrying the roller, leaving the plunger free. The lifter bar now begins to descend, ready to bring the plunger back when it is next gripped. The whole plunger system is supported on a platform, which can be raised or lowered by means of a screw till the plunger comes to the zero mark. It may be said that an instrument with spiral spring suspension such as is used in this meter, will not be perma- nent in its standardising. With springs wound with ordinary commercial wire, that would be the case. The spring are subjected to the following severe treatment and tests before being used: They are wound from selected phosphor- bronze wire. After winding, only uniform springs are taken, and these are hung in an oven having a tempera- ture of 70deg. C., with a weight on the lower end of each corresponding to twice the maximum pull during working. In about four days they are found to have come to a stable state and ceased to stretch. They are then removed, with their weight still on, and stored in vertical glass tubes. If at the end of three months it is found that no further stretching has taken place, they are considered fit for use.

THE KINGSLAND SYSTEM OF ELECTRIC TRACTION.

The designers of contact systems of electric traction using projecting contacts in the surface of the roadway are many, and as yet have not achieved much commercial success. This is largely due to the cost of their systems, and also to the number of the contact points required. In fact, the projecting contact and long collector, which has to make connection at all points of its length, is, in our opinion, the chief objection to the system from the local authorities' point of view. In Mr. W. Kingsland's system the number of contact points is less than in either of the two systems advocated by the leading American engineers. This is due to the fact that he uses the current from the power circuit to operate the automatic switches, and that a subsidiary accumulator circuit is not used. Mr. Kingsland has a model of his line at work at the Faraday House, where last Tuesday we were able to inspect it and to glean the following details: The main feature of the electrical connections appears to us to be the fact that the current to every stud is controlled by two switches, of which one is operated by the car moving in one direction, and the other if the car moves in the opposite direction. Thus the switch-gear under one contact controls the supply of current to contacts on either side of it. The connections possible are many, and in his patent specification Mr. Kingsland describes these at length, but the one arrangement he prefers is illustrated (Fig. 1). The details of the switch given are shown in Figs. 2, 3, 4, and 5.

The apparatus consists essentially of an electromagnet with two pole-pieces between which is a soft-iron armature, A, rigidly attached to the spindle, H, which is free to turn. At one end of the spindle is the main commutator switch, S, which is free to turn independently on the spindle, H, and is controlled by the quadrant-shaped boss, P. Fixed

to the spindle is also the counterweight, W, which normally keeps the spindle and armature in one particular position. The main commutator switch consists of a cylinder of insulating material on which are fixed on two metal plates, M N, which cover approximately one-half of the cylinder, with

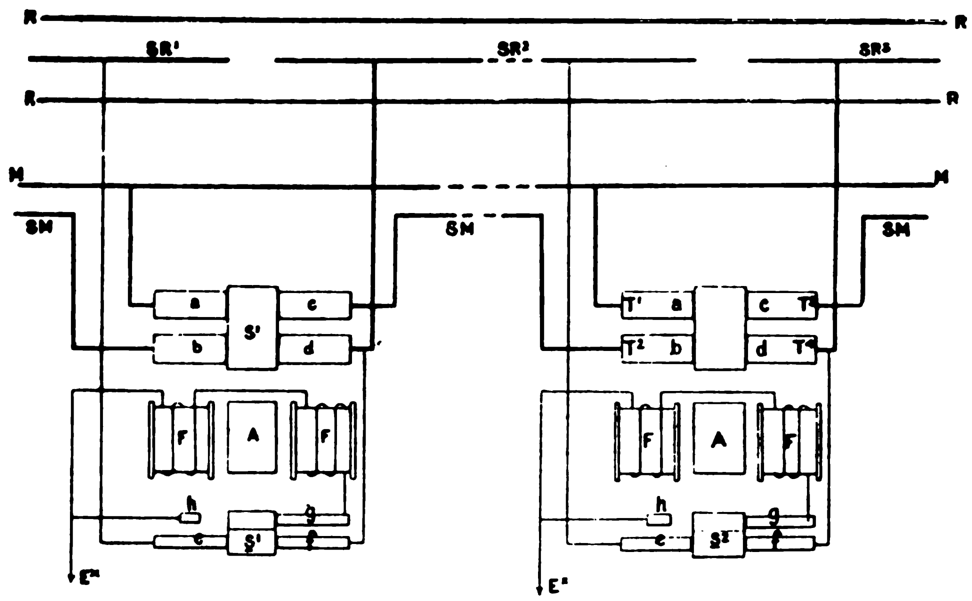


Fig. 1.

a small space between the two, so that they are insulated from each other. The main commutator switch is in contact with four contact brushes or springs, *a b c d*, connected respectively with the main conductor, the two

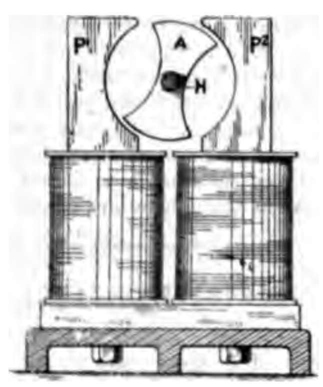


Fig. 2.

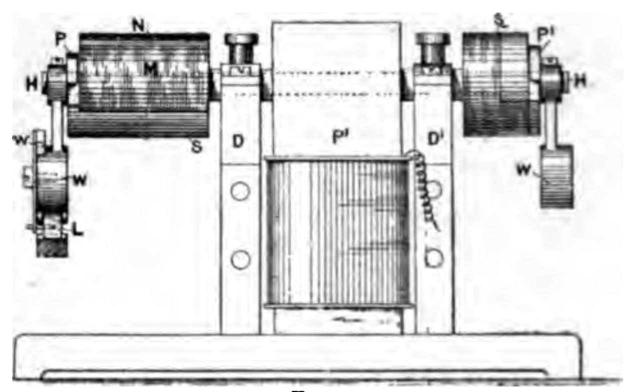


Fig. 3.

adjacent ends of two sectional mains and with one sectional rail, as shown in Fig. 1. At the opposite end of the spindle, and free to turn on it, is a smaller commutator switch, *s* (Figs. 3, 4, and 5), operated in the same mannner

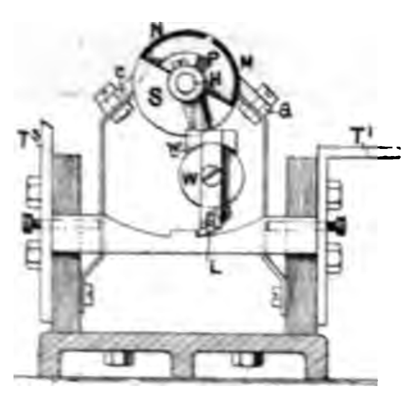


Fig. 4.

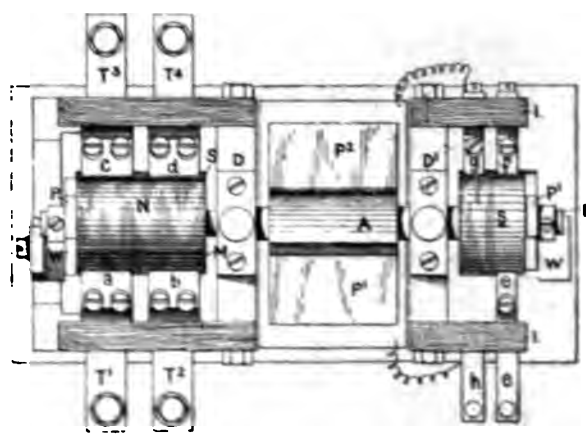


Fig. 5.

and at the same time as the main commutator switch. The metal plates on this smaller commutator, however, differ from those on the main commutator in that the insulating cylinder is entirely covered with metal with the exception of the upper half of, say, the end portion. There are three springs or brushes making contact with this

smaller commutator, one, *g*, being in contact w[...] part of the commutator which is covered with [...] round, and this will always be in electrical connect[...] it, while the other two brushes, *e* and *f*, are arrang[...] to make contact alternately as the switch is turne[...] right or to the left, and the contact is broken with before it is made with the other. The action of t[...] commutator, *s*, will be to place one or other of the *e* or *f*, in metallic connection with *g*. The small co[...] serves to control the action of the electromagne[...] following manner: One end of the circuit on [...] magnet (Fig. 1) is permanently connected to the brush *g*, and the other end to earth or to the ret[...] ductor. The contact brushes *e* and *f* are connect[...] sectional rails on either side of the apparatus, co[...] a current applied to either of the sectional rails [...] its way to earth through the electromagnet, provi[...] small commutator is in the right position. Supp[...] Fig. 1, that a vehicle is passing over sectional r[...]

l is about to enter sectional rail S R^2. As the vehicle travelling over S R^1, this sectional rail will be in connec- n with the main conductor through the main commutator, and the contacts a and b. When the collector on the hicle makes contact with the sectional rail S R^2, which it es before leaving S R^1, the current will flow from S R^1 S R^2 through the collector, and from S R^2 it will pass to e contact brush, f, of the small commutator and thence rough the field magnets to earth. The effect of this ll be to act upon the armature of the electromagnet d turn the spindle, which latter by its attached ctor-shaped parts, P P^1, will operate the large and e small commutators simultaneously, so that the ntacts will changed, a b of the commutator S^1 ing insulated, and c d connected, while f is insulated from and e is connected thereto. If a and b of the switch S^2 e already connected, then the vehicle can collect the rrent from sectional rail S R^2, but if the switch S^2 ould have been turned in the opposite direction, by ason of the previous passage of a vehicle in the same irection, then at the moment that the collector makes ntact from sectional rail S R^1 to S R^2 a current will flow hrough contact e of the small commutator S^2, and erating the electromagnet will alter the connection of e commutator S^2 from c d to a b, and so in conjunction ith the contacts, c d, of the switch S^1 will permit the hicle to collect the current from the sectional rail S R^2.

From the above description it will be seen that as soon s the contact bar touches two contacts in the roadway the ar one is disconnected from the main and put to earth rough the shunt coil of the regulating switch-gear under . This switch-gear work on the model was full size, d from what we could see would not be expensive to make. it no springs whatever are used, and gravity is relied on the return of the various counter-weights. The use of unwound Siemens armature as the moving part of the ectromagnet is good, and the design arranged for placing e armature a little out of the central position first in one ection and then in the other, is exceeding ingenious. rtain details of this switch-gear and its case are yet to devised, but we have no doubt but that Mr. Kingsland ll be able to complete these satisfactorily. The use of e full 500 volts on the shunt winding of the electro- gnets and the breaking the circuit repeatedly is perhaps e part of the system most likely to give trouble. Other- se it is a well-thought-out system, and we trust it will tain a practical trial.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers a practical character relating to central-station work, lway work, or construction work; and for each suit- le question offer *one shilling*, and for the best solu- n of any question we offer *ten shillings*. We also ve *five shillings* for every other answer we print. The swers to any question should be sent within 10 days ter the question has appeared, and should be written on e side of the paper only. We would call the attention those sending in answers to the fact that the neatness any sketches sent in is considered when marking the lative values of these answers. Questions may be sent any time.

QUESTIONS.

1. On a three-wire direct system, how is it possible to tell the actual amount of "earth" on +, 0, and − mains at the generating station without shutting down any portion of the system.—F. R. S.

2. Describe, with sectional sketches, a good form of self-oiling bearing for dynamos.—A. D. J.

ANSWERS.

Question No. 47.—**Discuss the advantages and disadvantages of the vertical engine for driving a flywheel alternator when the high-pressure cylinder is placed on one side of the flywheel alternator and the low-pressure cylinder on the other. Assume that a quick cut-off governor is used, and take up the question of parallel running.**

Best Answer to No. 47 (*awarded* 10s.).—The chief vantage to be gained by constructing flywheel alternators with the alternator between the high and low pressure cylinders is that only two crankshaft bearings are required. This is a very important point, for the weight of the shaft and wheel is then bound to be equally divided between the two bearings. It frequently occurs, when the alternator is placed on one side of the engine, and thus necessitating three main bearings, that the whole weight is thrown on to two of the bearings, due to unequal wear or to a slight displacement of the pedestal or foundation, resulting in increased vibration in the engine and greater friction, which may lead to heating in the bearings that are called upon to carry the extra weight. As a matter of fact, it is next to impossible to so adjust the main bearings that each will carry its extra share of the work. The best and most modern flywheel alternators are constructed with only two main bearings. The bearings are swivel—*i.e.*, the lower bearing block is spherical and rests in a seat bored out to fit, and is free to swivel in any direction to adjust itself for any deflection of the shaft. The crank-pin bearings are also made on this principle, and are lined with Magnolia metal as well as the main bearings. Having only two main bearings with generally forced lubrication, friction is reduced to a minimum, and consequently the highest efficiency is attained in this respect. If the alternator is arranged on one side of the engine, the work done on the outside crank has to be transmitted along the shaft through the other crank, thus necessitating a rather stronger shaft than would be required in the other case. One disadvantage to having the alternator between the cylinders is that water and oil is liable to splash from the glands and bearings on to the coils and field windings of the machine. However, this can be avoided by having suitable splash guards. It is not so compact, and rather more floor space is required than when the alternator is between the cylinders. Of course, in the case of Willans, Belliss, and one or two other types of enclosed engines, they do not adapt themselves to the alternator being placed between the cylinders, but the advantages to be gained thereby are not so apparent as in the marine type of engine owing to the speed being so much greater, thus enabling the weight of the alternator and flywheel to be proportionately reduced.

Several factors influence the success or otherwise of the parallel running of flywheel alternators. That which is of most importance is the percentage variation in speed during each revolution. This is affected by the weight of the fly-wheel and moving part of the alternator, the difference in the amount of work exerted by each of the two cylinders, and the method of governing. To secure the most even turning moment the momentum of the moving part should be great, the work of the engine should be equally divided between the two cylinders, and the engine should be governed by "wire-drawing" the steam. But "throttling" of the admission does not lead to efficiency of steam consumption consequently, in order to gain the utmost efficiency, it is best to adopt quick cut-off governors, and get the even turning moment by increasing the weight of the wheel. Then, again, the periodicity and speed of the machine has a deal to do with the parallel running. If the periodicity is comparatively high and the speed low, the number of coils required in the alternator is considerable, and the number of degrees of a circle occupied by each coil is small, consequently the variation in the turning moment required to throw the machine out of step must be very little.

In some cases, when the work done by both cylinders has not been equal, it has been found necessary not only to synchronise the alternator, but also the engines—*i.e.*, the crank of one engine with the same crank of the others.

It has been customary, when specifying for governors, to require that they shall not have a variation of more than 2 per cent. or 3 per cent. from no load to full. But for flywheel alternators to work parallel this practice is wrong. To secure the best parallel running it is necessary that the governor should have a variation of 5 per cent. or 6 per cent. from no load to full, and also provide means of adjusting the speed while the engine is running. With this range of variation the engines not only divide the load more equally between themselves, but the governor is far less liable to hunt, which is fatal to rigidly-coupled flywheel alternators.—J. P. B.

Question No. 48.—What are the reasons for and against laying armoured cables directly in the earth?

Best Answer to No. 48 *(awarded* 10*s.).*—The above practice has come very much into fashion during the last few years, and has no doubt a great deal to recommend it. The following are some of the advantages: It possesses the most flexibility of any system in existence, making it possible to lay it in situations quite out of the question with conduits, iron pipes, etc. This especially applies to the depth at which it can be laid, a foot or so being ample in ordinary cases. The facility with which it can be laid is another great point in its favour, requiring, as a rule, a minimum of skilled labour and permitting of the street being opened up and laid down again in an exceedingly short space of time. In fact, in congested thoroughfares it is quite possible to open up a few yards of street, lay the cable, and fill in again almost directly. Cast-iron stoneware conduits, on the other hand, require a considerable amount of skilled labour and time for laying, due principally to the time required in jointing, etc. The ordinary straight joints are much more simple and less expensive than those required in drawing in systems, because as a rule they are simply cast-iron boxes buried in the ground, thus obviating the necessity of constructing brickwork pits and dispensing with a lot of surface covers, except in the case of network and disconnecting boxes. As the cables are manufactured in longer lengths than it is possible to manipulate in drawing-in systems, these joints are also reduced to a minimum. Of course, in all fairness it should be stated that these latter advantages are possessed by most built-in systems. With cables laid direct in the ground there is perfect immunity from all danger of explosion and water in pipes, etc., except at brickwork pits, etc., but (as mentioned above) as these occur much less frequently, the danger is very much reduced. Now as to first cost, armoured cables are probably the cheapest system in existence. It is no doubt a difficult matter to compare the cost of this system with any other owing to absence of reliable data, but the following will give a rough idea of the relative cost of three alternative ways of laying cables:

One mile ·3 square concentric, paper insulated, lead, and armoured	£1,408
One mile ·3 square concentric, paper insulated, lead, and four-way casing	1,642
One mile ·3 square concentric indiarubber in 3in. cast-iron pipes	1,770

Of course, the advantages are greater in smaller sizes of main owing to the big percentage that the pipes, conduits, etc., bear to the total cost, as the following will show:

One mile 7/14 single, paper insulated, lead, and armoured	£202
One mile 7/14 single, paper insulated, lead, and three-way casing	350
One mile 7/14 single rubber in cast-iron piping	370

In addition to the difference in price shown above there is a saving effected in drawing-in boxes, laying, etc., which in a large contract could easily amount to a considerable sum.

Now as to the advantages of the system. Comparatively little is known as to depreciation with this type of main, and undoubtedly it is heavier than a similar lead-covered cable drawn into stoneware casing or even than indiarubber in cast-iron pipes. The real point to determine is if the nature of the soil is suitable for this sort of cable. Experience seems to have proved that depreciation in some situations is too excessive to warrant its use, the chemical action of the soil on the armouring rapidly corroding it away, and in special cases the lead sheathing as well. Electrolytic action, too, is sometimes troublesome. With regard to immunity from mechanical injury, it is inferior to cast-iron pipes, stoneware conduits, Callender's built-in system, etc., as it would be a fairly easy matter to pierce the comparatively light armouring if due care is not taken. This is especially so with cables armoured with steel wire, which would soon spread when struck by a sharp pick. In fact, in some instances boards have been laid over the cables to guard against this contingency. And, finally, it possesses the inflexibility of all solid systems, inasmuch as the cable has to be designed for ultimate requirements, which is somewhat of a disadvantage, as the lamp connection in any district must necessarily be an uncertain factor, and very likely will not develop in the
direction looked for at first. Of course, there is the
tive in high-tension stations of placing transformer
where required, but with direct current it is so
rather difficult to lay a large number of comparativ
feeders.—H. BELL.

Answer to No. 48 *(awarded* 5*s.).*—In answering th
question I think the best way will be to compar
a drawing-in system. The chief points then ra
(1) cost of installing; (2) convenience for handli
durability.

1. Under the first heading the cost of laying a
cable directly in the ground is cheaper than unar
cable drawn into pipe or conduit, although man
rities say the increased cost of armouring very
amounts to the cost of pipes; but I think the f
figures—which are actual costs and not assumed—w
the contrary:

Cost of laying one 2½in. cast-iron pipe and one ·15 concen
paper cable, 737 yards.....
Cost of laying one ·15 concentric armoured paper cable,
yards

The above costs do not include vestry charges, whi
the same in both cases. There is no need to give
examples, and from the above it will be seen t
difference is, roughly, 8 per cent. If the armour
is laid in troughing and filled in with bitumen or
cost is practically the same as for an unarmour
drawn into pipes.

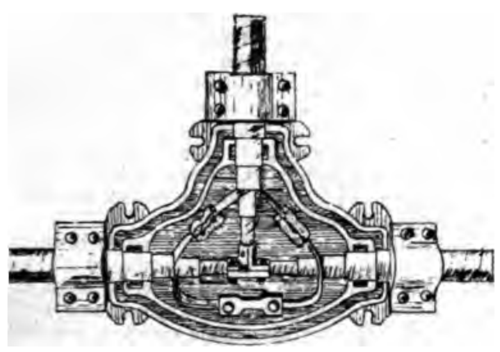
2. Referring to the second part, the drawing-in
is much to be preferred, as the cable can be draw
out without disturbing the pavement when it is n
to repair faults or increase the sectional area of the
whereas with a cable buried directly in the earth y
always take up the pavement, which means a serio
of expenditure, varying according to the class of pa
which in some towns is very expensive. In the i
you have to lay the cable whilst the trench is open,
length of trench allowed to be open at one time is
the different vestries and other authorities, which
inconvenient. An armoured cable system is far mor
than a conduit system, as you can surmount alm
obstacle you meet.

3. As to the durability of an armoured cable laid
in the earth, much can be said against it; but I
will suffice to say that the chemical action of so
will attack the armouring (and the lead also if
fibrous cable) severely, although there is an outside
or yarning. In nearly every town some part of th
or other is artificially made—that is, not the natur
and a most common enemy to the armoured ca
be met with—namely, refuse ashes; when such
case the cable needs additional protection, such as
ing, etc., and in that case you might just as well su
pipes and draw it in. Again, you cannot com
mechanical protection of armouring to a cast-ir
apart from its attendant advantages, and the prob
of a workman putting his pick through the armou
not to be forgotten. The only excusable reasons fo
armoured cable are where the district is not l
increase its demand for current over the estima
where the path for the main is such that a dr
system could not be advantageously used owing
inelasticity.

I have, perhaps, treated the subject in rather a
light than the question demanded, but by doing
aimed at completely covering the ground.—J. E. Do

Answer to No. 48 *(awarded* 5*s.).*—The chief o
using armoured cable laid direct in the ground is ch
and this is a point worthy of notice, for the cost of
no mean sum in a large area of supply. Cast-ir
used in the "draw-in" method are very expen
they have their advantages. Cables laid direct
ground are very serviceable in outlying districts,
some cases for feeders, but there are many draw
their use, one of the principal being the difficulty
finding. In the "draw-in" system, where the
located to within, say, 20 or 25 yards, that le
cable can be withdrawn and examined; but
armoured cable, many yards of ground may hav

up before the fault is arrived at. This impedes nd people, especially storekeepers, are not slow to at the obstruction. If much ground has to be it makes it very expensive. A strong point in of armoured cables laid direct in the ground is eedom from gas explosions. Expensive service are not necessary to fix, as the cable is laid. can be cheaply made, and all that is required a small split junction box of cast iron placed joint and filled up with insulating material. etch below shows a simple form of box. Care taken that the ground is made solid under the when the earth is filled in and pounded down t is put under severe strains. The "dead ends" of bles should be well insulated, or they may cause in "earth." Armoured cables laid direct are liable to rom sharp-pointed tools handled by careless work-



hen opening-up roads. As a rule, when gas com- etc., have occasion to lay new pipes and gear in inity of electric light cables they seldom take ouble to enquire of the electrical engineer as r whereabouts, with the result that sometimes is driven into the cable. Armoured cables laid seem to have given trouble in some cases. nt soil has a different effect on armouring. In one St. Pancras, where the street had been made up of cable had to be withdrawn after 15 months. The ing had rotted away, and nothing remained but a st. A good protection is a wooden trough filled asphalte composition. The trough will perish, but immaterial—it is only used as a mould. A good s of lead armouring is essential, and this is a point hould not be overlooked when buying cables of this

F. BRUTON.

ALTERNATING-CURRENT MOTORS.*

BY E. E. TASKER.

(Concluded from page 407.)

fonocyclic System.—This system was instituted by Mr. tz in America, its object being to run motors from what ally a single-phase generator, so that, whilst only having k leads to run, the advantages of having three-phase

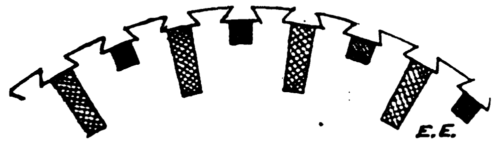


FIG. 21.

re at the same time obtained. At the time this was the only single-phase motor in use was one that ran ously with the generator, necessitating its being run eed by some external means, and also the use of a direct to excite its field magnets, except in the case of the " motors, where the alternating current is commuted purpose. This system is operated by means of a gene- lled a monocyclic generator, the winding of which is a sketch (Fig. 21). It consists of a single-phase alternator additional winding called a teazer, wound in slots between the main windings. This teazer winding s an E.M.F. 90deg. out of phase with the ordinary , and is used for starting and running motors.

e polar diagram (Fig. 22) the vector A B represents the voltage measured across P Q, and A C that across O R, whilst A X represents the potential difference between Q R, and A Y that between R P. O R represents the teazer winding, and is of comparatively fine wire, being used for the motor circuits only, and from the diagram we see that the motors are really starting as three-phase motors: they have a good starting torque, so can therefore be started when loaded. When they have then obtained the requisite speed, the machine runs merely as a single-phaser with short-circuited rotor, this being brought about in the following manner: The winding of the motor to which the "teazer" wire is attached has such a number of turns that the back E.M.F. when it runs synchronously exactly equals the E.M.F. generated by the teazer

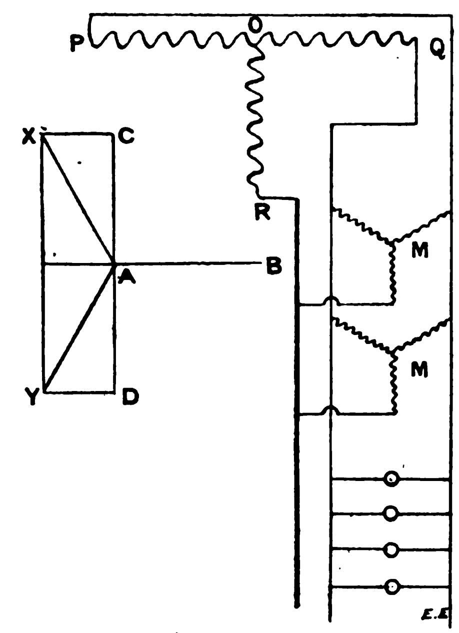


FIG. 22.

winding, O R, in the dynamo; then at this speed no current is supplied by the "teazer." The lamps and motors are all on the same circuit with a single-phase current. If now the motors for any reason slow down, such as overloading, the third wire again comes into play, and the motor continues running as a three-phaser until its normal speed has been attained. I might here add that during starting in the two windings connected to the mains the difference of phase of the currents in the coils diminishes from 180deg. to approximately 120deg.—that is, when the motor is started from rest.

The same results may be obtained if transformers are used. We may employ two transformers connected in series across the mains (Fig. 23), the common junction being connected to the teazer. The secondaries are connected in reverse relation to the

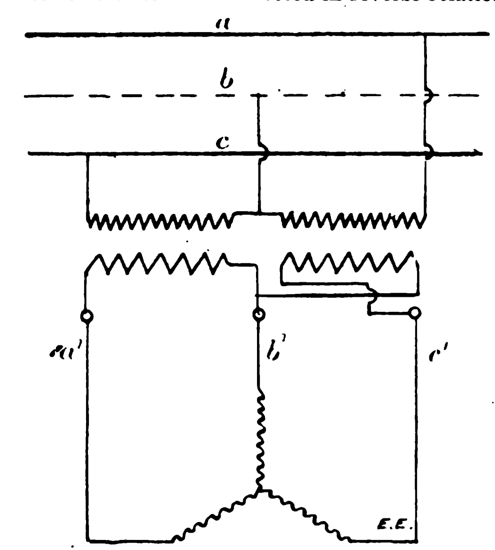


FIG. 23.

three terminals of the motor. Then the primaries are in series and the secondaries in multiple. In this case the duty of the "teazer" wire is to carry only a magnetising current, and can, therefore, be made of comparatively small wire. The reason the secondaries are reversed is to alter the phase relations from 60deg. in the primary to 120deg. in the secondary. When the connections are made in this way the reaction of the machine causes a displaced E.M.F. on the main, b', which is transferred back through the transformers, thereby causing

* r read at the students' meeting of the Institution of l Engineers, March 16, 1898.

the phase relations as well as the E.M.F.'s to alter in the primaries and secondaries. Fig. 24 shows another method of making the connections with transformers, and it will be noticed that it somewhat resembles Mr. Scott's system of converting two-phase currents to three-phase, the three-phase portion being only used for the motor starting and running; the lamps, as

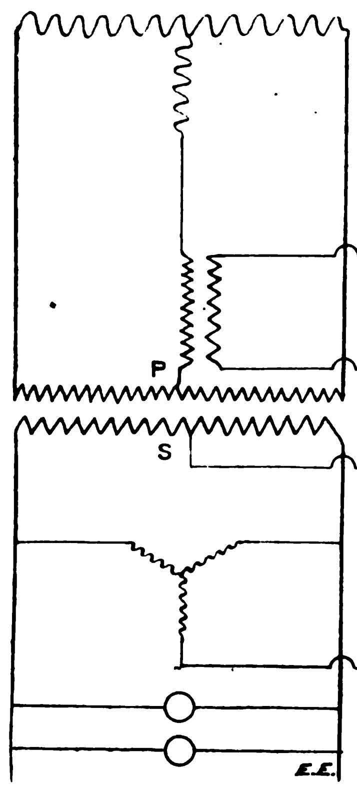


FIG. 24.

before, merely put on two of the mains. Two-phase motors can also be used in a similar manner in this system, since the necessary two-phase currents may be obtained direct from the transformers.

It is not absolutely necessary to have a separate winding on the generator for the monocyclic system, but is applicable to the ordinary single-phase alternator. The principle of working is shown in the diagram, and is as follows: a three-phase

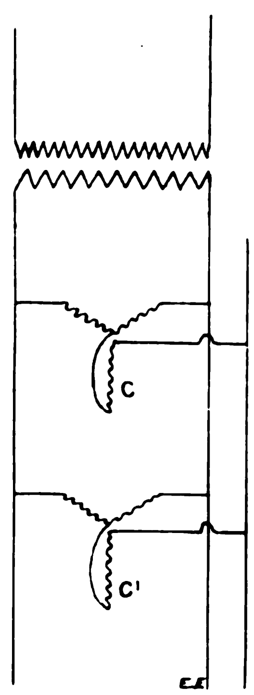


FIG. 25.

induction motor is run single phase, then between its impressed and counter E.M.F. there will be found another E.M.F., these three being nearly 120deg. apart. In Patent No. 533,379, issued on April 11, 1894, to Mr. Steinmetz for "motors operated from line circuits in which currents flow 60deg. apart in phase," he says: "The difference in the motor being in reversing one *of the three coils*, so that the current through it is in an *opposite direction from that* in an ordinary motor, and produces the same effect so far as the action of the motor is co that which heretofore has been secured by currents d phase by 120deg." He also adds that if a teaser this case the secondaries of the transformer are not You will notice in the diagram (Fig. 25) that the fi has its connection reversed to the other two, then, field of the induction motor has a single-phase cu through it with the armature revolving, the three w the armature cut this field, and give rise to E three-phase relation; the counter E.M.F. of the reacting on the single-phase field gives at t terminals of the induction motor field three-phase The reason that the coil, C, is reversed is this: winding on a monocyclic generator gives an E.M.F. i direction, and the back E.M.F. in the coil, C, is in th direction; then it is evident, in the case under con that to start other motors this coil should act as winding in the generator, and it will be found that be mains and this extra wire 120deg. difference of phase The drawback to this branch of the system is that it i to keep one machine running as a single-phase sho armature motor. If, then, another motor be put o one supplies the necessary difference of phase to e start, and when it has attained its proper speed i current from motor No. 1; it merely acts as a s induction motor, since the two coils, C C, have induce which balance each other. When other motors are s those already running change to three-phase motors the requisite three-phase currents to enable them to same thing happens if by any chance one or more of become overloaded and lags.

A special induction motor was designed by Steinm monocyclic system, which is here represented diagra (Fig. 26). This motor acts at starting as an unbalan phaser, but when running at normal speed takes its p the two mains. He has also made synchronous mo in reality are wound the same as the generators

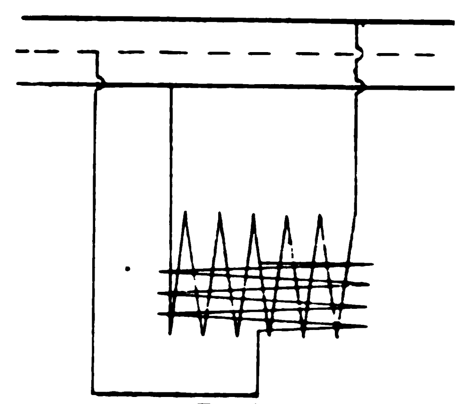


FIG. 26.

important advantage which this system possesses ordinary three-phase one is that there is no u where lighting and power are used from the same since it is practically all derived from one circuit, and only one on the machine.

NOTTINGHAM ELECTRIC TRAMWAY

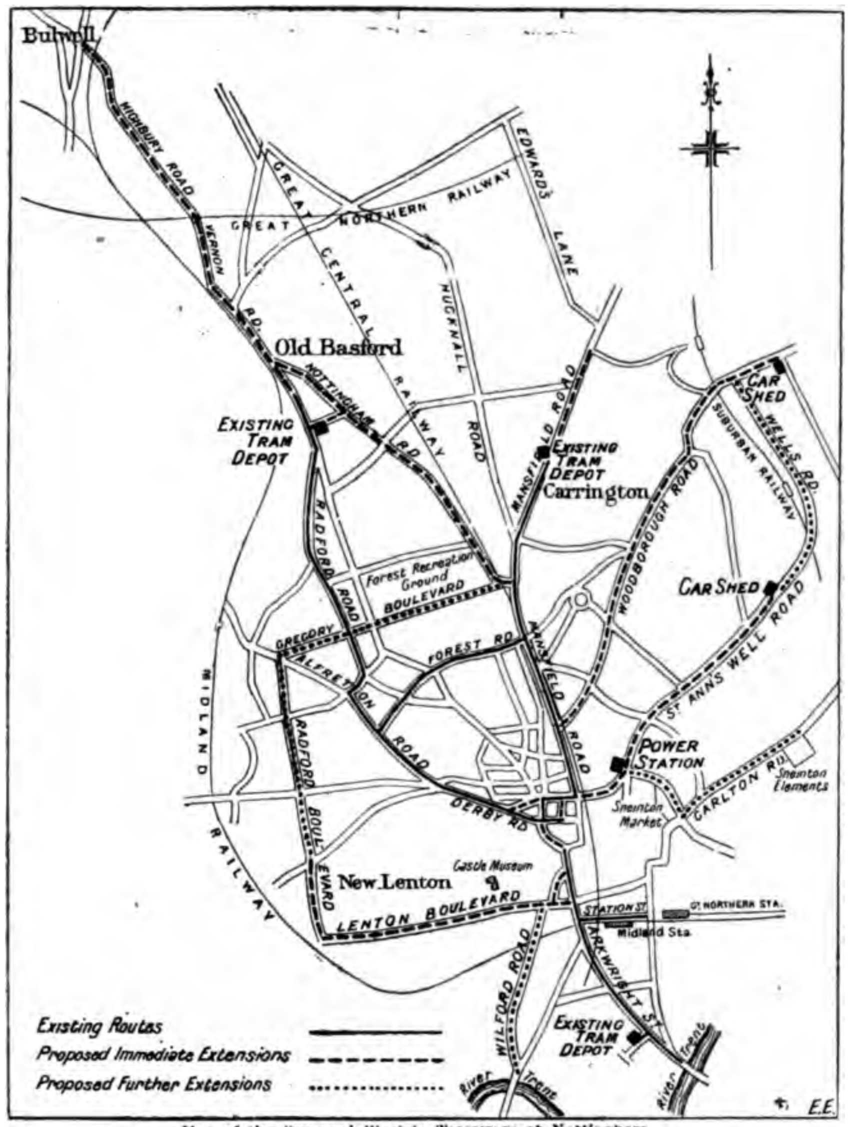
The following is the report of the Tramways C as to the reconstruction of the existing tramlines extensions required, and as to the method of tract adopted and the works necessary for carrying out and other matters:

In accordance with the arrangements entered into committee with the Nottingham Tramways Company approved by the City Council on June 14, 1897, the have been acquired, and they were formally handed o city on Oct. 18, 1897. Since then your committee h carefully considered the whole question of tramways the reconstruction of the existing lines, what extens desirable should be made, and what form of mechanic should be adopted. They now come to the Council following recommendations: (1) that the permanen the whole of the existing system shall be reconstru that certain important extensions to this system, give detail later in this report and shown on the sketch-p be carried out as soon as parliamentary powers can be (3) to equip the whole of the system on the principle o overhead traction.

1. As regards the reconstruction of the existing tramways, these lines were constructed in 1878 and were laid without any concrete foundation for the

i way; the rails were exceedingly light and weighed
i 45lb. per yard. They are absolutely worn out. This
rail, if new, is not strong enough to carry the heavy
i are necessary where mechanical traction is adopted;
i are being propelled mechanically very heavy rails
sed, the most recent examples of tramway construc-
g rails weighing from 90lb. to 100lb. per yard. Your
i believe that it is the soundest policy and the cheapest
to construct the lines in the most substantial manner,
educe materially and to as low a figure as possible the
aintenance and repairs. It is intended, wherever
, to pave the very busiest thoroughfares with wood,
ely use hardwood paving for this purpose.
xtensions proposed to be carried out by your com-
oon as powers can be obtained from Parliament are
: (a) The doubling of such portions of the Basford
single lines now occur—viz., in Alfreton-road and
ed—and the extension of such lines to Bulwell
ce. (b) The doubling of the Carrington line from
r's Church to the terminus, and the extension of the

It is intended to abandon the St. Peter's-square terminus; this will relieve the congested state of this square, and be a great advantage to the ordinary traffic, as it is very much overcrowded; double lines in Albert-street will be continued up Wheeler-gate into the Market-place. The street recently formed across the Market-place from Market-street to Wheeler-gate will be widened and formed into a tram centre, with four sets of rails and crossovers, etc. It is intended to run through cars from Carrington to Trent Bridge, and from Bulwell to Trent Bridge. The tram centre will be used as a junction where passengers can exchange from one car to another, only a few yards distant; a waiting-room, an office, and conveniences will be constructed in a convenient position close to this tram centre. The existing double line on Long-row East will be be taken up, for which will be substituted a single line, which will be carried up King-street to Parliament-street. All outward cars to Carrington or St. Ann's Well-road will pass up King-street, and return *via* Market-street. The double lines in Long-row West, from Market-street to Chapel Bar, will be taken up and a single line substituted for the same; a new single line will be



Map of the Proposed Electric Tramways at Nottingham.

inchester-street, Sherwood. (c) A new line, com-
the east end of the Gregory-boulevard by a junction
arrington line and passing along Sherwood-rise and
-road and joining the Basford and Bulwell line
rnon-road, near the Basford Station; this line
orm an alternative route to Basford and Bulwell.
line, commencing by a junction with the Carrington
he south end of Milton-street and passing along
lament-street and the intended new street through
d thence along St. Ann's Well-road as far as the
Coppice-road; a short extension of about 400 yards
ells-road will be required to provide access to the
ew car shed. (e) A new line, commencing by a
ith the Trent Bridge and Station line near the
ntain and passing along Grey Friars-gate and the
levard as far as Derby-road; the return line will
Canal-street instead of *vid* Grey Friars-gate. (f) A
mmencing by a junction with the Carrington line
end of Bluecoat-street and passing along Wood-
d and Mapperley Plains *as far as the Porchester-road.*

constructed from Derby-road and along Parliament-street to the top of Market-street. All outward cars to Basford and Bulwell will go along Long-row West and Chapel Bar, and return *vid* Upper Parliament-street and Market-street. This arrangement will conduce to the comfort and convenience of passengers, and will be more economical to work, as all outward cars going uphill will take the route with the easiest gradients.

Your committee have also considered the desirability of making, in due course, further extensions indicated on the plan accompanying the report, and they consider that in the near future it will be desirable to have a system of trams (1) along the Radford and Gregory Boulevards; (2) an extension of the intended St. Ann's Well-road line up Well-road, to join the line on Mapperley Plains; (3) if a convenient route can be found, a line of tramway to Sneinton; this however is a most difficult problem, as the streets along which the pedestrian traffic now goes—viz., Goose-gate and Hockley—form an impossible route for tramways on account of the narrowness of the carriageways in those streets. The only possible route is *via* the St. Ann's Well-road line as far as Bath-street, and then turning along

Bath-street to Carlton-road, and thence along Carlton-road (this is the route shown on the plan); the objection to this route is that it is very circuitous, does not follow the line of pedestrian traffic, and would therefore carry only through or long-distance passengers. Your committee are informed that the Improvement Committee is considering the possibility of opening out a new thoroughfare in continuation of St. John's-street, through Cur-lane and Colwick-street to Carlton-road, and it is therefore desirable that the intended new tramlines to communicate with Sneinton should be postponed until the question of the new street has been decided. (4) The other line which your committee consider should be carried out is along Wilford-road as far as Wilford Bridge; in this case also the narrowness of the carriageway renders it difficult to lay down even a single line; this could only be done by the co-operation of the owners and occupiers along the route, and would necessitate the narrowing of the causeways for the greater portion of the length of the road.

The choice of a suitable site for the power station has fortunately not been a matter of very much difficulty; the essential points required in the site are that it should have a considerable area in order to provide for future extension, and that it should be in a central position. The only site which can be secured to answer these requirements is the area which is proposed to be cleared by the Improvement Committee in connection with the new street through the gaol; this site will lie between the St. Michael-street recreation ground and the new street, and will provide ample accommodation for everything required for power for tramway purposes, for car sheds, offices, etc., leaving ample space for future extension. It will be necessary to carry out considerable structural alterations to the existing tramway depôts in the Meadows, at Basford and Carrington, so as to convert the stables into car sheds, etc.; additional car sheds will have to be built, one on the Wells-road and one at the junction of Porchester-road and Mapperley Plains.

As to the form of mechanical traction to be adopted, your committee have unanimously come to the conclusion that overhead electric traction is the best known system of traction, having due regard to efficiency and cost. They have given the subject most careful consideration, and have had the opportunity of seeing the most recent and most perfect equipment of tramways on the cable system at Edinburgh, and have seen the most recent types of overhead construction at Bristol and Dover. They have also had the very great advantage of carefully perusing the most excellent and exhaustive report issued by the city of Sheffield, giving a full description and ample particulars of the tramways in about 18 cities (principally on the Continent) visited by the deputation appointed by the Sheffield City Council to enquire into the best methods of mechanical traction for tramways.

As regards the system of cable tramways at Edinburgh, it is believed that when completed it will be the most complete system of cable traction known. It is being carried out regardless of cost, and embodies all the newest principles. It has certain advantages. For instance, there is, of course, an absence of overhead wires in the streets; it easily adapts itself to increased traffic, as additional cars can easily be attached when the traffic demands it; it is also economical as regards working expenses. The disadvantages are: the speed of every car being limited to six miles per hour, whether travelling in a crowded thoroughfare or on a road in a very quiet suburb; if a car loses time it cannot make it up, and if it has to move more slowly than the six miles per hour (the speed of the cable) the gripper is slackened and the cable worn by the slipping of the gripper on the same; a car cannot be reversed and run back—this often has to be done in foggy weather on single lines. The slot is objectionable, and the noise from the cable running in the pulleys below the ground is found to be a constant annoyance to the residents on the route. A breakdown of the engine or cable stops the traffic on the whole length of that particular route. The great disturbance to gas and water mains and services during construction is a very serious item of expense, and, lastly, the principal objection is the very heavy initial cost of the system.

As regards the system of propelling cars by electricity, the best known methods of applying this power are as follows: (1) by underground conductor in conduits; (2) by accumulators; (3) by overhead trolley wires carried on poles or span wires. The great objection to the first system is the expense; it is more expensive than the cable system, the slot is wider, and there is considerable danger of frequent stoppages in times of snow or heavy rainfall. No matter what precautions may be taken to ensure the efficient drainage of the conduit in ordinary rain, in times of heavy storms, when the sewers become overcharged, the conduit would be filled with water and mud, and the tram service stopped and could not be started until the water and mud had been all cleared away. The second system—that of accumulators—is not making any progress, and it is not likely to do, as its serious disadvantages are the objectionable smell from the accumulators, *the great expense* of maintenance, and necessarily the great *cost of working; some idea* of this may be seen from the fact

that the only tramway worked on this system in
is at Birmingham—the cost per car mile run is
compared with from 4½d. to 5½d. per car mile f
electric traction and as compared with 8d. per c
horse traction at Nottingham; in fact, at Birm
company spend 18·43d. per car mile to earn 15·70d.
which cannot be long sustained.

Having had these facts brought before their notice
mittee did not think it desirable to waste time in se
which it was impossible to carry out; they theref
their attention to the claims of the cable and overh
system. The only possible objection to the overh
system is on account of the overhead wires, but i
advantages over cable traction: the cars can accomm
selves to the traffic, they can run slowly or quickly,
backwards, in case of an accident to a trolley wire
of the system, which is most unusual, only that
half-mile length) is thrown out of use, and it is v
repaired. The units of power employed in the s
are all coupled together, sending current thro
to all sections of the trolley wire. An accident to
does not affect the running of the cars, as an
engine can immediately be run to take its plac
one of the great advantages of the overhead syste
cable system, is its comparative cheapness and
The advocates of cable traction point to the heavy
motorcars, and that this expense goes far to put
overhead system on the same footing as the cabl
regards expense. Your committee were somewhat
Edinburgh to find that a cable car equipped with
design of gripper and brake cost £450; at Bristol a c
with two motors costs only £570, so that there is a d
only £120 in the cost of the cars, which makes on
only about £500 per mile. As regards the objec
overhead wires and poles, your committee after thei
at Bristol and Dover consider that this objection
exaggerated. The poles can be made most ornam
overhead system of tramways has been carried t
principal streets in Rome and particularly th
magnificent ruins of the Capitol, without causing
comment; at Milan the overhead system has bee
almost into the precincts of its magnificent cathed
the system has not destroyed the beauties of Rom
residents in Nottingham scarcely need fear that the
of any streets in this city will be spoilt. The dang
overhead system has been greatly magnified; writers
that many fatal accidents have occurred through
wires, etc., base their opinions on American prac
the bulk of the wires (both for electric light and
carried overhead, and the majority of accidents the
been caused by the breakage of tramway trolley w
electric light wires carrying a high voltage; the Engl
is to carry all wires underground, except of course
wires, and these are very strong, and breakages
unknown.

The municipal authorities of the most importan
England and Scotland have decided in favour o
electric traction; for instance, Liverpool, Manchest
Bradford, Hull, Leeds, Glasgow, Bristol, and o
decided on this system after most exhaustive enquir
the Continent and in America. The cable syste
from £4,000 to £5,000 per mile more than the electr
system, and taking the ultimate mileages at 50
your committee are not prepared to recommen
Council to spend from £200,000 to £250,000 extr
to instal this system. The total estimated cost of
struction of the existing tramways and the extension
the equipment of the same with an electric system o
traction, tramcars, power station, engines, boilers,
etc., will be about £425,000. This does not include
sions marked on the plan by dotted red lines.
remembered, however, that it includes an outlay o
station, engines, boilers, and car sheds, which will
considerable additional mileage of tramways.

Your committee beg to recommend the Council t
overhead electric trolley system of traction for the
the tramways, and to approve of the scheme of re
and extension of the tramlines and the works for eq
new system set forth in this report. Your com
recommend the Council to authorise them to obt
parliamentary powers and consents of the Board o
other authorities as may be necessary to enable th
out the above works, and to empower the Finance
to raise the capital moneys required under the po
Tramways Acts or otherwise as they may deem mos

ANDERSON BROWNSWORD, C

Dated March 28, 1897.

At a meeting of the City Council held on the 4th inst.
Brownsword moved, "That the report of the Tra
mittee now presented to the Council be received and
and for the first reading, and that the second reading

e quarterly meeting of the Council in May next. That antime the Tramways Committee be authorised to city engineer to proceed with the necessary surveys, sections which will be required for the purpose of e Council to give notices and take all proper steps to Bill during the next session of Parliament for carrying ommendations of the Tramways Committee now laid Council if that course be ultimately adopted."
siderable debate, the resolution was carried.

BRIGHTON ELECTRICITY WORKS.

ROPOSED REDUCTION OF CHARGES.

ghton Town Council yesterday considered the following from the Lighting Committee on the proposed reduc- charges for electricity in the town, accounts for the trading, and many other interesting items.

ounts show that borrowing on the electrical account has rised to the amount of £234,581, of which £198,155 ised, leaving an uncalled balance of £36,426. Owing miums at which the loans were issued, the actual curred is £188,543. 13s. 5d. The gross revenue 7 was £32,722. 17s. 10d., of which £18,512. 4s. 6d. nded on maintenance and £14,210. 13s. 4d. carried Leaving £110. 13s. 4d. of this as provision for bad adding £5,000, balance from 1896, the Corporation d £19,100, of which £2,000 were applied in aid of t rate, £3,000 transferred to reserve fund, £5,688. l as interest, £5,547. 9s. 1d. to the sinking fund, and 5d. carried forward to 1898 account. The assets are £229,522. 4s. 5d., leaving £19,496. 16s. 10d. above which include a reserve fund of £5,901. 13s. 11d., ase account of £350. Private consumers purchased units last year, and the public lamps consumed its, 111,693 units were used in the works, and its represents the extra quantity generated but not ler.

rt of Mr. Wright to the committee, recommending duction in the price, was presented to the Lighting on March 28 as follows: "In recommending you to charge for electricity, after the first hour's average rom 1½d. to 1d. per unit, I have thought it well to nd you of the cardinal principles on which the ystem of charging was established. In the first s recognised that the business of electricity supply similar to the hiring or renting of privileges or such, for instance, as telephones, carriages, or nd that it is a great mistake to assume for a moment anything like the business of supplying such com- gas, water, or goods usually purchased over the counter. istinction between the supply of electricity and gas that in the former case the cost of providing the machinery and mains bears a very much larger to the cost of running the machinery than it does in It follows that practically the greater part of the electricity must always be that due to the rent or that particular amount of machinery which it is to allocate to each consumer's demand, as it borne in mind that, owing to the fact that nter months practically everybody requires the n after dusk, each electricity consumer has to ain amount of machinery always standing by ready is wants, and that this machinery cannot be used for of other consumers. The annual chartering of a steamboat is analogous to an electricity supply busi- th the electric machinery and the carriage have to be chartered or allocated to each consumer's wants for year. Now, let us suppose two individuals, A and riages by the year, and that one uses his carriage for day on the average and the other only one hour per sponding to the consumer who uses his lamps all day basement and the other who only uses the electric dusk to about seven o'clock every evening—then it vious that the average hourly cost of using the car- chinery must be very nearly 12 times as much in the as it would be in the former, owing to the hire of the machinery constituting nearly the whole of the cost. it is absolutely fair to insist on anyone who requires he use of the carriage or machinery to first pay an hich will cover the hiring or renting of the same y allowance is made to him for continued use. in the second place, it was recognised that no in the charges for the supply of electricity could ly made to any consumer until the revenue derived had at least covered the cost of maintaining the and mains in a state of readiness to supply him. hat it was advisable for a municipal commercial g to so frame its tariff as to ensure as nearly as he charges to every ratepayer supplied bearing some lation to the actual cost of supplying him individually. It was also thought necessary to avoid as much as possible the commercial absurdity of taxing those consumers, the supply to whom results in a profit, for the benefit of those short-hour users of the machinery whose supply at the maximum allowable price of 7d. must for some years to come result in a loss. Lastly, that the Corporation of Brighton started their electricity works with the primary object of affording as many of their ratepayers as possible an opportunity of deriving a benefit from the use of electricity. With regard to the first principle, an analysis of the accounts for 1897 undoubtedly shows that the charges made against the revenue account for keeping our machinery, staff, and mains always in a state of readiness to supply current as it was required in that year were not less than £20,714, or 81 per cent. of the total charges against the revenue account; also that the extra cost the Corporation were put to in having to continue to run the machinery after it had been once started came out to £4,895, or slightly more than ½d. per unit. It can also be shown that if everyone of our consumers had just used their demanded number of lamps only one hour per day, or 365 hours in the year, the charge would have to have been about 7½d. per unit for the revenue to cover the actual cost, thus unmistakably proving that those consumers who used their light one hour or less per day on the average, of which there are several, were supplied at a loss of about ½d. per unit. With regard to the third principle, as the cost of continuing to run the machinery after it is once ready is only about ½d. per unit, the Corporation can obviously afford to supply electricity after the standing-by charges have been covered at an exceedingly low figure, which, although having to be sufficiently in excess of ½d. to make up the loss made during the first hour, could, as the accounts of 1897 show, have been a great deal lower than the figure charged—viz., 1½d. per unit. With regard to the suggestion sometimes made to reduce the already insufficient charge of 7d., it must now be obvious that this would mean the taxing of the great bulk of the long-hour consumers, who always must form the majority in any town, for the benefit of the hopelessly unprofitable class who use the electric light only during the few winter months or at most irregular intervals. As no commercial man would consider for a moment the suggestion that he should lower the price of those commodities on which he invariably loses and make up for this increased loss by raising the price of the goods from which he derives his profit, I need not further dwell on this proposal. With regard to the probable effect of the proposed reduction, I must ask the members of the committee to bear in mind when discussing this question that any calculation based on the effect of this reduction on last year's revenue is entirely misleading, as the suggestion is not to reduce the charge from the first day of the past year, but from July 1 next, a date 18 months later in the development of the business, when there will be in all probability no less than 550 more consumers connected to our mains than there were at the beginning of 1897, and when the output will be at least 60 per cent. greater than during that year. It must also be borne in mind that in a business such as electricity supply, the standing-by costs per unit must diminish as the number of consumers connected increases, and that a reduction to the long-hour consumer means, judging from the past effects of similar reductions, an enormous increase in the number of applications for a supply from the small ratepayers, householders, and users of electric motors, who can so justly claim to be supplied with the most perfect and now cheap means of artificial illumination, heating, and motive power. That the conditions on which the Brighton system was based are substantially correct can be judged from the fact that the following towns have decided to adopt the Brighton system of charging: Bournemouth, Preston, Southport, Cheltenham, Stafford, South Shields, Blackburn, Blackpool, Bolton, Kingston-on-Thames, Hove, Oldham, Coventry, Cardiff, Northampton, Glasgow, Islington, Nottingham, Southampton, Taunton, Dewsbury, Hull, Hammersmith, Walsall, Coatbridge, Burnley, Sunderland, Aberdeen, Ayr, Hanley, Derby, St. Luke's (London), Morley, Shoreditch, Torquay, Wandsworth, Dover, Worcester, Bury, Wakefield, Burton-on-Trent, Salford, St. Pancras, Wolverhampton, West Ham, Barrow-in-Furness, Paisley, Belfast, Winchester, Salisbury, Ventnor, Bootle, Lincoln, Plymouth, Folkestone, Bromley (Kent), and High Wycombe. In conclusion, I only trust that the policy inaugurated by the Lighting Committee of the Brighton Corporation in vigorously encouraging the use of electricity among the vast body of small ratepayers, who, either in their business or private residences, are in the habit of using artificial light for many hours per day throughout the year, will be continued, and thus keep Brighton in the enviable position which it now holds, of being the first to enable the smaller ratepayers and householders to benefit by the many advantages of electricity.

The committee resolved: "That from and after June 30 next the charge for electricity after the first hour's consumption be reduced from 1½d. to 1d. per unit.

[We regret that the Easter holidays prevent us from giving the result of the Town Council's meeting in this issue.—Ed. *E. E.*]

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TO CORRESPONDENTS.

 Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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THE TELEPHONE SERVICE.

The discussion in the House of Comm week, if it did nothing else, brought out t held by the Government with regard to phone service. These views are, as they have been, of a most invertebrate charact worst feature in the discussion was the thr blame upon the late Mr. Fawcett, the Pos General in the early days of telephon recollection of events is not the same as forward by Mr. Hanbury on behalf of the ment. Without consulting authorities an our view is to the effect that the man rather pooh-poohed the commercial the telephone, and the warnings of scien uttered in vain to deaf ears. Certainly, as the system, there did not seem much to be its commercial value. Afterwards it was fo that he had designed a receiver that coul be, and has hardly been, improved. The wea his system was that his good receiver wa good transmitter. But then came alo Hughes with his French nails and pieces o and metals, and showed the world how to good transmitter. Even then commercial this side held strangely aloof from the exp of the system, and had it not been for A enterprise we are not sure that we should h a telephone exchange yet. However, ex were tried and succeeded. Then—and we f till then—the Government came to the co that telegraphic receipts were being, and w diminished, and a lawsuit favourable to the ment was the result, asserting that te was telegraphy under another name, and c it as a State monopoly. That decision broug the system of licenses, varied from time to t still in vogue. We have often said hard w the monopolist company—as to its lack o prise, excessive charges, and bad servic really when we come to examine the shallying of various Governments the is that a company exists at all. Wha all this vacilliation result in but a greatl gerated purchase price when purchase i as it will be a few years hence. The value of shares will appreciate as th draws near, and although the Governme protest against the exorbitant price, they w to pay it; for sentiment and the Stock E will walk hand-in-hand, and against th bination any Government is powerless. very well to say two Governments have decided against arbitration, and to hint tha no circumstances will arbitration take place fairness to the company, nothing but arbitr possible if the two parties cannot agree. "W the innocent holders of shares know about wa will be the cry of the sentimentalists; or, Government stop the licenses in 1911 and co a keen competition, the outcry will be still A competing system carried out without pur absolutely impossible.

When one comes to consider the whole p Governments from the earliest telephonic ti

resent, it can hardly be gainsaid but it has a policy without backbone. Afraid, in the first ice, of touching the matter; afraid, subsely, of loss of revenue; afraid at two opportunio arbitrate, knowing that company or private etition was impossible, that the monopolist any was daily getting stronger and ger, spending more and more money, that ultimately the State must, in self-rvation, take over the system. We say, knowll this, and a good deal more of the same there has been pursued from first to last icy of procrastination, a policy Micawber-like, ig for something to turn up. Mr. Hanbury s that free licenses failed, admits that the nment offices have practically failed, admits nust fail as matters stand at present, but puts ith in a committee which is to determine iether a change in the law is not desirable, and iether if municipalities or others but the Post extend the telephone system, it will not damage ficial revenue. It seems very clear without l of the report of any committee that the best i is one under central control; but if the Post will not undertake what it is plainly their o do as a development and improvement upon it methods of telegraphy, there is no valid why municipalities should not undertake the Surely payment for use of an exchange tus could follow somewhat the same lines as nt of international postage, with a percentage on total receipts for trunk lines.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

GAS v. ELECTRICITY.

–My letter of the 29th ult. was not written in tion that you would publish the contents. The r and fairness of your paragraph in last issue of irnal encourages me to accept your offer to amplify ements. As regards cost of light from incandescent ompared with gas, I based my estimate on the s which have been published of the tests made by ece, which, by compounding curves of candle-power ciency, show that four watts per candle-hour is a is. Thus, 1,000 watts ÷ 4 equals 250 candle-hours t. Edinburgh gas gives a light of five candles per ot. Hence, $\frac{1,000 \times 5}{250}$ equals 20 Board of Trade units; ubic feet of gas cost 36d.; 20 Board of Trade units costs 70d.

r anticipate a common objection that a light of five per foot is not generally obtained, but that is the f the consumers; if good governor burners are ich as are manufactured by a local firm—a light s 28 candles can be obtained from five cubic feet of gh gas. On the night of my lecture the hall was by 12 Welsbach lamps, each fitted with governors 3ft. of gas per hour, so that the total volume conwas at the rate of 36ft. per hour. On a moderate s each foot of gas would yield a light of 15 candles, total of 540 c.p. per 36ft. The hall is genelighted by 24 16-c.p. incandescent lamps, which, g full efficiency, only amounts to 384 c.p. If ce is made for the superior light of the gas me of which would have yielded more light than incandescent lamps, the comparative cost would be: d. per hour, as against $5\frac{1}{4}$d. for electric light. My s for common burners is borne out by actual cost. The last annual gas bill for the hall amounted to £25, whereas electric light costs £51 per annum. The cost of installation amounted to over £100. We may, therefore, add for interest and depreciation £5 per annum. The chairman of the Electric Lighting Committee, who was present, attributed the great cost of the electric light to its lavish use. Such is not the case; the greatest economy is exercised. In referring to street-lighting, you state I allow no value for "additional light." My object was solely to state the increase of cost to the ratepayers by the use of arc lamps. If other districts of the town were to insist on a fair share of electric lighting, the additional cost would probably be not less than £20,000 per annum. When the lavish expenditure for electric light is compared with the stingy spirit displayed towards gas lighting, one is tempted to think that it is not done altogether in the interests of better illumination, else why not increase the present beggarly quantity of gas—2ft. per lamp—to 3ft., or even 4ft. per hour; the present light could be doubled at a very small cost compared with electric light. Electricians may justly claim that for certain positions electric light is the proper illuminant, but too much is claimed for it—for instance, why describe arc lamps as 2,000 c.p. when it is well known they are considerably less than half that value? Lack of time prevents me including anything about electricity as a source of heat or power at present.—Yours, etc.,

G. K. Grieve.

[We do not think after this Mr. Grieve can complain much about electrical journals boosting up the electric light. What he would say if he found that 12 Welsbach lamps did not on the average give more than 25 c.p. each, and that they usually take more than three cubic feet each, we do not know.—Ed. *E. E.*]

THE TELEPHONE QUESTION.

Sir,—It is important that at the present juncture the public should realise how completely the estimates prepared for the proposed Glasgow municipal telephone exchange have been justified by the Post Office. In last Friday's debate in the House of Commons Mr. Hanbury said: "Without entering into any minute calculations as to the actual value of the National Telephone Company's plant, while he believed the capital stood at something like £6,000,000, the Post Office calculation was that the plant could be entirely replaced at a cost of very little over £2,000,000." In the "Electrical Trades Directory" for 1898 the National Telephone Company returns the number of its lines in 1897 as 106,188. Divided into £2,000,000, this number gives an average value per line of £18. 6s. 8d. The estimates prepared by me for the Glasgow Corporation, and confirmed by eminent experts (5,200 lines for £97,833), worked out at £18. 6s. 3d. per line, a difference of only 5d. per line.

I have just had access to returns made by the German Government showing the capital cost of the lines at its principal telephone exchanges. The figures are:

Town.	Number of instruments at work.	Capital cost per line.
Berlin	28,785	£22 0 0
Hamburg	13,561	23 0 0
Leipsig	5,289	19 2 0
Frankfort-on-Main	5,053	22 18 0
Cologne	4,701	19 12 0

This return, besides confirming my estimate, effectually disposes of the oft-repeated fallacy, that large telephone exchanges are necessarily relatively very much more costly than small ones.—Yours, etc.,
A. R. Bennett.

Whitehall Club, S.W., April 5, 1898.

RECENT SMASHES AT BRIGHTON.

Sir,—In last week's *Electrical Engineer*, appearing rather ominously on April 1, there appears an alarming report to the effect that Mr. Crompton distinctly stated in his speech at the Institution last Thursday evening that there have been recently a great many smashes at the Brighton electricity works, and implied that these were due to the use

of high-tension steam dynamos and to the breaking of steam-pipes. Perhaps it will be sufficient for me to say briefly (1) that there have been no smashes at Brighton recently or during the last seven years; (2) high-tension steam dynamos are not used at Brighton; (3) there are no steam-pipes in proximity to high-tension apparatus; (4) no breakage of steam-pipes has occurred.

From the above it is very evident that there is a "nigger" somewhere in the reported speech of Mr. Crompton, who is the very last person to intentionally mislead his audience.—Yours, etc., ARTHUR WRIGHT.

Brighton Electricity Works, April 5, 1898.

[The "nigger" in the report is the word "there."—ED. *E. E.*]

THE JURIDIC SIDE OF THE MUNICIPALISATION OF TRAMWAYS.

BY GEORGE BEYNON-HARRIS.

(*Concluded from page 403.*)

Hitherto we have been bound by the rigid restraint of inflexible law. It was not for us to concern ourselves with what ought to be, or with what might be, but only with what is; because from the very nature of the thesis absolute correctness was wholly indispensable; and without it the statements would have been as useless and unpractical as the vapourings of a platonist. In the following corollary, however, our duty is not so much to state a stern legal fact as to consider a pleasing economic theory. Let us then first endeavour, in as few words as possible, to make clear what "municipalisation" means.

It means the adoption by a municipal corporation, in respect of undertakings of a public nature, of a line of policy which shall increase to the utmost the benefits and conveniences, and diminish to the utmost the pains and disadvantages, which the public derive from the undertaking.

Assuming our proposition to be correct, it becomes the first duty of a corporation, in regard to the tramway undertaking which they intend to municipalise, to ascertain with absolute precision what their existing powers, as given them by law over the undertaking, really are; because it stands to reason that if a corporation's powers are already so great as to enable them by the full exercise of those powers to coerce the promoters or owners of a tramway into granting concessions to the public which shall be equal to what the public will get if the undertaking were worked by the corporation, there would not only be no necessity for municipalising the undertaking, but it would probably be unwise in a corporation to burden themselves with the proprietorship of it. Having then ascertained with exactitude their own existing powers, the corporation should next enquire to what extent these powers are already being exercised for the public benefit. If, after full and careful enquiry, it is found that the corporation are not exercising their protective powers to the full extent which the law allows, they should at once call into play whatever powers may be lying fallow in the statutes and the orders, so that the resources of law may be exhausted in defence of the public. These powers consist chiefly in their ability to enforce by-laws; to arrange stopping places; to regulate the services; to direct or alter the routes; to appoint passing places, crossings, sidings, junctions, doubling of lines, and other works; the fixing of fares; to ensure the good behaviour of the conductors, provisions as to passengers' luggage, the repair of the permanent way, etc.

Having then strained every fulcrum to a legitimate tension, and brought the undertaking into as perfect a state as the powers at their command will enable them to do, the corporation will then pause and consider whether it would be for the public benefit that the undertaking should be allowed to remain in its present state, or whether, with due and careful regard to its working expenses, they could still extract from the undertaking sterling and greater advantages to the public by acquiring the undertaking and working it themselves. If they consider that the maximum of public benefit can only be derived by this process of
taking over and working the undertaking as a prop
municipal concern, it would not only be a wise polic
it would be the duty of the corporation to so take i
and work it.

Beyond this, of course, the corporation cannot go.
must henceforth inaugurate and maintain a critic
wholly efficient administration of the undertakin
then, if the experiment (for experiment it will be)
a profit on an average balance-sheet over a given n
of years, the corporation would be entitled to say th
concern has been worked by them at a *pecuniary prof*

Now, for the purpose of an election cry, a pec
profit would be a sufficiently *ad captandum* argume
argument which might also appeal with unanswerabl
to an automatic official whose vision may be bound
the routine of his own circumscribed channel, who s
art and knows of no science in the harmonious c
local administration, and whose ambition culminates
increase of salary. But to the genuine, thoughtful s
of the real and true science of local governme
the man who sees in this noble system of decent
administration, in this splendid delegation of in
functions to the people, an indication more f
than anything else can ever be of imperial tru
confidence in the people, to such an one a mere pec
profit would for many reasons be not an unq
assurance of the success of a municipalised under
It is quite clear that a municipalised undertakin
show a substantial profit to the corporation ownin
working it, and at the same time, in consequence p
of supineness on the part of the corporation, enge
by the absence of competition and for other r
the method in which the undertaking is carri
may be such that the public derive far less fa
accommodation, and benefits from it than they
have done had it remained in the hands of
promoters. For instance, the cars may be unpunct
times unreliable, the passing places ill-arrange
fares high, the stopping places inconvenient
permanent way badly kept, and the lateral p
the streets correspondingly unsatisfactory, and
The mere fact, therefore, that the balance-sheet
municipalised tramway shows a pecuniary profit is
any means to be taken *in itself* as a satisfactory pr
indeed, as a proof at all of the success of the undert
Hence it were incorrect to call a municipalised
taking a success merely because it shows a pe
profit to the corporation; that only can be prop
called where the public have also benefited in the
of locomotion, the lowness of the fares, the excellenc
accommodation, the punctuality of the times, the ab
irritating delays, the provision for wet weather, the ab
crowding, the repair of the permanent way and of the
the morning and evening provision for the labouring
and the thousand and one incidentals which in aggr
militate against public convenience. When, therefo
corporation have made every improvement which, w
regard to other departments, the resources at their co
justify them in doing to increase to the utmost the b
and conveniences, and to diminish to the utmost th
and disadvantages which the public derive fr
tramway, the undertaking, well equipped, and in
working order, will then be before the public
experiment. At the end of a given number of ye
balance-sheet for that period will show the result
experiment. The balance-sheet may not—in all prob
it will not—show a pecuniary profit to the corporati
may—it probably will—show a pecuniary deficit,
the same way as a pecuniary profit must not alone b
to indicate the success of the experiment, so, equ
pecuniary deficit must not be taken to denote its
On the other hand, just as such an undertaking,
showing a pecuniary profit, may, nevertheless, be a
failure, so the undertaking, though showing a pe
deficit, may be an undoubted success; for it must b
in mind that the increased public conveniences a
diminished public pains and disadvantages may f
weigh any mere pecuniary deficiency on the workin

For example, if the corporation tramway fares
than they were under the old *régime*, and the tr

re in consequence a larger patronage, the times more iable, the accommodation superior, and the transit more peditious, the public are benefited, not only generally, pecuniarily also. Probably, too, pecuniarily even to a greater extent than they would be by any mere appropriation of a pecuniary profit to the augmentation of the rough or administrative fund of the corporation; because reduction of the rates which could happen in consequence of such a profit (even if the corporation were permitted by law to so appropriate it) would be inappreciable, r would such profit appreciably affect the fiscal operations the council in regard to the making of the rate.

Not only then is it quite clear that the public may rive far higher advantages, both general and pecuniary, m a municipalised tramway, notwithstanding that the rking may show a pecuniary deficit, but up to a certain int the higher the advantages derived by the general blic from the tramway, the greater the pecuniary deficit likely to be; because, to take a somewhat extreme illustion, if the corporation ran a free tramway, the pecuniary vantages to the public would undeniably be greater than otherwise could ever be, but the pecuniary deficit on the rking would in the nature of things be correspondingly at. Perhaps inthe not very remote future, when the great nding departments of a corporation shall have liquidated ir borrowed capital, when sinking funds shall in consence have ceased to swallow up the profits actually made, rates in aid shall be things of the past, the incidence of ng may be so manipulated as to admit of a free munilised tramway; but as we fear such an utopia has yet cely become the dream even of the most visionary of ocrats, we need not linger over the prospect just at ent, except to hazard the prophecy that in the platms of the future this plank will be found Our object his part of our statement is to clearly understand that ere pecuniary profit must not be taken as the sole and ailing test of the success of a municipalised tramway.

At the same time it would, of course, be an act of inistrative unwisdom to sacrifice the balance-sheet to very great extent to the personal convenience of the lic, for such a policy would not only react upon other lertakings of the corporation, but would also touch h inequitable stress the ratepayers who use the mway as distinguished from the large body who use tramways, and who are not ratepayers, and whose conience and advantages would, therefore, be purchased at expense of the ratepayers. Such a system, if pracd to any great extent, would be inimical with the sound nciples of a scientific municipal polity. The real effective ue of a municipalised tramway can only be disclosed by careful maintenance of a just equilibrium between the lic advantage on the one hand and a broad economic licy on the other—that is to say, the benefits accruing to public from a municipalised tramway should not be rchased at the expense and to the prejudice of other partments of the corporation, but should, as far as ssible, be fairly commensurate with, or certainly should t exceed to an inordinate extent, the legitimate working penses of the tramway undertaking.

To recur, therefore, let us suppose that the corporation, n full possession of and working the tramways, have by a wise administration of its operations succeeded in reaching the highest point of perfection with regard to the facilities nd advantages which it offers to the public, and suppose that though the satisfaction of the public is great, and the rporation themselves are satisfied that nothing more can be done by them for the public benefit—suppose, we say, that the balance-sheet shows a deficit, notwithstanding. What course is then open to the corporation? The corporation cannot clip the advantages which the public have ce tasted and become accustomed to. That would be a retrograde step, and unworthy of a great public body. It would, moreover, raise a public outcry, and some of the mways committee would in consequence probably fall the eclectic strife of November. What course is then en to the corporation? Their course is quite clear. ey must reduce their working expenses, but in h a manner that the existing public facilities shall in any way be diminished or impaired. It is cisely at this point that the fate of the municipalised tramway hangs in the balance. And all that can be said now is that the assured success or dismal failure of the undertaking wholly depends upon the policy to be adopted at this juncture. The committee are now standing at the cross-roads gazing with tremulous indecision upon the finger-post of destiny; and it is precisely at points like this that municipal reputations are made, for the capacity of every member is rudely and decisively challenged, and it is now that the capable man steps out from the crowd and points the way.

It is not within the province of our unpretentious statements to attempt to define the policy to be adopted at this crucial moment in the fate of the undertaking. That policy may, in all probability it would, assert itself in the adoption of a more economical form of traction, but it is no part of our plan, as indicated at the outset, to enquire into the comparative merits of the various methods of traction available. An extended, a precise enquiry, a critical collocation of the opinions of disinterested experts, and, above all, a broad and prescient comprehension of the scientific possibilities that are noiselessly but surely developing in the womb of the future will alone enable a corporation to vindicate the wisdom of municipalising their tramways.

THE PRESENT USES OF AND FUTURE PROSPECTS OF ELECTRICITY ON BOARD SHIP.*

BY E. GEORGE TIDD, A.M.I.C.E., ETC.

When first your secretary asked me to read you a paper, the present subject was proposed, and in order, as I thought, to make the matter easier, I gave a wide title to the paper, so as to give myself plenty to talk about, and called it "The Present Uses and Future Prospects of Electricity on Board Ship." Instead of simplifying my task, however, I have rendered it more difficult, as I find myself compelled to keep to a middle course, the time at my disposal preventing my entering to any extent into details, and, on the other hand, a mere outline of what is being done would not be of very much service or interest to you.

I am glad to say that at the present time electricity has come to be looked upon as a necessary part of a ship's equipment, and not, as was the case till very recently, a fad of the owners, and a machine which if it worked all right was all very well, but which if anything went wrong with it, the oil lamps would just have to be used for the rest of the voyage till the ship got back to port. In these remarks I do not, of course, mean to refer to the large mail boats, etc., which carried their own electrical engineer, but to the smaller boats, which would be fitted with 100 or so lights for the working of the ship, and lighting of limited passenger accommodation. It is quite the exception nowadays for any boat which carries passengers at all not to have its installation of electric light, and certainly a line not thus fitting their boats would stand a very poor chance of securing passengers. Even most of the modern cargo boats now being built are fitted with electric light. The special equipment and requirements of battleships will not be touched upon in the present paper, except in an indirect manner, as the subject opens such a wide field that time would not be available.

I cannot too strongly impress upon marine engineers the importance of gaining some slight knowledge, at all events, of electrical matters. A dynamo is one of the simplest machines to work; at the same time it must not be neglected, but must be most carefully looked after, although it need not have the constant attention that must be given to some other kinds of machinery. Year by year this becomes more important, as more is being done by means of electricity than formerly, and although the lighting still forms the chief duty that it has to perform, it is not now only the light for the comfort of officers and passengers, but it is the light in most cases that the ship is worked by; and it is therefore not only for the comfort but also for the safety of all concerned that there should be no breakdown with the electrical plant. Besides the lighting, there are several other uses that the electricity generated by the dynamo can be put to, and to which reference will be made further on: as, for instance, heating, cooking, disinfecting, ventilating, pumping, etc. These applications of electricity are not being so rapidly introduced as one would like to see, and the reason doubtless is that the original installations of electric light were not always the success that they should have been, and that engineers have got to distrust electricity for what they are pleased to term real work. Seeing, however, the work that is being done in all descriptions of trades by means of electric motors, the

* Paper read before the Glasgow Students' Association of the Institution of Civil Engineers, Jan. 10, 1898.

time cannot be very far off when one will see a great demand for them on board ship, and one certainly looks forward to see the day when electric wires will replace all the steam-pipes that at present hamper a deck for the use of winches, etc. In fitting up an electric installation on a boat sufficient consideration is not, as a rule, given to the question of providing adequate spare or duplicate plant. My opinion is that every boat that is used for passenger traffic, except, perhaps, some of the quite small ones, should be fitted with at least two sets of plant. By two sets of plant is not meant duplicate plant, but a very good proportion is to make each set capable of running about two-thirds *of the entire number of lamps.* In this way it is more than *likely that, except in exceptional* circumstances, or for short periods, one of the plants will do all the work required the other serving as a stand-by in case of accident. A fu advantage of this is that the one plant is most of the running at a much more efficient load than would have bee case if it had been capable of running the whole of the in the ship. I might say that, from my experience of large number of moderate-sized boats, I have found tha seldom that more than two-thirds of the lights are re alight at the same time. Even in the event of a break should they be required, it could always be arranged to cu the number to within the output of the dynamo. Of cou the large mail-boats more than two sets of plant are ge fitted—as a rule four sets, each capable of giving one-t

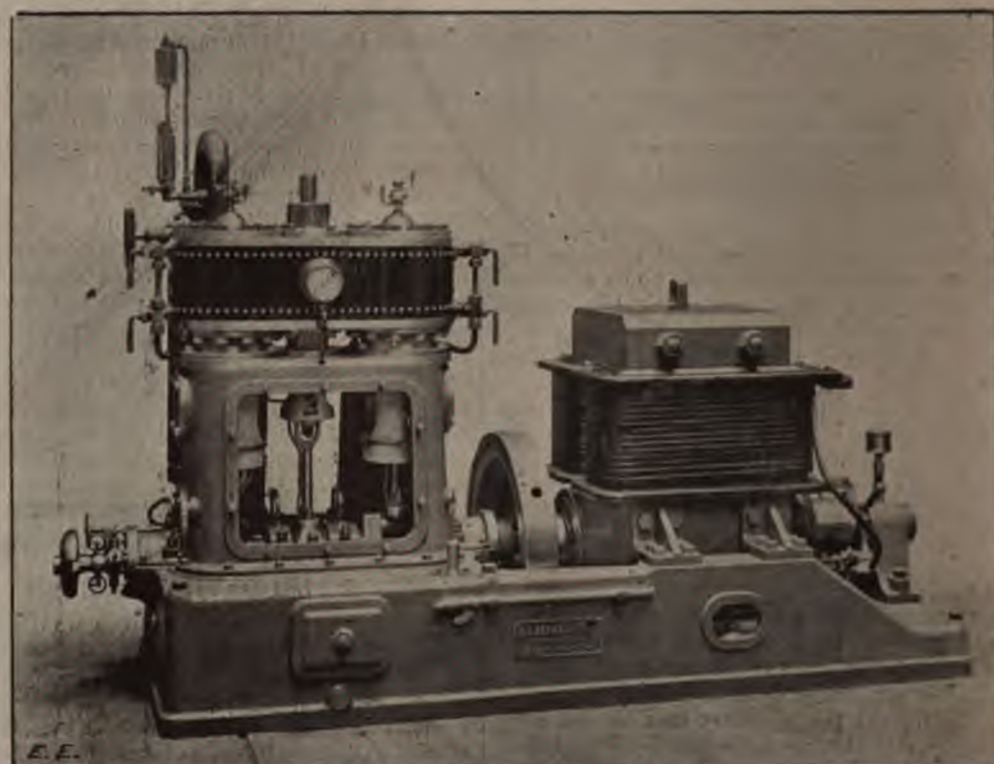

FIG. 1.—Belliss Enclosed Type Engine with Covers Removed.

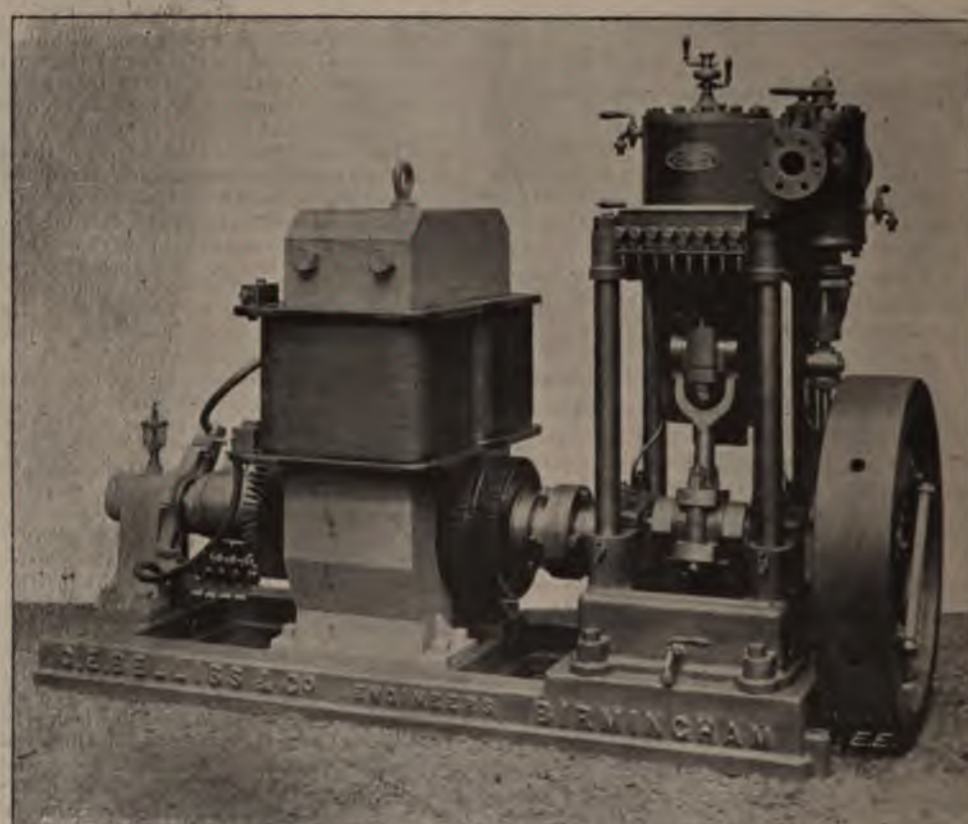

FIG. 2.—Single-Cylinder Open Engine of the Column Type coupled to Westminster Dynamo.

required output—thus when all the lights are in use leaving set as a stand-by. In this class of boat, seeing that such a proportion of the total number of lamps will be in the able pride in keeping his engine-room very spick-and-span, and if the electrical plant forms a component part of it, it comes in for its due share of attention. As regards the position of the

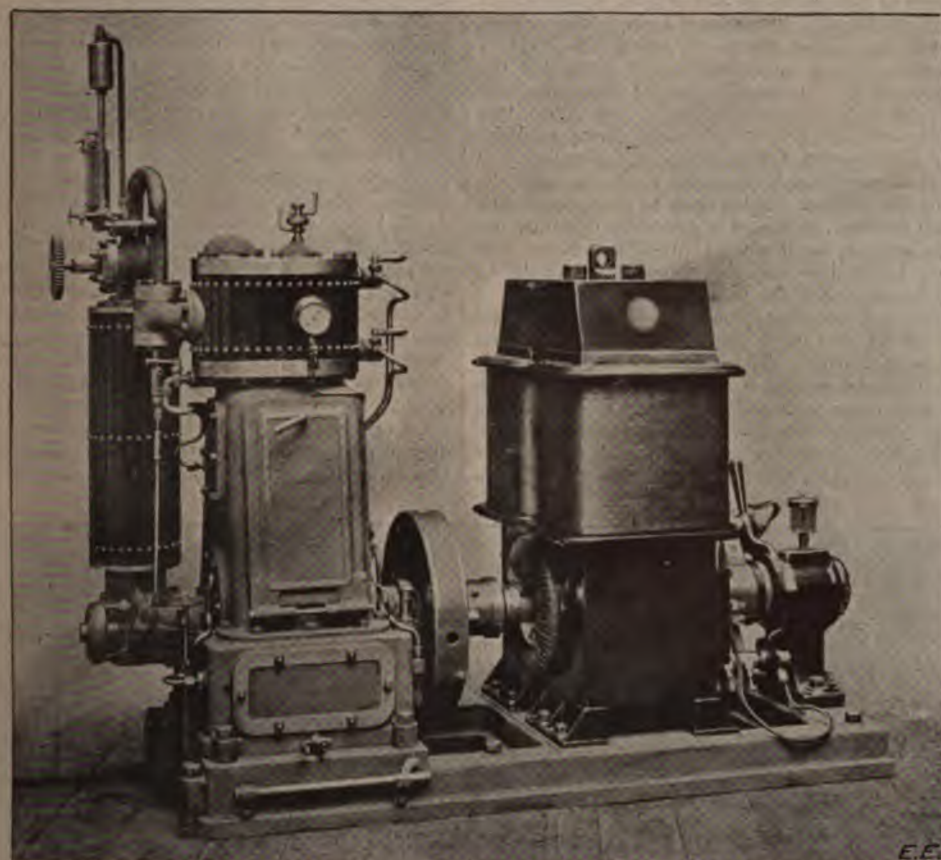

FIG. 3.—Belliss Single-Cylinder Enclosed Engine, with Throttle Governor, coupled to Mather and Platt Dynamo.

ngers' quarters, it is quite likely that practically the whole em may be required at the same time.

important consideration is the position of the plant on essel. On the large liners the plant is, as a rule, fitted eparate room to itself, but unless an electrician is carried, plant in the engine-room, the electrician generally has not much choice in the matter, or he would frequently not fix it in the position in which it is often to be found. Perhaps in boats carrying one or even two sets of plant, the most common position is on the bottom or starting platform in

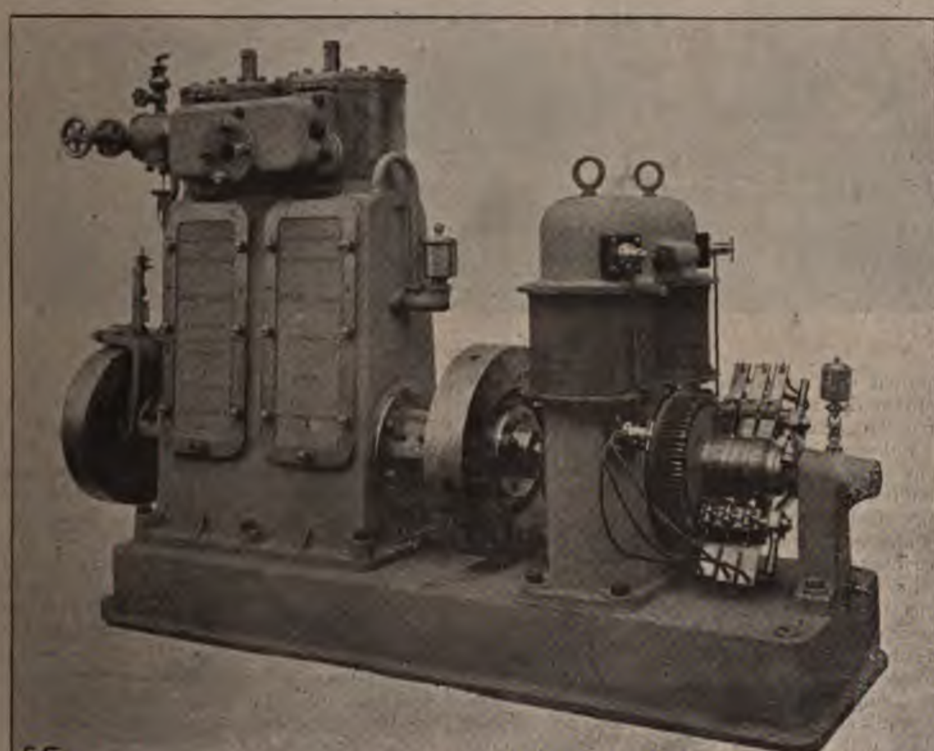

FIG. 4.—A Holmes-Chandler Combined Set.

here is a constant attendant to look after them, it is able to have the plant, if not right in the main engine- at all events in a recess off it, so that it is constantly under e of the chief engineer. A chief, as a rule, *takes consider-* front of the engine; this position has the advantage that it is right under the eye of the engineer on watch, and it will also, in a degree, experience less vibration down there than it would higher up; on the other hand, however, there is the serious disadvantage

that in the event of any accident happening to the ship, and the engine-room getting flooded, the chance of the safety of the passengers and the absence of panic might be greatly reduced owing to the failure of the light at the critical moment. A position that I very much like, and where I have had several plants fixed, is over the thrust recess on about the level of the middle platform; it is a fairly convenient place for the shipbuilder to arrange for, especially in the case of twin-screw steamers. As regards the position of the plant, this should always, unless absolutely impossible, be placed with the shaft fore and aft. The reason of this is that a boat rolls much more than she pitches, and by arranging the shaft fore and aft, it is not affected by the rolling. I also prefer to place the engine aft and the dynamo forward, as a boat is generally down by the stern to a certain extent, so if placed in this manner any dripping of oil or water has not the same tendency to be splashed over the dynamo as if the positions were reversed.

The Type of Plant.—Some few years ago we had several methods which could be and were employed for the electric lighting plant of a steamship. The plant could be (1) belt driven; (2) rope driven by several ropes; (3) rope driven by a continuous rope and cross-over pulley; (4) driven from the main engine shaft; (5) direct coupled on same crankshaft.

As regards the first three methods, they all had their advantages and disadvantages, some superintending engineers

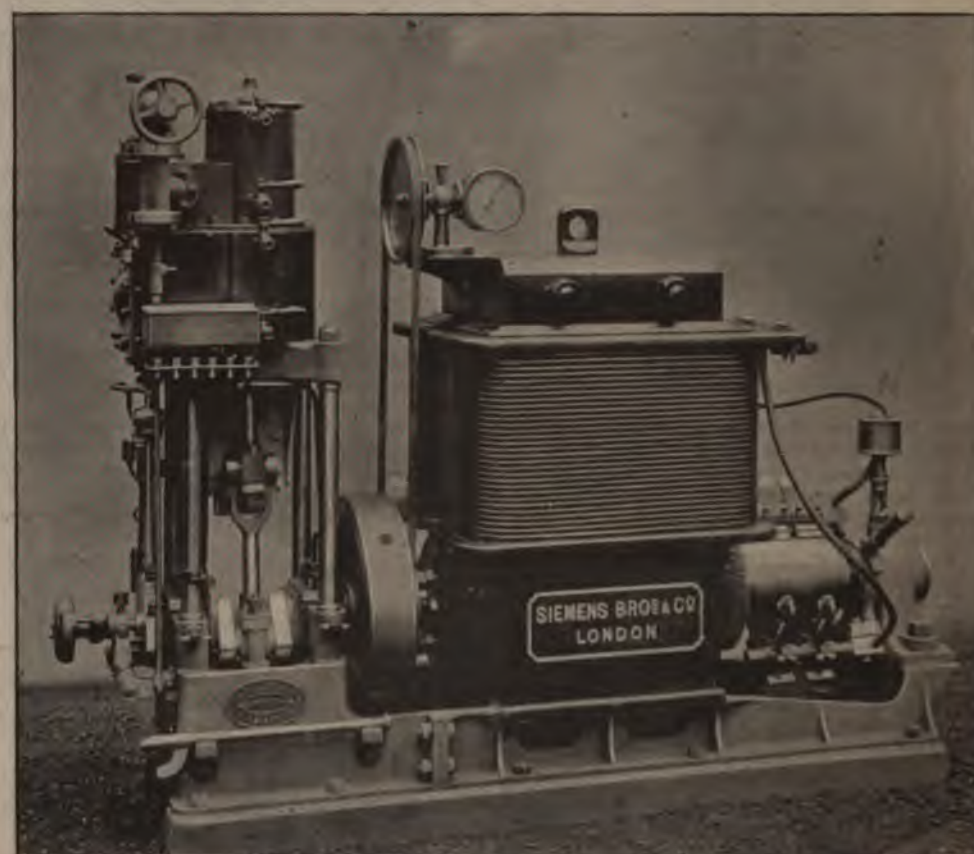

FIG. 5.—Torpedo Boat Set—Belliss Engine and Siemens Dynamo.

preferring one method and some another, but they all labour under the disadvantage due to there often being more or less moisture about an engine-room and so causing slip, belts and ropes to leave the pulleys with the roll of the ship, and so on. I have heard of one or two cases of the dynamo being driven from the main engine shaft, but this is of more historical interest than of practical value. At the present time direct-coupled plants are almost universally used for shiplighting, and certainly any superintending engineer in passing a new boat would admit no other kind.

A few words as to the types of engines most generally employed on board ship for electric lighting. Dividing the mercantile marine into the two classes of (1) large liners, and (2) small liners, coasters, tramps, and cargo boats generally, it will be found that the majority of the first class are fitted with two-cylinder, two-crank compound engines, while the majority of the second class will be found fitted with double-acting single-cylinder engines. Among the makes of compound double-acting open-type engines, it is somewhat difficult to say which are most generally used, but undoubtedly the following are very frequently found: Brotherhood, Belliss, Allen, Browett-Lindley, Paul, etc. (The author then showed a series of lantern slides of such coupled sets, of which Fig. 1 is a typical example.) *The makes of single-cylinder engines that are in general use are still larger, and to the firms already*

mentioned as makers of compound engines might be ad
names of Tangye, Robey, Clarke-Chapman, Ransome
and Jefferies, Marshall, Shanks, etc. (Figs. 2 and
examples of these single-cylinder engines.)

Although most of the engines that are now fitted for
light purposes are of the open type, the author must co
a great liking for the enclosed type, providing that it is
made as the open type, and that it introduces no compl
simply because dirt, etc., can be so much more readily k
of it and more efficient lubrication introduced. The
types of engines that have been on the market sufficien
to have become generally known are the Willans, Chand
Belliss. Messrs. Willans and Robinson's engine, alth
we all know, it is universally admitted to be one of t
beautifully designed high-speed engines in the world,
made a name for itself that few other engines can hope t
still has been far from a success when used on board
fact, the author believes that the Admiralty has now
ceased to use it owing to the trouble it gave, alth
one time they employed a large number. The reason of t
doubtless largely due to the fact that this engine require
care in looking after it, and marine engineers have not
same opportunity of mastering its various peculiarities a
charge of central-station plant, etc., generally have ha
Chandler engine (Fig. 4) has been very largely used f

lighting, both in its single-cylinder and double-cylind
and from all appearances with a considerable degree of
Although it is only a single-acting engine, as is the W
does not possess the same peculiarities of design as
Willans, and, further, owing to its extensive employm
driving fans, marine engineers had got to unders
The author, seeing that he is more or less connect
Messrs. Belliss's engine, does not wish to enlarge on th
made on its behalf, except to remark that the engines
are simply the ordinary Admiralty pattern of doubl
engine, with which every driver is accustomed,
with a special system of lubrication, and with shields
and front to keep out dirt from the working parts. O
the system of lubrication, these engines run as silentl
single-acting type, while having all the advantages
double-acting engine. There is still another class o
that, although not frequently, is sometimes used f
lighting, and that is the rotary engine of various kinds
years ago, an engine that had a good spell for a short
Tower's spherical engine, but not many are seen now. Th
is the Parsons steam-turbine, which is well known, and
by no means in general use, still, is often come acro
another steam-motor of this class is the Laval turbin
has recently been fitted on several steam-yachts, where
lightness and freedom from noise and vibration was im

re leaving the engines, it would be well to refer to the types rnors that are most generally to be found fitted to eleclants. There are, of course, the valve governer and the governor, but the former kind is seldom met with on hip, the chief reason doubtless being that it is absolutely ry to be able to adjust the speed of the engines while ;, and this can only be conveniently done by a throttle r. Two types of throttle governors are fitted, one of s driven by a belt from the main shaft, such as the well- Pickering, Acme, etc. The other type is driven direct ie crankshaft, such as fitted by Belliss, Brotherhood, , etc. The disadvantages of the belt-driven governors liability of the belt to slip owing to steam, moisture, d even the risk of its entirely breaking or coming off; ngineers to guard against this specify that two belts are tted. On the other hand, some of the governors that ren direct from the crankshaft through a train of levers ry much of their sensitiveness by friction due to the : of levers employed.

(*To be continued.*)

ELECTRIC CRANES.*

BY J. G. STATTER.

ringing this subject before you, I do so with the intention ting you to consider the question of lifting and transportds by means of electrical energy from first principles— to say, I do not propose to assume that an ordinary com- l motor is necessarily the best means to employ to convert al energy into mechanical work for this particular e. The requirements of a crane in respect to its supply rer differ very materially from the conditions of supply to ry machine tools or textile machinery; and it is worth ering whether a better form of converter can be devised he ordinary commercial electromotor. I am within the in stating that nine out of ten electrical or mechanical ers, when called upon to design an electric crane, start ith the assumption that any conveniently-shaped and iently-speeded direct-current motor will answer their e, and devote their attention to the arrangement of ;, or switches, or both.

Ravenshaw, in a valuable paper read at the Institution l Engineers on March 30 last stated: "The class of elecotor which is employed does not call for special descrip- Any good commercial machine can be used, the principal ty being that it should require little attention." He then i to enumerate a few desiderata, such as sparklessness rying loads, self-oiling bearings, and so forth. To adopt isfied mental attitude towards the electric crane reduces tter to one of mechanical design; to a question of girder iction, and the design of gears and clutches, or of gears itches if we reverse the motor. In my opinion, we have neans reached finality in the general scheme of electric and, as before stated, we are not at all under the same ons of working as when transmitting power for general ial purposes. An electric motor (which I will in future o as a motor) driving a machine tool, or any piece of machinery, is not usually being continually started and l; it is subject to a variable load, perhaps, but it is l to revolve for a considerable time without being stopped; refore the apparatus required for stopping and starting, not unimportant, is not of that paramount importance is in an electric crane where no clutches are employed. iway work offers a practical parallel to crane work, but not require its power so intermittently as a crane. The n of starting, stopping, and accelerating, and its converse, n fairly well solved in the case of tramway work by the specially well constructed switch-gear. The details of not concern us at present, except that it may be stated magnetic device for blowing out the spark is used, which is worth importing into the design of crane switch- The motors used for tramway work and the general of their connections are also worth attention. very excellent jib cranes for ship use have been nd provided with a couple of tramway-type switches, r the lifting motor and one for the slewing. An lectric crane lifting a load from rest should start motion slowly, accelerate it rapidly, and carry it for the portion of the lift at full speed, then slow the motion and stop. If the crane slews or traverses the same nst be gone through, and it is still more important that rting and stopping should be gradual to prevent surging d. In cranes as at present constructed this cycle is, lly speaking, only attained by that class of crane in a separate motor is provided for each movement, and the control is by switch-gear. I will call this type h-controlled cranes." In such cranes almost any form ing, if efficiently and well arranged, will answer the purpose, but worm-gear is the best from the handling point of view on account of the small amount of inertia of this class of gearing. Cranes which derive their movements from one motor do not fulfil the conditions of a steady start with a rapid acceleration so well, but very good results are nevertheless obtained with the one-motor crane, which I will describe as "clutch-controlled cranes" Perhaps the best results are given in this class by those employing open and crossed belts as transmitters. Friction gear also gives good results, and a particularly nice drive is given by a gearing which combines both belt and rolling contact transmission, and which has been brought out and used with considerable success by Messrs. Wimshurst and Hollick.

So far I have divided cranes into two types—first, switch-controlled, which includes cranes in which the motors are started, stopped, and reversed for each movement by switch-gear; second, clutch-controlled, which includes all those where the motor runs continuously, and is thrown into gear either by belting on fast and loose pulleys, or by any form of friction gear or clutch. I will now add a third type, which, as far as I am aware, is novel—it is a switchless clutchless type. As with the switch-controlled type, it has one motor to each movement, which motor is started, stopped, and reversed as required. The type can be constructed to work either with constant E.M.F. and variable current, or with constant current and variable E.M.F. The first variety of switchless crane has little commercial value. It is possible to conceive a few cases of small hoists to which the system might be applied with advantage, but, generally speaking, it may be regarded as an interesting toy. The regulation of the current is effected by always permitting relative movement to take place between armature and field magnet by the rotation of either the one or the other; it is, in fact, the equivalent of two motors, with their armatures arranged in series, and each of which is capable of absorbing the full E.M.F. of the supply circuit. With such an arrangement it is obvious that if we stop one of the armatures by main force the other will increase its speed and take up the full E.M.F., and will, if running light, permit so little current to flow through the armature that has been stopped, that it can be easily rotated in the direction opposite to that in which it was previously running. The author showed a small model of this type of crane arranged so that either the armature may revolve and do useful work by lifting a load, or the load may be stopped and the field magnets allowed to revolve in order to take up the E.M.F. and keep the current flowing through both armatures and field magnets down to a small value. In attempting to construct a useful crane of this type, one would use a multipolar field and a light large-diameter armature. If the latter were very highly constructed, and, say, about 2ft. in diameter by 6in. wide, and revolved within a light cast-steel multipolar field, the relative differences of mean diameter would be much less than in the model, and such an arrangement with a lifting barrel geared to the field magnets might in some cases answer a useful purpose. Armature and field magnet might also be designed to have the same diameter, and multiphase motors are applicable. This system, when worked with one motor, cannot be reversed, and can, therefore, only be used for a hoist in which the load overhauls the winding drum. It is, however, possible to arrange for reversal by coupling two motor armatures mechanically to a drum by means of differential gearing, and electrically in series and arranged to run in opposite directions. The effect of such a combination is this: When the drum is at rest each armature runs light and absorbs half the total E.M.F. of the supply circuit; if we apply a brake to No. 1 armature No. 2 takes charge, accelerates as the other is retarded, and finally reaches practically twice its former speed. The drum is then revolving. If we wish to reverse the drum we let No. 1 armature go and apply a brake to No. 2, the speed of the drum falls, and when the two armatures are revolving at the same speed it stops and then commences to revolve in the opposite direction and reaches full speed when No. 2 armature has been brought to rest. The graduation of the speed and the complete control of the drum is excellent; but the plant efficiency is bad, and therefore commercial applications of this system are not likely to be extensive.

I will pass on to the practical form of switchless crane, viz.: that in which the motors are fed by a constant current. Messrs. Chamberlain and Hookham, Limited, completed early in 1897 a 10-ton travelling crane upon this system. This crane has since then been in successful operation in a steel foundry. It is the first of its kind, and is in consequence by no means mechanically or electrically perfect. In point of handling it is, however, superior to any crane that the writer has yet seen, and the practical experience gained demonstrates fully that no trouble is experienced by sparking at the commutator. I make the above proviso as to imperfections to disarm criticism in respect to details which I myself consider leave much to be desired. The crane has a span of 30ft.; the crab is carried by two built up fish-bellied girders of steel, supported by end carriages built of deep channel sections plated over. The three motions are derived from three independent motors, all directly geared, and

* tract of paper read before the Northern Society of Elecngineers.

started, stopped, and reversed as required. These motors are standard open-type constant-current motors, of which Messrs. Chamberlain and Hookham, Limited, possessed the patterns at the time of taking the contract. Enclosed motors would, of course, be employed for further cranes. With respect to gearing, all three motors are geared alike with a worm and wormwheel, and afterwards with one further reduction by spur gear. With this arrangement the wormwheel can be driven a fairly good pace, and in the case of the lifting motor it is doubly threaded, a combination which gives a very fair efficiency.

The control of the motors is effected merely by altering the position of the brushes on the commutator. All motors are worked by chains from below, since it would be impossible for a man to live, if perched up near the girders, owing to heat and fumes. With the brushes at right angles to a line drawn midway between the polar gaps, there is no tendency in the motors' armature to rotate either way, the effect of one-half of the turns upon it exactly balancing the effect of the other half. In order to obtain a movement, the brushes are displaced by a pull upon a chain passing over a chain wheel, which forms the brush rocker. With the two traversing motors a displacement of about one-third the maximum is sufficient to cause either motor to rotate and traverse the crane, showing that these motors are very much over their work, and can produce a sufficient twisting movement even when a part of the winding on the armature is neutralised. With the lifting motor readiness to revolve depends upon the load to be lifted; the size of this motor should be such that it will just accelerate with full load. This effectually protects the crane against over-load. In order to reduce the E.M.F. required to circulate the current when all motors are at rest, and also to make them stop quickly, a short-circuiting device is employed, which acts when the brushes are at the position corresponding to that of rest of armature. The same cam also gives a determined position for the chain wheel corresponding to rest, and informs the attendant that the motor is standing. The action of this short-circuited armature coming to rest in an excited field gives all the brake power needed and renders the brakes unnecessary.

The author then proceeded to describe in detail the more general types of electric cranes under the two following heads: Clutch-controlled cranes, and cranes partly clutch-controlled and partly switch-controlled.

Illustrations of various examples of these were given by the aid of lantern slides.

THE TELEPHONE QUESTION IN PARLIAMENT.

On Friday last, April 1, a considerable amount of time was given to the telephone question in the House of Commons. We are indebted to the *Times* for the following report, which we have, however, been compelled to condense very much from that appearing in their issue of the 2nd inst.

Mr. Caldwell opened the debate by calling attention to the position of the Post Office with regard to telephone licenses, and moved: "That the continued refusal of the Post Office to grant licenses to and allow municipal corporations and other responsible bodies to compete with the National Telephone Company is contrary to the Treasury minute of May 23, 1892; is inconsistent with the letter and spirit of the agreement entered into with the telephone companies when the Post Office took over the trunk lines; and is calculated to prevent the establishment of a cheap, adequate, and efficient telephone service in the United Kingdom of Great Britain and Ireland, and to increase the difficulties and costliness of any arrangement for the assumption by the State of the whole telephone systems should that step ultimately be considered desirable." The subject, he said, was one of national and local interest and importance, and one outside of party politics. He reminded the House that the Post Office granted a license to the United Telephone Company authorising them to erect and work telephone exchanges in London within a radius of five miles from a central point to be fixed by the company, the royalty charged in all cases being 10 per cent. of the gross earnings. The United Telephone Company confined its own exchange operations to London, but it allowed its apparatus to be used in other parts of the country by subsidiary companies. These subsidiary companies were left to negotiate with the Post Office for a license. The licenses granted were all made to expire on Dec. 31, 1911. At the date named, therefore, all telephone licenses would lapse, and the State would then be free to assume the sole right of working the telephones. After referring to the way the monopoly of the United Telephone Company had come into existence, the speaker proceeded to argue that competitive exchanges were the best means of counteracting this monopoly. He then complained of the way Glasgow's application for a license had been refused.

Mr. Griffith Boscawen seconded the motion. He said he was animated by no hostile feelings to the National Telephone

Company; he admitted that that great corporation had
instances given satisfaction, although in other instance
not. His quarrel was not so much with the National T
Company, which would scarcely be human if it did n
use of its monopoly, as with the Post Office, who all
monopoly to grow up. He thought it would be well i
were passed to enable all corporations to establish t
services without having to come to Parliament for pow
any rate, if the Government allowed competition to s
in some form or another, their action would be most a
to a great part of the inhabitants of the country.

Mr. Faithfull Begg rose to move as an amendmen
motion to leave out all after the first word "the" in
order to add "acquisition by the State of the whole t
system of the country is the only solution of the d
which exist and are increasing under the present s
licenses." The confusion arising from having different
in a town was terrible. Bad as he admitted the s
London to be, the confusion would be worse confounde
had numerous systems growing up in the Metropolis
purchase, he was convinced, presented the true reme
that means the whole telephone system of the count
be consolidated and developed on definite and clear lin

Mr. Lough hoped no such course would be adopted as th
mended by the hon. gentleman. His arguments against
licenses to different municipalities were of a slight an
trivial character. On all grounds he held that the gr
licenses to municipalities was the most excellent
Government could adopt.

Mr. Pickersgill, in dealing with the cost of insta
telephone service, drew attention to the evidence given
Bennett before the enquiry held in Glasgow. The Po
Department had been guilty of a gross deception on
poration of the City of London. The Corporation de
give the company the use of its streets without receivi
quid pro quo. The company sent in its application thr
Post Office unknown to the Corporation. Last year,
on the subject, the Secretary to the Treasury decla
where the telephone service was shown to be inefficient
costly the Government would step in and remedy th
either by the Post Office providing a service or giving
authority a license to do so. He hoped the right hon
man would speak as decisively this year as he did last
contended that as a result of the Glasgow enquiry he w
by his statement of last year to provide a rival telephon
for that city by giving the Corporation a license to su
necessary communication.

Mr. Hanbury said the amendment before the Hou
that certain municipalities should be allowed to e
competition with existing licenses of the Governmen
same area. At first sight that might seem a rathe
suggestion, especially when it had to be borne in m
regard to the telephone business generally that there w
difficulties with reference to competing companies in
area. He thought, therefore, the first question w
House should ask was whether it was fair that the
allow competition to take place; and in the next pl
was fair whether the municipalities of the country were
form of competition. In the early days of telephones, w
was known about them—in 1880 they had only been
about four years—the Postmaster-General of that da
arrive at a decision as to the course that the Go
should take with regard to the new system. Mr. Fa
those days decided that the telephone service should b
on by the Government. If that had been done, it mi
been the best solution of the difficulty. However, the T
rightly or wrongly, ruled otherwise. It imposed on the
of the telephones by the Post Office certain conditio
he admitted did make the competition and workin
Post Office very difficult. The result was that Mr.
finding that the Post Office could not work the te
efficiently as a Government monopoly, instead of
local licenses, which he had done up to about 1884,
the companies to definite areas, instituted a system of
free competition. He announced in August, 1884,
would grant licenses freely to every company that ap
him, and licenses which would extend all over the
so that any company would be at liberty to set up e
in any portion of the country. His idea was tha
monopoly could not be in the hands of the Governm
would take steps as seemed to him best to prevent a m
falling into the hands of any private company. T
showed that Mr. Fawcett made a grave miscalculat
the first place, he omitted to recollect that in those
company, the United Telephone Company, had a great a
because it owned patents, and it was not possible for co
generally to get patents except under the rules and regul
the United Telephone Company; but the small compan
soon bought up, so that a series of companies came u
entire control of that company. Some of these comp
become somewhat strong competitors of the mother c
and in 1889 the United Telephone Company bought

Lancashire and Cheshire Company and the National Company, and they were amalgamated in the National Telephone Company, which now worked the telephones. In 1891 the patents expired, and it then became possible for other companies to come into competition totally independent of the mother company. Two new companies were started, the Mutual Company and the New Company. The New Company soon bought up the Mutual, and that brought the New Company and the National Company face to face. The Treasury minute of 1892 was drawn up with the distinct recognition of competition as against monopoly. Very soon after the issue of the Treasury minute a very vigorous flirtation took place between the two companies, and they were all but amalgamated before the agreement was formally signed. Therefore Mr. Fawcett's anticipations were entirely falsified, and the very means he took to promote free trade in competition resulted in an actual monopoly. Now that one company had swallowed up all the other companies they had a very remarkable state of things. They had not only a monopoly, but one which was not under strict control or under stringent regulations. Their railway, water, gas, and electric lighting companies were all placed by Parliament under very strict limitations with regard to their capital, dividends, rates, and, especially, preferences, and on all these points this Telephone Company was absolutely unfettered. He thought that that was a strange state of things. Without entering into any minute calculations as to the actual value of the plant of the company, while he believed its capital stood at a value of something like £5,000,000, the Post Office calculation was that the plant could be entirely replaced at a cost of very little over £2,000,000. Then there was a further point which had resulted from the want of competition. When he looked at the little competition there had been he could not blame the company for its defects. He was rather astonished that its service was as good as it was. He wanted to recognise that in a good many parts of the country they were giving a service about which there was no great complaint; but at the same time in several large and important towns, even in the Metropolis itself, and in Glasgow and other Scotch towns, there had been complaint made of the inefficient service; and in the case of Glasgow the complaint had been proved to be true by the Government Commissioner, and with regard to London, Mr. Forbes himself had admitted the charge to a great extent. He did not want to go into minute details as to the number of subscribers compared with the population in the various exchanges, and to compare the service with that of foreign countries, but it was most important that this country should not be behind other countries, and it was no doubt the fact that at the present moment the number of subscribers in London did not compare favourably with the number in Berlin and Paris and in some of the smaller Scandinavian towns. There was also the fact to be remembered that the service was now confined to the more populous parts of the country, and that very little had been done in the country districts, and that even in the populous towns, after all, the service was rather one for the rich merchant classes than for the smaller tradesmen, who could not bear the heavy subscription in order to get the benefit of the service. He did not blame the company for this. They had only taken advantage of the grave error committed by the Post Office in 1883. Now they had to accept the facts as they were and to try to make the best of a bad bargain. The figures he had already given showed that they would make a very bad bargain if they purchased the company at anything like the present market value. Although both in 1890 and 1897 it was possible for the Government to give notice to purchase by arbitration, two Governments in succession had decided not to exercise their option. It was not likely that they would put themselves into the hands of arbitrators, who were never very favourable to governments and municipalities, and run the risk of having to pay such an enormous sum with probably 10 per cent. added. It had also been definitely decided that these licenses would not be extended beyond the year 1911. The Select Committee which sat in 1892 said in their report that they were perfectly willing to leave everything else to the Government, but that they must make some strong recommendation that the licenses should not extend beyond 1911. That being so, the Government had undoubtedly to face this difficulty. The National Telephone Company was in possession of the field at the present moment. It was extending very rapidly and, he did not hesitate to say, becoming more formidable every year. If it was known that the licenses would expire in 1911, and if the Government of that day did not agree to purchase, by notice or arbitration, the plant of the company, its assets generally, it might be, its goodwill, and even the wayleaves the Government had conceded to it, it was possible that the company, seeing that there were only a few years to run, might take the opportunity of trying to put the Post Office and the Treasury in a difficulty—he did not say unfairly. The danger, therefore, to be guarded against was this. He could not suppose that anybody would buy by arbitration in 1911, and even if a bargain was come to in 1904, the company would still have control for seven years. But possibly the company would not agree to a bargain, and unless the Government had started themselves very early, with an entirely new plant of their own, the company would be unwilling to sell to them, and raise their rates, with the result that there would be such an outcry in the country that the Government might have to buy out the company at its own price. This was one of those contingencies which the Post Office and Government must keep in view. This evil, however, might be avoided to a limited extent by competition. Of course, it would be grossly unfair to do anything which in any degree trenched on the agreement with the company. The Government were bound to stand by the agreement, but it was distinctly reserved in that agreement, and had been admitted—distinctly admitted—by the chairman of the company before the Select Committee, that not only were the Government entirely free to start in competition when they liked as against the company, but neither in honour nor in faith were they bound to take any other course. They were, therefore, absolutely free to enter into competition. Then came the question, What was the best form of competition? He did not believe that competition by companies would be by any means the proper course. Companies got bought up, and the company that bought them up had to charge higher rates in order to cover the cost, and he could not believe that any company would be able during the short period the licenses would run to realise a sufficient surplus of income to pay both interest and redemption of capital. Then as to competition by the Post Office. He perfectly admitted that some of the criticisms passed on the working of Post Office exchanges were to a certain extent just. They had not been worked hitherto as vigorously as he thought they ought to have been. It was a perfect absurdity that the company should have been allowed to invade the Post Office area; but that had been done, and the Post Office was committed to that arrangement and had to make the best of it. He thought that the reason why the Post Office had not competed, even in its own exchanges, was partly the idea that it ought to work harmoniously with the company. With regard to the greater portion of the area of the country be perfectly admitted it was necessary to work in amicable relations with the company. They were perfectly entitled to do their best to see that those exchanges were worked in active competition with the company. Two things had hitherto militated against their doing so. Those Treasury regulations which were framed in 1882, and which caused Mr. Fawcett to throw the whole of this valuable service to open competition, he was sorry to say was still in existence, but they proposed to abolish them; they proposed to enable the Post Office to try and canvass for work in just the same way as any private company. He was afraid that even when they had done that there was a difficulty which militated against the success of the Post Office exchanges even more than the Treasury regulations. He had said already that the National Telephone Company had got certain unrestricted privileges which, so far as he knew, were enjoyed by no other monopoly. It had got the privilege of granting preferences to particular subscribers, and by means of giving free wires or reduced rates to large firms who would bring them a large amount of business, they did what the Post Office exchanges naturally could not do, because they could not give preferences. It had thus been able to drive the Post Office altogether out of an exchange, or to make its business less profitable than it might be. Of course, this was a privilege which they could not take from them, and the company probably would exercise that right of preferences in competition with the Post Office or anybody else who might be brought against them. If that was the case he did not think it quite fair that the Post Office should not on its side use its privileges, and if the company was to compete, as he thought unfairly, in these exchanges with the Post Office, it must not in future expect from the Post Office a great number of privileges which the Post Office outside its bargain and agreement had hitherto given. They must insist on having a fair competition in the exchanges. A promise had been given over and over again by various Postmasters-General in that House, and he had repeated that promise only last session, that if in any case where there was a dear or unreasonable service and no competition it would be the duty of the Post Office itself, if necessary, to enter the field and extend the exchange. There was the less objection to their doing so, because although the Post Office might be blamed for not having worked its exchanges as vigorously as it might have done, still in spite of all the difficulties—and the question of preferences was a serious one—the Post Office exchanges had paid the Post Office a very large interest on the money expended. Therefore from a financial point of view there was very little reason why the Post Office should not where necessary extend its exchanges, and if it did so of course it would be gradually preparing for the day when the whole of the telephone system would fall into its hands. Then they came to another class of competition which had hitherto not been dealt with. Until at any rate 1892 the municipalities were about the only bodies who could not well enter into telephonic competition with the company, because of the general licenses granted all over the country, including the right to work the trunk lines. The municipalities were the only bodies whose action must necessarily be confined to their own areas, and they

were therefore shut out from competition. Now they had this motion submitted to the House that the municipalities should be allowed to enter into competition, and from some points of view there was a good deal to be said for the municipalities. The municipalities or local authorities were perfectly willing, as he understood, to undertake licenses and to work them on condition that in 1911 they absolutely surrendered those licenses to the Government. That was one argument undoubtedly in in favour of the local authorities. Another argument was that they certainly would not be bought up as a company might be, and in addition they had wayleaves and would be able therefore to lay an efficient underground service. Municipalities argued also that, while they were willing to allow their streets to be taken up for their own exchanges, they did not wish those streets to be at the mercy of any private company. He thought there was a great deal of justice in that contention. Under the Treasury minute of 1892 the municipalities had an absolute control over any new companies, and no new company could work within the area of any local authority unless it got the permission of that local authority. Therefore, if they were not going to allow the municipalities to compete he did not quite see what chance of competition there was from other sources. On the other hand, there were serious difficulties involving questions of policy which Parliament itself ought to decide. Even if they were to grant a license to the Glasgow Corporation, for instance, although Glasgow had got a common fund, differing in that respect from the English corporations, it would not be able to exercise that license, and there would be no use therefore in doing so. There were two questions of policy to be considered in granting licenses to municipalities. Hitherto undoubtedly the telephone in England was more or less a luxury of the rich, although it was not confined to the richer classes in other countries. That was at any rate one question which the Select Committee which they proposed to appoint would have to decide—whether a telephone service was a matter of such general benefit to the community living within the area of a municipality or local authority as to justify the local authority in using public funds for the purpose of undertaking telephone work within the area. That was a question which a department ought not to decide, and which ought to be left to Parliament. There was this further peculiarity with regard to the telephone service, that there must be, even with regard to large municipalities, areas outside which it would be for the public convenience to include in the area of the municipal exchange. He was bound to say that by some means or other certain areas had already been assigned to the National Telephone Company, which even the largest municipality could not possibly embrace within its operations. The area of the exchange of London, he was told, had 750 square miles—an area a great deal larger than even the London County Council could possibly attempt to work. He should have thought with regard to a large body like that, that if a license were granted to it, it ought to be contented with its own area. What they proposed was to appoint a Special Committee of that House which should confine itself to these two legal points: whether any change in the law should take place which would, by the removal of restrictions, make it possible for a municipality to engage in such an undertaking, and how far this extension of the telephone system in the hands of persons other than the Post Office was likely to damage their revenue. That was a subject which the Treasury had gone very carefully into with the Post Office, and undoubtedly a great deal of the danger of our telegraph revenue diminishing was removed when the Government bought the trunk wires. There was a feeling now at the Post Office, for which he thought there was some justification, that if a telephone service was properly worked in close communication with the Post Office so far from damaging the telephone service it might actually assist it. They were bound to treat the company with fairness; they were bound also to consider the telegraph revenue. He did not think either of those considerations would suffer under the suggestions he had made. They had, also, however, to consider that this was a new agency of communication which other countries had availed themselves of to a much greater extent than this country had, and that it was a means of communication which need not necessarily be limited, as it was in England, to the richer classes, but which might become of very much service to small traders. Although we were at the present moment somewhat behind other nations in this respect, he thought it was incumbent upon us in the face of the keen commercial competition existing to see that in regard to this new and important means of communication this country did not fall behind other countries.

Sir C. CAMERON said the speech of the right hon. gentleman showed the advantage of having in the House of Commons a gentleman representing both the Treasury and the Post Office. He was sorry the right hon gentleman was so strongly opposed to the granting of licenses to companies, for he was aware that there were some companies which desired to take out licenses, even though they would lose those licenses in 1911; but he was sure the new policy announced by the right hon. gentleman would, on the whole, be greeted with great satisfaction in the country.

LEGAL INTELLIGENCE.

HODGES AND TODD v. WATSON AND ANOTHE

This was an action before Mr. Justice Wright in the Q
Bench brought by Messrs. Hodges and Todd, electrical eng
against Mr. Watson, of Sheffield, and Mr. Robert Hodson, a
receivers and managers for the debenture shareholders in M
Priestman Bros , of Hull, for damages for breach of cont
the supplying of an oil-engine.

Plaintiffs alleged that the engine was purchased for t
produce electrical power in an installation of electric light
country house of Mr. Combes, the well-known brewer. Pl
also said the engine worked unsatisfactorily, and that by
to purchase another they had been put to the expense of £
The question really involved was one of damages, as defe
had offered to take back the engine and return the money p
it. Taking this into consideration, his **Lordship** awarded p
£50 damages, but there should be no costs.

COMPANIES' MEETINGS AND REPORT

BRITISH ELECTRIC TRACTION COMPANY, LIMIT

Directors: Sir Charles Rivers Wilson, G.C.M.G., C.B., cha
the Right Hon. the Earl of Suffolk and Berkshire; th
Sir Charles William Fremantle, K.C.B.; John Smith R
M.I.C.E ; Emile Garcke, M.I.E.E., managing director. Sec
Charles Walmsley.

Report of the directors (with abstract of accounts) prese
the shareholders at the second ordinary general meeting
Company, held at Donington House, Norfolk-street, Strand,
on April 7, 1898, at 1 p.m.:

The Company was registered in October, 1896, and 20,00
30,000 ordinary shares offered for subscription were allotted
subsequent issue of the remaining 10,000 ordinary shares pr
a net premium, after payment of expenses, of £1,218. 15s.,
amount has been applied in reduction of preliminary e
account. Since the closing of the books, an issue has bee
of 10,000 6 per cent. cumulative preference shares of £10 e
a premium of £2. 10s. per share. The proceeds of this is
be brought into the next account. The gross profits am
£14,422. 14s. 9d., and, after deducting the proportion of
expenses chargeable to revenue, and also the expenses inc
connection with schemes not proceeded with, there remain
profit of £9,804. 9s. 6d., which the directors propose sh
carried forward to next account. Arrangements for the a
of electric traction at the following, among other places
various stages of progress: Coatbridge and Airdrie; Cork;
Dudley, Stourbridge, and district; Gateshead-on-Tyne;
pool; Lake District; Kinver; North Shields, Tynemou
district; North Staffordshire; Oldham, Ashton, and
Kidderminster and Stourport; Middleton and district;
and district; Potteries District; South Staffordshire; S
Wolverhampton and district. Provisional arrangement
also been made, and negotiations are pending, in rega
number of other places; but it would be premat
inexpedient, to refer to them in this report. In
the above cases, agreements have been made for the p
or leasing, of existing tramway undertakings, while fo
undertakings, parliamentary powers, or orders under th
Railways Act, have been secured or applied for. I
instances the Company has acquired the majority of the s
existing tramway companies, and controls the business
companies with a view to the adoption by them of
traction. In a few cases the arrangements have been
co-operation with other parties. With regard to South S
shire, the existing electric tramways are being worked
Company, and are a source of income. Contracts ha
placed with responsible parties for the work of construct
electrical equipment at Dudley-Stourbridge, Hartlepool,
minster and Stourport, North Staffordshire, Oldham, Asht
Hyde, and Potteries, and the work is being proceeded wit
directors who retire this year are Sir C. Rivers Wilson, G.
C B., and the Hon. Sir Chas. W. Fremantle, K.C.B., and
eligible for re election. Under the powers of the ar
association, the directors have appointed Mr. Fred W.
C.A., to audit the accounts for the first year. He also reti
is eligible for re-election.

BALANCE-SHEET, DEC. 31, 1897.

Liabilities.	£
Capital—30,000 6 per cent. cumulative preference shares of £10 each, and 30,000 ordinary shares of £10 each	600,0
Issued: 30,000 ordinary shares of £10 each, fully paid	300,0
Less calls in arrear	(
	299,9
Sundry creditors	6,0
Amount owing to British Electric Traction (Pioneer) Company, Limited, in respect of the purchase of its undertaking	25,0
Profit and loss account	9,8
	£340,8

Assets.	£	s.	d.
nd undertakings — expenditure on ary and other rights, lands, and build- nanent ways, electrical equipments, :k, surveys, etc., including a propor- ieral expenses charged in connection arious contracts and undertakings	86,666	6	7
ount—payments to the British Electric (Pioneer) Company, Limited, and the formation of this Company	15,000	0	0
ees and of testing and developing new electric traction	7,843	3	9
ors	16,367	19	0
isols at cost	14,057	11	3
—debentures and shares in associated companies, at cost, including £24,940 :ish Electric Traction (Pioneer) Com- ited	148,179	17	0
expenses, £7,097. 16s. 8d.; less received on ordinary shares, £1,218. 15s.	5,879	1	8
ire and fittings	693	10	3
unt and in hand	46,132	1	5
	£340,819	10	11

Loss Account from Oct. 29, 1896, to Dec. 31, 1897.

	£	s.	d.
f general expenses not charged to con- undertakings, including expenditure kings not proceeded with, and written	4,618	5	3
ng net profit, transferred to balance-	9,804	9	6
	£14,422	14	9
	£	s.	d.
ts on contracts and undertakings	11,335	18	5
dividends on deposits, and on invest-	3,046	3	10
....	40	12	6
	£14,422	14	9

ing notice of extraordinary general meeting accom- sport:

hereby given that an extraordinary general meeting ers of the British Electric Traction Company, Limited, at the registered offices of the Company, Donington folk-street, Strand, London, W.C., on Thursday, 8, immediately upon the conclusion of the ordinary ing convened for one o'clock in the afternoon, for the onsidering and, if thought fit, of passing the following

the proposed Dudley and district light railway order, iich has been submitted to the meeting, be and the oy approved, subject to all such additions, alterations, is as the Light Railway Commissioners or the Board y think fit to make or sanction therein.

the proposed Middleton light railway order, a draft been submitted to the meeting, be and the same is oved, subject to all such additions, alterations, and s the Light Railway Commissioners or the Board of hink fit to make or sanction therein.

the proposed North Shields, Tynemouth, and district order, a draft of which has been submitted to the and the same is hereby approved, subject to all such terations, and variations as the Light Railway Com- r the Board of Trade may think fit to make or sanction

the proposed Coatbridge and Airdie light railway t of which has been submitted to the meeting, be and iereby approved subject to all such additions, altera- riations as the Light Railway Commissioners or the ade may think fit to make or sanction therein."

article number 106 of the Company's memorandum of association be altered so as to read as follows: 'A y of such balance-sheet, account, and report shall, reviously to the meeting, be sent to the members in in which notices are hereinafter directed to be served, ies of each of these documents shall at the same time d to the secretary of the Share and Loan Department, inge, London.'"

nt of such resolutions being duly passed, they will be r confirmation as special resolutions to a second extra- ieral meeting which will be subsequently convened.

rch 26, 1898. C. Walmsley, Secretary.

INE FLECTRIC LIGHT COMPANY, LIMITED.

: George Boulton (chairman), James George Langham, ur Skinner, and Frederick Hollins. Manager: Henry ason, A.M.I.C.E.

the directors (with abstract of accounts) for the year 31, 1897:

tors are pleased to again present a satisfactory report reholders. A reference to the subjoined accounts the gross profit realised on the working for the was £3,619. 7s. 11d., and that the net amount r reserve and dividend, after allowing for the idend paid to June, 1897, and £400 carried to the depreciation fund, is £1,838. 9s. 9d. The directors propose that £412 be placed to reserve, and that out of the balance left of £1,426. 9s. 9d. a dividend at the rate of £10 per cent. for the half-year, making, with the interim dividend paid in June, £7. 10s. per cent. for the year, free of income tax, be paid upon all the share capital of the Company. This, after allowing for the interim dividend, will absorb £974 15s., and leave £451. 14s. 9d. to be carried forward to next year's account. The depreciation fund now stands at £3,025, and if the proposal of carrying £412 to the reserve fund for 1897 is adopted, the reserve will stand at £3,250, making a total reserve of £6 275. The capital account shows a considerable outlay in the past year for main extensions and for additional machinery and plant, bringing up the deficit on this account to £5,553. 1s. 1d.; and the directors have to provide for a prospective outlay for the next two years of at least £4,400, making a total further capital required of £9,953. 1s. 1d. The directors have had under serious considera- tion the desirability of placing the depreciation and reserve funds upon a more solid basis. The aggregate of these funds, as stated above, is £6,275, but the money is actually in use in the Company's business, and is not represented by separate cash. It is proposed that the amounts standing to the credit of both these funds be placed aside in cash and invested in reliable securities at remunerative interest. To carry this proposal into effect, and to provide sufficient working capital, the directors suggest that, in pursuance of the powers given by the memo- randum of association of the Company, an issue of £1,500 prefer- ence shares of £10 each, carrying interest at £4. 10s. per cent. per annum, be authorised and to be called up as required. This would have very little effect upon the ordinary shares, as against the dividends upon the preferred capital thus raised bank interest would be saved, and the interest upon the investments of the reserve could be appropriated to revenue account. The sanction of the shareholders to the course thus proposed is looked for with confidence. The lamps in circuit, reckoned upon an average of 8 c.p. per lamp, number 19,288 against 16,690 at the close of 1896, an increase of 2,598 lamps for the year. The net increase of customers for 1897 was 56. Units sold amounted to 240,086. The whole of the Company's machinery is in good working order. The mains are also generally in a thoroughly satisfactory condi- tion, but the cables laid in the first instance in too small pipes, when the electric lighting industry was in its infancy, and which are being as rapidly as possible replaced, have on one or two occasions caused a little trouble. Mr. James George Langham retires from the direction this year, but is eligible for re-election. The auditors, Messrs Hart Bros and Co., also retire; but may be re elected.

Revenue Account.

Dr.				£	s.	d.
Generation of Electricity.						
Coal and other fuel	£1,333	19	8			
Oil, waste, water, etc.	278	19	9			
Repairs and maintenance of mains, buildings, etc.	297	15	4			
Proportion of salaries of superinten- dents, officers, etc.	120	16	8			
Wages at generating station	851	0	8			
				2,882	12	1
Distribution of Electricity.						
Proportion of salaries of superinten- dents, officers, etc.	120	16	8			
Wages to linesmen, fitters, and labourers	76	3	3			
Repairs and maintenance of mains... ..	248	16	9			
				445	16	8
Attending and repairs to public lamps				81	18	8
Rent, Rates, and Taxes.						
Rents	70	2	0			
Rates and taxes	221	19	7			
				292	1	7
Management Expenses.						
Directors' remuneration to December, 1896	200	0	0			
Proportion of salaries of engineer and secretary	237	2	9			
Stationery and printing	49	6	0			
General establishment charges	65	11	6			
Auditors of the Company	17	0	6			
				569	0	9
Insurance				87	16	7
Allowances				24	15	9
				4,384	2	1
Balance to net revenue account				3,619	7	11
				£8,003	10	0
Cr.	£	s	d.	£	s.	d.
Arc lighting	735	13	6			
Incandescent lighting	6,733	17	9			
				7,469	11	3
Rent of meters	297	8	9			
Rents	113	10	0			
Sale of carbons, ashes, etc.	0	19	8			
Tuition fees	25	0	0			
				436	18	5
Installations and services—earnings ...	973	15	0			
Less expenditure	876	14	8			
				97	0	4
				£8,003	10	0

Dr. GENERAL BALANCE-SHEET.	£	s.	d.
Sundry creditors—on open accounts	1,388	8	10
Unpaid dividends	84	16	0
Debenture interest to this, less tax	690	17	6
	2,164	2	4
Balance of net revenue account	1,838	9	9
Balance from depreciation fund account	3,025	0	0
Balance from reserve fund account	2,838	0	0
	£9,865	12	1
Cr.	£	s.	d.
Sundry debtors	3,597	12	2
Sundry debtors on trade accounts	2	6	2
	3,599	18	4
Stores in hand: coal, £80. 10s. 11d.; oil, waste, etc., £22. 19s. 10d.; engine-room and general stores, £58. 12s. 7d.; installation, £292. 1s. 7d	454	4	11
Cash at bankers and in hand	258	7	9
Balance of capital account	5,553	1	1
	£9,865	12	1

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Derby.—The Derby School Board are prepared to receive tenders for the electric wiring of their Traffic-street Board School, Derby. Tenders by April 11. For particulars refer to our advertising columns.

Bucharest.—Tenders are invited for the supply of 55,000 double-petticoat porcelain insulators and 30,000 porcelain buttons. Tenders, addressed to Post and Telegraph Department, Bucharest, by April 11.

Manchester.—The Corporation invite tenders for the supply and delivery of about 500 tons of steel tramrails. Drawings and specification may be seen at the City Surveyor's Office, Town Hall, Manchester. Tenders by April 11.

Accrington.—The Corporation invite tenders for the supply and fixing of various articles and engineering appliances in connection with their electricity works. Full particulars appear in our advertising columns. Tenders by April 19.

Ocana (Toledo).—Tenders are invited for a public electric lighting installation. The provisional deposit required is 6,250 pesetas. Specifications, etc., are to be obtained from, and tenders addressed to, the Administrator of the Province at Ocana, Spain, by April 19.

Madras.—The Secretary of State for India in Council announces that the time allowed for the receipt of tenders by the Chief Engineer for Irrigation, Madras, for the utilisation of water power of the Periyar Lake has been extended from Oct. 31, 1897, to July 1, 1898.

Manchester.—The Corporation invite tenders for the supply and delivery of about 500 tons of steel tramrails. Drawings and specification may be seen at the City Surveyor's Office, Town Hall, Manchester. Tenders, endorsed "Tender for Steel Tramrails," and addressed to the Chairman of the Paving Committee, to be delivered at above office by 10 a.m. on April 11.

Derby.—Tenders are invited by the Corporation for electric wiring of their Ford-street yard and premises. Specifications, etc., may be obtained from the Engineer and Manager of the Electric Lighting Works, Sowter's-road, Derby, on prepayment of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders to be addressed to Mr. H. F. Gadsby by April 12.

London, E.C.—The Shoreditch Vestry invite tenders for the supply and erection of arc lamps and accessories, also for electric cables. Specifications, etc., can be obtained from Mr. C Newton Russell, chief electrical engineer, Electricity Supply Department, Coronet street, Shoreditch, on payment of a fee of £1. 1s., which sum will be returned on receipt of a bona fide tender. Tenders by April 12.

London, S.W.—The Secretary of State for War is prepared to receive offers in writing, accompanied by competitive designs and specifications, for the supply of portable electric search-light apparatus. General particulars as to requirements can be obtained on application, either by letter or personally, to A. Major, director of army contracts, War Office, Pall-mall, S W. The offers and designs must be delivered at the War Office, Pall-mall, London, S.W., by April 27, addressed to the Director of Army Contracts, and marked on the outside "Designs for Search-Light Apparatus."

London, N.W.—The St. Pancras Vestry invite tenders for the erection of buildings in connection with the extension of Regent's Park generating station, 47, Stanhope-street, N.W. Specification, conditions of contract, and form of tender may be obtained upon application to the Chief Clerk, Electricity Department Offices, 57, Pratt-street, London, N.W., on payment of a deposit of £1, which will be returned on receipt of specification, accompanied by a bona fide tender. Tenders to be sent to Mr C. H F. Barrett, vestry clerk, Vestry Hall, Pancras-road, London, N.W., endorsed "Tender for Buildings," by 12 noon on April 19.

Edinburgh.—The Mid-Lothian and Peebles Lunacy Board invite tenders for the installation of electric light in their asylum at Rosslynlee, near Edinburgh, including generating plant, *wiring, fittings, lamps, etc. Plans, etc., may be seen at the office of Prof. Baily, Heriot-Watt College,* Chambers-street, Edinburgh.
Specifications, etc., can be obtained from Prof. Baily
R. Addison Smith, clerk and treasurer, 19, Heri
burgh, on payment of £1. 1s., which will be returned
of a genuine tender. Separate tenders may be ac
the generating plant, including accumulators, swit
and (2) wiring, fittings, lamps, etc. Tenders by Apr

Victoria (Australia).—Tenders are invited by th
the city of Hawthorn for the supply and erectio
supply only, of: (Section A) buildings only; (B)
heater, pumps; (C) engines, dynamos, switchboard
mains, transformers, meters, arc lamps, insul
instruments; (D) supply of poles and their erection
the plant for three years. Specifications and forms
be obtained at the office of the Agent-General for Vi
General Sir Andrew Clarke, G.C.C.M., Victori
Victoria-street, Westminster, London, S.W., on
£1. 1s., which will be returned on receipt of a bo
Sealed tenders, endorsed "Tender for Electric L
addressed to the Mayor of Hawthorn, Victoria,
June 24, at 5 p.m.

Belfast.—The Belfast Harbour Commissioners in
the supply and erection in the electric light stat
Basin, Belfast, of three compound, two-crank, se
single-valve, quick-revolution vertical engines, ea
developing 70 h.p., with a steam pressure of 130
inch; also for the supply of three belt-driven, conti
series-wound dynamos, capable of giving 15 ampere
at a speed not exceeding 800 revolutions per minute
continuous running, without undue heating. Copie
tion, form of tender, and any further information re
obtained from the harbour engineer, Mr. G F. L.
tenders, on the special forms provided for the p
addressed to Mr. W. A. Currie, secretary, Harbour
endorsed "Tender for Engines" or "Tender for D
sent in by 18th inst.

London, S.E.—The Vestry of St. Mary, New
tenders for erection of an electric lighting station in
Walworth-road. Bills of quantities, with specifica
of tender, may be obtained from the Vestry's consult
Messrs. Kincaid, Waller, and Manville, 29, Great
Westminster, upon payment of £5. 5s., at whose offic
can be seen during business hours. The deposit wi
after the tenders are opened by the committee. T
will be required to sign the following declaration
declare that we pay to the workmen employed by u
the recognised trade union rate of wages in each
trade." Sealed tenders, endorsed "Tender for Ele
Station," together with specification and priced bill
must be received by Mr. L. J. Dunham, clerk,
Walworth-road, S.E., before noon on 18th inst.

Wallasey (Cheshire).—Tenders are invited by
trict Council for the erection and completion of exte
and boiler house at their electric supply station,
Liscard, in the parish of Wallasey. The drawings
application to the engineer, Mr. J. H. Crowther,
Great Float, near Birkenhead, and copies of the sp
bill of quantities obtained either on personal appl
address or by letter on and after 13th inst. on paym
which will be returned on receipt of a bona fide t
tenders, on the proper form, addressed to the Ch
Gas, Water, and Electricity Committee, and endo
for Erection and Completion of Engine and Boiler
left at the office of Mr. H. W. Cook, clerk, Public O
street, Egremont, by 4 p.m. on 21st inst. The con
required to enter into a bond, with approved su
performance of contract.

BUSINESS NOTES.

Treeton.—An additional £140 has been borrowed
lighting installation.

Harrow.—The Council have received notice of th
company's intention to extend their mains to Sheep

Islington.—At Tuesday's meeting of the London
it was agreed to lend the Islington Vestry £13,3
lighting.

Cheltenham.—The Local Government Board h
their formal sanction to the borrowing of the sum
purposes of electric lighting.

Folkestone Electric Light Company.—We un
the shares for this Company have been subscribed
and that local applications will be allotted in full.

Luton.—A letter from the Municipal Electric Su
with regard to an electric light installation for L
consideration by the Electric Lighting Committee.

Wednesbury.—Application is to be made by the
under the Electric Lighting Acts for a provisi
supplying electricity for lighting and other purpose

Monmouth.—The Council have decided to appl
borrow the £10,000 required for completing the d
of the combined scheme for drainage and electric li

Brompton and Piccadilly-Circus Railway.—
that the prospectus of this Company will be pla
public in a short time. The capital will be about

rborough.—The Local Government Board have again d to sanction an application made by the Town Council for rity to contract a loan of £30,000 for electric lighting ses.

dix.—The Town Council have referred back to the Health ittee a proposal to erect a new engine-house and battery- at the sanatorium with the object of lighting the same by city.

t Railway.—The Light Railway Commissioners have d to recommend an order to authorise the construction of a railway from Strathord Station, on the Caledonian Railway, ikfoot.

wnhills.—The National Telephone Company have offered to their lines to Brownhills if the Urban District Council would ntee £100 for the first five years. The matter is under ration.

don United Tramways Bill.—We understand that the al to double the line from Richmond to Kew will be dropped, it the company still propose to continue with the substitu- electric for horse traction.

tminster.—The Vestry have approved of several notices he St. James's and Pall Mall Electric Light Company and Electric Supply Corporation for the laying of mains and cting street boxes, subject to the usual conditions.

m.—Colonel W. Langton Coke has held an enquiry on f the Local Government Board into an application of the Council for sanction to borrow £7,000 for the purposes of ipply. This sum includes £850 for a telephone installation.

ngton.—At the last meeting of the Vestry of the parish Mary Abbotts notices and plans from the Notting Hill Lighting Company and the House-to-House Electric Light Company relative to extension of mains were agreed to, to the usual conditions.

m.—The points at issue in the election of members to the District Council were the proposal for the erection, near lale, of a refuse destructor and an electric lighting r. The result of the election is regarded as a victory by idents who opposed these schemes.

r.—The Local Government Board have granted a al order authorising the Town Council to "supply l energy for public and private purposes within the " Under this order it will be the duty of the Council wn the necessary plant within the next two years.

ment.—In the House of Lords the Great Orme Tramway nroad Bill has been read a third time and passed. In the s the City and South London Railway Bill, the Charing Euston, and Hampstead Railway Bill, and the Great Railway (General Powers) Bill, have been read a third time.

w.—The annual dinner of the officials of the Corporation electricity departments was held in the Trades House at on the 31st ult. The company numbered over 100 s. Bailie Mitchell presided. The toast of "The Elec- partment" was proposed by Mr. Bowers, and acknow- y Bailie Maclay.

ston.—At a special meeting of the Electricity Committee nchester Corporation, which had been called to consider ed extension of the city electric lighting system to on and Moss-side, under agreements with the With- d Moss-side authorities, it was decided to apply for to borrow £150,000. The estimated cost of extending n to these suburbs and of completing certain works is

—The electric tramways are making great progress. a large length of the western portion of Katherine- been up for the laying down of the rails. During the operations in Oldham-road have been carried on between irch and Wellington-road. A crossing has been made way bridge. The short length of temporary line laid e months ago near Wellington-road has been taken up ed.

l.—At the last meeting of the Town Council it was on a report and recommendation from the Highways that the provisional order as to electric lighting be otherwise disposed of, to any public or private company ling to take over the same, provided that satisfactory d be arranged, and that it be referred to a sub-committee our to arrange terms and report. The motion was nd a sub-committee was appointed.

ttha.—The Vestry have received a letter from the f the County of London and Brush Provincial Electric Company, Limited, stating that they notice that no objec- n by the London County Council to the company's appli- a provisional order in respect to this district in their he Board of Trade, and therefore presume the matter n and trust it is not too late for the Vestry to give their sent to the company's application to the Board of Trade

—At the monthly meeting of the Corporation the Lord ed the report of the committee of the whole house in the application of the Corporation to the Local Govern- l for a loan of £20,000 for new electric cables and work herewith, and for the establishment of sub-transformer With this report was considered a letter from the the tramway company, offering on behalf of his Board the electric lighting of the city on certain conditions. r of a similar nature from *Messrs. Janson, Cobb*, Pearson, and Co., 4, Finsbury-circus, London, E.C. The report was adopted, and the letter of the tramway company was marked read.

Camberwell.—It appears that the question of the proposed purchase of the undertaking of the County of London and Brush Provincial Electric Lighting Company, Limited, will not be further proceeded with. The Vestry have received the statutory month's notice from the same company of its intention to lay electrical conduits in Glengall-grove, Glengall-road, Langdale-road, Bird-in-Bush-road, Hill street, and Old Kent-road; also in Thurlow-park-road, Park-road, Alleyn-park, Dulwich Common, Lordship-lane, Crystal Palace-road, East Dulwich-road, and Peckham Rye to Rye-lane.

Leeds.—Considerable alarm was caused in Briar-lane, Leeds, on Tuesday afternoon, by the breaking of a guard wire in connection with the electric tramways, which are on the overhead system. The broken wire dropped first on to one of the cars and fell across a woman named Ellen Grasby, of Chesapeake-street, Meanwood-road, giving her a severe shock. It then dropped to the pavement, and a police officer who attempted to move it was thrown to the ground and his fingers were burned. Mrs. Grasby was taken to the infirmary in the ambulance, and recovered sufficiently in the course of an hour to proceed to her home.

Weston-super-Mare.—The Great Western Railway Company have offered a portion of their property—on the south side of the Locking-road—as a site for the contemplated electrical works, and the clerk has been instructed to further negotiate with the railway company until such terms were forthcoming as he might think suitable to submit to the Council for their acceptance. The Council have asked the Board of Trade for their sanction to connect the intermediate conductor of the three-wire system to earth. The Council was quite satisfied that it would be practicable to keep the conduits containing their conductors free from water and gas.

Dewsbury.—The Electricity Committee have approved of the doubling of the existing trunk mains at a cost of £5 000, of an extension of mains in a part of the borough not yet served at a cost of £2,500, and of the purchase and laying down of an additional engine and dynamo at a further charge of £2,450, including the cost of an extension of the building at the central station. The electrician (Mr. Mitchell) having resigned, to take a situation at Southend-on-Sea, it was decided to postpone the carrying out of the extension scheme until the appointment of his successor. The new electrical engineer will be paid a salary of £250, but will not be allowed to take a pupil.

Eccles.—A special meeting of the Council was held on the 4th inst. The minutes of the General Purposes Committee submitted for approval stated as follows: "The special sub-committee appointed to deal with the question of the Manchester Carriage and Tramway Company Bill, 1898, reported that they had had an interview with the representatives of the company, and had arranged that the company should lease the tramways in the borough for the period from March, 1899, to April 27, 1901, at the annual rental of £900 per annum." The sub-committee also reported that they had lodged a petition against the passing of the above-mentioned Bill. The action of the special sub-committee was approved.

Bristol.—The City Council at their last meeting discussed the question of the extension of electric tramways. The debate turned almost entirely upon the period at which the city should be entitled to purchase the tramways. The committee recommended the opposition of the company's Bill because they could not come to terms with the company, who also declined to discuss the subject of limiting the hours of work of their employés as suggested by the Council. The advantages of the electric cars were generally admitted, and it was urged that negotiations should be renewed with a view to arriving at an agreement as to the period at which the whole of the lines should be purchasable by the city. The period suggested was 18 years, but eventually the matter was referred to the committee to negotiate, without any stipulation as to the period.

Sheffield.—The city surveyor (Mr. C. F. Wike, C.E.) is contemplating an early start with the work of laying the tramlines along High-street. The first step in the operations will be to lay the tramlines down the centre of the street, and then the sides of the thoroughfare will be paved with wood. In order to avoid dislocating the vehicular traffic more than is absolutely necessary only one side of High street will be taken in hand at the same time, the other being left free for the passage of traffic. The city surveyor intends to put as big a staff of workmen on as it is possible to find labour for, and from three weeks to a month will, it is anticipated see the completion of the High-street section of the extensions. Afterwards Fargate will be taken in hand, and the lines continued along to the Moorhead. The city surveyor's staff will also shortly begin to set back the property at the corner of Brookhill and Western Bank, preparatory to taking the Walkley section in hand.

Great Northern Telegraph Company.—The ordinary general meeting of the Company will be held in Copenhagen on Saturday, April 30 at 3 p m, at the Exchange, when the following business will be submitted: (1) a report of the business for the past year, and of the conditions of the cables and all other property of the Company; (2) production of the Company's accounts and balance-sheet, resolution to be passed of the amount of dividend to be paid for the past year, and discharge given to the directors for the same period; (3) election of two members of the Board; (4) election of two shareholders to act as auditors for the present year; (5) proposal for modifications of the Company's articles of

association. From April 16 the accounts and the proposal for the modifications of the Company's articles of association will be open to the inspection of the shareholders at the Company's offices, and at the same place cards of admission to the meeting may be obtained on shareholders proving their rights as such in accordance with Article 14 of the articles of association.

Bradford.—The Gas and Electricity Supply Committee of the City Council have decided to reduce the charge for electricity used for lighting purposes from 5d. per Board of Trade unit to 4½d. A sliding scale of charges for electricity used as a motive power has been adopted. At present the charge is 2½d per unit. By the new scale this charge is retained as a standard, but deductions are allowed where the consumption is continuous and the quantity used not below a certain minimum. For four hours' continuous use and a consumption of 550 units the charge will be 2d per unit, and as the length of time and the quantity used increase the charges will decrease. For eight hours' continuous use and a consumption of 1,200 units the charge will be only 1d. per unit. It is intended that these charges shall come in force on July 1. The report from the deputation which recently visited the Continent for the purpose of enquiring into the modes in operation there of electric lighting and traction, has been presented to the City Council. The deputation visited Hamburg, Berlin, Dresden, Brussels, and Leipsic. They expressed the opinion that the arrangements made at the Valley-road electricity works for running the Bolton road and Great Horton tramways were as complete as anything which they had seen upon the Continent.

Tipton.—At the monthly meeting of the District Council a letter was read from the Board of Trade enclosing a communication to them by the South Staffordshire Tramway Company on the renewal of licenses in which they state that the form of the new debentures which they had agreed to issue in exchange for the old ones has been approved, and that, so far as they were concerned, they had concluded arrangements which would, with the consent of the local authorities, enable an improved form of traction to be installed on the steam lines of their system at a comparatively early date, and as a new Act of Parliament will be necessary, all the local authorities concerned will have ample opportunities for stating their wishes in the matter. The following statistics of the working of the line during the past year were appended: number of car miles run, 584,809; number of passengers carried (exclusive of season-ticket holders, who number 124), 5,504,784; receipts, £32,417. 19s. 1d, the majority of which is distributed in the district in the shape of wages or material. The average of these figures are: passengers carried per car mile, 9·24; average fare per passenger, 1·41d.; amount earned per mile, 13·43d. Following this was a letter from the Board of Trade stating that they had renewed the authority of the company to use steam power on the tramways for a further period of three months, to allow time for a conference to be arranged as suggested in the preceding letter. The Chairman said the Council could not take any further action in the matter until the application was made for parliamentary powers for the use of electric traction.

Leeds.—Mr. Edmund Pearse Buird, Local Government Board inspector, held an enquiry on the 31st ult. into an application by the Corporation of Leeds for a provisional order empowering them to create irredeemable stock bearing a dividend not exceeding 5 per cent. for the purchase of the undertaking of the Yorkshire House-to-House Electricity Company, Limited. The Corporation was represented by the Town Clerk, and Mr. Cyril Dodd, Q.C. (instructed by Messrs. Nelson, Barr, and Nelson, Leeds), appeared for the company. There were also present the Lord Mayor and other members of the Corporation. The Town Clerk stated that the company was constituted about 1890. Its total expenditure on capital account to the end of December was £161,000, and it had laid 21 miles of mains, while notice had been given of its intention to lay mains for 12½ miles more. Mr. Dodd, while not opposing the application, suggested that the enquiry be adjourned to see if the Council would consent to an agreement similar to the one arrived at at Sheffield. The Town Clerk was unable to agree to Mr. Dodd's suggestion, and said that it remained for the Local Government Board to facilitate the carrying out of the wishes of the Corporation and the ratepayers.—The lighting of Leeds during the past 12 months has cost the Corporation £27,901. 13s. 9d. During the past year the Lamp Committee have authorised the erection of 613 new lamps. At the last meeting of the committee a letter was read from the Great Northern Railway Company asking the Corporation to extend the electric lights further along Wellington-street. The committee decided to leave the matter in the hands of a sub-committee, the members of which will visit the locality at an early date.

Grimsby.—The following is the text of the draft agreement between the directors of the Provincial Tramways Company and the Corporation, mentioned in our last issue: (1) The time at which the Corporation are to have power to purchase the lines to be extended to 21 years from the date at which they could do so under the Tramways Companies Act; (2) the tramway company to reconstruct the lines with girder rails suitable for electric traction, and to bond them with copper bonds in accordance with the Board of Trade rules; (3) the tramway company to keep the tramway lines in repair to the satisfaction of the borough engineer; (4) the Corporation to erect the standards and put the trolley wires, the tramway company to pay for their use such a sum as will cover the interest and sinking fund upon the amount expended by the Corporation, it being understood that if the standards are used for electric lighting, the cost to be divided between the company and the Corporation; (5) the tramway company to uphold and renew as may be necessary the trolley wires, or to pay to the Corporation the net cost of doing so if
done by them; (6) the Corporation to allow the tram
pany to alter the position of any of the existing passing
lines, and to construct such additional passing places
necessary for the efficient working of the tramways by el
(7) the Corporation to provide the feeders and other
necessary to supply the electric current for running
(8) the tramway company to pay to the Corporation
Board of Trade unit for the electric current, and to gu
take a minimum of 360,000 Board of Trade units pe
(9) the Corporation to undertake to supply the electric
the tramway company under a penalty for any failure
from any cause whatever.

Salford.—A sub-committee of the Town Council has
upon the probable cost of taking over and working the
and also the cost of electric traction, and that it is not
tion of the Manchester Corporation to engage an expert
them, but they will rely upon the advice of their
trical engineer in any matters relating to the futu
ing of the tramways of the city. Further, t
Hopkinson has been engaged by the Manchester C
to give evidence on their behalf before the Parl
Committee against the Manchester Carriage and
Company's Bill. The Salford Highways Commit
resolved: "That it is desirable to obtain from the M
Corporation a written undertaking that if and when th
of the tramways of the city and borough are taken ov
respective corporations, the Manchester authorities wi
pared to enter into an agreement to permit the cars be
this Corporation to run over certain portions of the lin
the city and at the same time to offer similar facilities wi
to the Manchester cars running over portions of the Salf
lines; and that the town clerk be instructed to communi
the town clerk of Manchester upon the subject." Also:
chairman and deputy-chairman of this committee and
man of the Tramways Sub-Committee and town clerk be
to endeavour to obtain an agreement from the Mancheste
and Tramways Company to a clause being inserted in th
lease of the tramlines in the borough to allow the Corp
exercise the power of Section 43 of the Tramways
within six months of the termination of the renewed ter
years, and in the event of their rejection of this pro
town clerk be instructed to call a meeting of the Coun
the before-mentioned section."

Canterbury.—The *Kentish Gazette* says, referring to the
electric lighting scheme for Canterbury: "We are sangui
to believe and hope that we shall be able to report like
borough: 'The board of directors in presenting their
pleased to be able to state that the shareholders will find
accompanying accounts for the year 1897, that the busin
company is progressing satisfactorily. The number of lamp
on Dec. 31, 1897, was equivalent to 4,985 of 8 c.p.; since
395 have been added. In the course of the year a ne
twice the size of the original ones, has been added, and t
cell capacity has also been doubled. The net profit for
£1,256. 16s. 7½d., as shown on the net revenue account,
this sum the directors recommend that a dividend of 4
free of income tax, be declared on the paid-up capital of
pany, the dividend on the new shares being calculated
dates of allotment and call. This will absorb £652. 7s. 4
a balance of £604. 9s. 3½d. to carry forward.' £1,256. 1
not bad for one year's working, and especially when one
the fact that this is the first year of working. At all ev
is sufficient to pay the interest on the loan Canterbury
and a good sum to spare. Unfortunately, the Windsor C
has allowed a private company to step in, and thus, inste
Corporation reaping a 4 per cent. interest, to be appl
alleviation of the rates, that amount goes to the sha
after, as we say, only one year's existence. Indeed, so
has the new illuminant proved in the Royal borough,
directors have already taken into consideration the fe
reducing the price. Luckily, the local parliament of C
has decided to instal the electric light as a municipal und
and apply the receipts to the reduction of rates. If Wi
be taken as a fair criterion—and we assert that it may—
pects of the undertaking in Canterbury are far from unsati

Halifax.—The members of the Halifax Corporation
made a tour of inspection of the electricity and gas work
wards, the company were entertained at dinner,
Alderman Woodhead, as chairman of the Gas Committee,
Alderman G. H. Smith, in submitting "The Corporatio
Electricity Undertaking," said the time would come w
great works would to a great extent be run by
instead of, as now, by the steam-engine. There
the slightest doubt that electrical power would
place of gas-engines, and they, in that Corporat
doing a great service, especially to shopkeepers
who wanted small power, in affording them opportuni
to hire or to buy small motors. It should be the
Electrical Committee to supply the energy at such
that people would be compelled to use it as being ch
any other power. The electric light, so far, had not b
earn anything to diminish the rates. He believed, how
the time would come when it would earn them a little
only the committee would have energy enough to take t
across the moor. He did not know whether, as was t
America, the Tramways Committee intended to warm
cars by electricity. If they could see their way to do s
be a great advantage, as it would supply warmth
passengers without any disadvantage of smell. Alderm

reply, said with respect to the electricity works, notwith- that they appeared to have an adverse balance against still regarded it as a flourishing institution. They had for an output far in excess of what they required either then or present needs. The limit for borrowing money ectricity department was a comparatively short one, and king fund for the past year amounted to something over vhilst their loss was only £800. Practically, therefore, 'ed a profit of over £500, not reckoning the sinking fund. :ept the building, plant, and everything in good repair, vere doing, and kept up the sinking fund, in 30 years the ing would be their own, and everything paid off. He :hat, in the light of these facts, he had good grounds for that the electrical undertaking was fairly paying its way. rted by taking over the number of customers which the nany had in Halifax before they began. That company more than 700 lights of 16 c.p. Connected with private s, motors, and a limited amount of street-lighting, they , they estimated, nearly 10,000 16-c p. lights. A year otal was 7,000, so that the rate of progress had been very ndeed. The nearer they arrived at the maximum output, r they would be towards making the electrical concern a ndertaking. The fact they could increase the maximum rith a little expenditure three times, showed that the works were going to be a good concern towards the he rates of the borough.

ide Electric Trams.—The work of the new Tees-side ramways is in a very forward state, according to the *ough and Stockton Evening Telegraph*, to which source we ted for the following description of the works now in the construction, under the superintendence of Mr. Holliday: wer house and chimney stalk tower high above the ing buildings, and present an imposing appearance, ill be greatly improved when the outside scaffolding is wn. The building is one of splendid proportions, being g inside by 52ft. 6in. in breadth, and 36ft. in the clear floor up to the roof principal. A proper idea as to the dation of the building can now be obtained as the roof is the scaffolding inside removed. The white glazed brick ch the walls are lined give the place a beautiful light and erance. In the basement of the engine-room the three s have already been erected, and all the steam-piping also has been fixed here. When the condenser plant is exhaust steam will be utilised over and over again and to the boilers in the form of water, at a 20lb. to 30lb. pressure, and only some 4 or 5 per cent. will be lost in on. The condensers are of the most improved kind, and, seen, effect a great saving in waste. The water supply oilers will be taken from the river. The engines and will be laid down on the ground floor, and very careful ns have been made in the construction of the beds on ponderous machinery will rest, so that not the slightest will be felt in the huge room. Three beds of concrete laid down in the basement, rising to the ground floor, , and when it is stated that in each of these beds no less tons of concrete have been used, it will be seen how solid antial are the foundations for the engines. The overhead has already been fixed, and the glazing of the skylights mpleted. Already the slaters are at work on the roof, gh the work on the top of the building was delayed to nt by the blizzard of last week it is in a forward Adjoining the engine-room is the boiler-house, another hy, and spacious room. In it there have been erected multitubular boilers, economiser, and a storage water The boilers are of the newest pattern, are now in use in s of the globe, and have successfully withstood the tests 160lb. pressure, at which they will be worked. The stokers which are to be fixed will be worked by a motor. the power-house the new battery-room, 40ft. by about been built, and will soon be completed. It is lined with ed bricks, and a concrete floor will be laid down. The mulator cells will be placed on stands round the Outside in the yard the car sheds are also receiving ion, all the principals having been put in. The walls of eds have been used and raised some feet, but the building rried for a considerable distance, until it will be almost size of the old one, and will accommodate some 30 cars d. The whole of the lines leading into the car sheds laid, and pits constructed inside the sheds for the on of the cars as they return to the depôt. Underground onnect all the pits, so that the inspectors can travel to the other without having to come to the surface in from one part of the sheds to the other while on duty. of the ground in the depôt has also been raised with a to the street, and is being repaved. A water-main has duced into the depôt, and hydrants will be laid down in the buildings that may be considered advisable, and ecessary supply of hose the company will be prepared to any emergency in case of fire. The staff have been ight and day in the engine room, and in about another s it, as well as the other work, will be well on towards . The Norton depôt is also rapidly approaching . Outside on the road the laying of the cable is also ed forward. It has been laid from Norton to the depôt ead, and the main feeder cable from the latter place to is well in advance, the workmen having got through with the laying of it, and well on the way to the ugh depôt. The cable is also being laid down with oughout Middlesbrough, so that in a very short time will have been finished. The stretching of the trolley wires, too, has gone on rapidly from the North Ormesby end. Some days ago they were finished as far as the Erimus Hotel, where a halt was called while the men went back stretching the wires from Parliament-road to Linthorpe terminus. The thread of the work has been taken up again at the Erimus, and the wires have been erected as far as High-street, Stockton. There is thus only the distance from there to Norton which remains to be completed."

TRAFFIC RECEIPTS.

Dover Tramways.—The traffic receipts for the week ending April 2 were £117. 16s. 0d. The total receipts for the year 1898 are £1,395. 14s. 7d. The mileage open at present is 2¼ miles.

Bristol Tramways.—The traffic returns for the week ending April 1 were £2,339. 11s. 6d., compared with £2,025. 7s. 10d. for the corresponding period of last year, being an increase of £314. 3s. 8d.

Birmingham Tramways.—The traffic receipts for the week ending April 2 were £3,508. 3s. 9d., as compared with £3,186. 15s. 8d. in the corresponding week in 1897, being an increase of £321. 8s. 1d.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended April 3 amounted to £1,313, as compared with £1,323 in the corresponding week of the previous year, being a decrease of £10.

City and South London Railway.—The returns for the week ended March 27 were £1,066, compared with £974 for the corresponding period of last year, being an increase of £92. The total receipts for the half-year amount to £13,891, compared with £13,791 for the corresponding period last year, being an increase of £100.

South Staffordshire Tramways.—The traffic returns for the week ending April 1 were £567. 11s. 11d., as compared with £568. 3s. 4d. in the corresponding week of the previous year. The aggregate receipts for the year are £7,472. 3s. 4d., as against £7,443. 7s. 0d. in the corresponding period of the previous year.

Dublin S.D. Tramways.—The traffic receipts for the week ending April 1 were £358. 12s. 8d., as compared with £367. 11s. 1d. in the corresponding week in the previous year, being a decrease of £8. 18s. 5d. The number of passengers carried was 62,971 in 1898 and 60,701 in 1897. The aggregate returns up to date are £5,152. 1s. 8d., as compared with £5,514. 4s. 9d. last year, being a decrease of £362. 3s. 1d. The mileage open is the same as last year—viz., 8 miles.

PROVISIONAL PATENTS, 1898.

MARCH 28.

7398. **Improvements in dynamical machines.** Franz Stolze, 5, Seydelstr, Berlin.

7408. **A new or improved electricity meter.** William Holmes, 39, Brodrick-road, Upper Tooting, London.

7423. **Process for the extraction of pure metals or metallic alloys and carbides by electric heat.** Heinrich Aschermann, 8, Rue des Princes, Brussels. (Complete specification.)

7450. **An underground electric current delivery for street railways.** Hermann Daniel, 5, Seydelstr, Berlin. (Complete specification.)

7455. **Improved method of making the active mass in accumulators.** Friedrich Frentzel, 102, Burdett-road, Bow, London.

7468. **The telephone memorandum and advertising card.** Frederick Simms and George Gerrish, 5, Melford-road, East Dulwich, London.

7467. **Improved means applicable for use in operating electrically-illuminated signs, advertising media, or the like.** William Thomson Bell, 191, Fleet-street, London.

7470. **Improvements in and apparatus for effecting electrolysis.** William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Solvay and Co., Belgium.)

7471. **Improvements in electrolysis.** William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Solvay and Co., Belgium.)

MARCH 29.

7487. **Improvements in electric batteries.** Robert Metcalf Minton-Senhouse and George Frederick Emery, 5, King's Bench-walk, Temple, London.

7514. **Improvements in plates for battery and other purposes and method of making same.** Arthur Warburton, 132, Crookes, Sheffield.

7545. **Apparatus for electrically winding springs or weights for clock movements.** George Keith Buller Elphinstone, 101, St. Martin's-lane, London.

7566. **Improvements in systems of electrical distribution.** William Lord Bliss, 6, Bream's-buildings, Chancery-lane, London. (Complete specification.)

7570. **Improvements in and relating to means for connecting electric cables.** Franz Clouth, 45, Southampton-buildings, Chancery-lane, London.

7569. Improvements in electric furnaces. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. ("Volta," Société Anonyme Suisse de l'Industrie Electro-Chimique, Switzerland.)

7575. Improvements in electric furnaces for manufacturing calcium, carbide, etc. William Phillips Thompson, 6, Lord-street, Liverpool. (Corydon L. Wilson, Charles Muma, John W. Unger, Henry Schneckloth, Amos P. Brosius, and Joseph C. Kuchel, United States.) (Complete specification.)

7577. Improvements in electrical batteries. Nathan B. Stubblefield, 6, Lord-street, Liverpool. (Complete specification.)

7583. Improvements in and connected with electrical switches. Henry Charles Edward Jacoby and White, Jacoby, and Co., Limited, 21, Finsbury-pavement, London.

7586. Improvement in magnetic separators. Alexander Melville Clark, 53, Chancery-lane, London. (The Metallurgische Gesellschaft A. G., Germany.)

MARCH 31.

7696. Improvements in apparatus for indicating and recording electric currents and signals. Walter Judd, Beechcroft, Hook-road, Surbiton, Surrey.

7700. Improvements in and relating to shields for incandescent electric lamps and the like. James Dewar, 96, Buchanan street, Glasgow.

7718. Improvements in ships' and analogous telegraphic apparatus. William Chadburn, 15, Water-street, Liverpool.

7725. Improvements in holders for incandescent electric lamps. Jan Meines Huisman and Henry Charles Gover, 62, St. Vincent-street, Glasgow.

7731. An automatic electric fog and general signal apparatus. Charles Cropp, 22, Pownall-road, Fulham, London.

7754. Improvements in and connected with electric motors for motor vehicles, launches, and for other driving purposes, and in gearing to be used therewith. James Thomas Robson, Charles Henry Marsden, and Henry William Headland, 77, Chancery-lane, London.

7764. An improved apparatus for the electro-deposition of metals. Joseph Henry Hope, 11, Burlington-chambers, New street, Birmingham.

APRIL 1.

7798. Electrical switch. Frederick Nunns, Shaw Syke, Halifax.

7825. Improvements in interchangeable electric signs and the like. Charles Raleigh, 58, Chancery-lane, London.

7855. Improvements in transmitting electric impulses and signals and apparatus therefor. Ernest Wilson, Herbert Godsal, and Charles John Evans, 108, Castelnau, Barnes, London.

7862. New or improved combined globes and shades for incandescent electric lamps, and for electric arc lamps, and for facilitating the application of advertisements thereto. Ernest Böhm, 306, High Holborn, London.

APRIL 2.

7873. Improvements in telephones, electric bell pushes, and the like. Alice Anders and Verity's, Limited, 31, King-street, Covent Garden, London.

7877. Improved means in the production of white lead and oxide of lead by means of volatilising metals or ores by the use of the electric arc. Ernest Bailey and George Reeve Cox, Beech Villa, Holgate, York.

7895. An improved construction of fusible cut-out for electric circuits. Thomas Barton, the Electric Works, Ainsworth-street, Blackburn.

7903. Improvements in electric interrupters. Jean Marie Dominique Soulé, 8, Rue des Princes, Brussels. (Complete specification.)

7907. An improved electrical cut-out. Laughlan Greig, 134, St. Stephen-street, Edinburgh.

7929. High-insulation electric light switch. Thomas Linforth Jones, 14, Mayfield-road, Enfield Highway, London.

7939. New or improved telectroscope. Henry Bauer, *Invention* Office, Mitre-court, Fleet-street, London.

7940. An improvement in coin-freed electric meters. Thomas Hubert Minshall, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

7941. An improvement in holders for electrical glow lamps. Philip Frederick William Simon, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

7958. An improved system of electric propulsion for ships, yachts, submarine boats, torpedoes, and other purposes. James Harold Barry, 10, Basinghall-street, London.

7961. Improvements in electric switches. Archibald Wilson, 53, York-place, Edinburgh.

SPECIFICATIONS PUBLISHED.

1897.

6212. Means for supplying electric current to electrically-operated time-keeping mechanism. Staveley, Parsons, and Murday.

8185. Generation and distribution of alternating currents for light and power. Wetter. (T tricitäts Aktiengesellschaft vormals Schuckert u

8970. Electrical indicating apparatus and couplings connection therewith as a system for electri munication. Hampson.

9127. Electric meters. Evershed and Vignoles, Lim Evershed.

9803. Voltaic battery having its depolarisation ef heat. De Lavison.

11226. Telephones. Priddle.

11808. Incandescent electric lamps. Woodley.

15238. Manufacture of electrical resistances. H Vogt, Kirchner, Konig, Weiner, and Jörg.

24073. Switches for electric light or power. He Smith.

26935. Apparatus for indicating and registering vari insulation resistance in electric networks and generally. Boult. (Travailleur.)

27544. Automatic electro-mechanical circuit closers fo and signalling systems. Price and Gould.

28965. Controllers for motors and brakes of electr Grossman.

29826. Conductors for electrical machinery and electric machines, motors, and other electric ratus. Millis.

1898.

494. Device for use in controlling electric motors.

665. Electric switches. Hinds and Crouse.

1194. Secondary batteries. Philippart.

1380 Regulation of dynamo-electric machines and Johnson.

3074. Electric bells. Jenisch.

COMPANIES' STOCK AND SHARE LIST

Name.	Paid.
Birmingham Electric Supply Company	5
Brush Company, Ordinary	2
—— Non. Cum., 6 per cent. Pref.	2
—— 4½ per cent. Debenture Stock	100
—— 4½ per cent. 2nd Debenture Stock	100
Callender's Cable Company, Debentures	100
—— Ordinary	5
Central London Railway, Ordinary	10
——	6
—— Pref. Half-Shares	1
—— " "	5
Charing Cross and Strand	5
—— 4½ per cent. Cum. Pref.	5
Chelsea Electricity Company	5
—— 4½ per cent. Debentures	100
City of London, Ordinary	10
—— Prov. Cert. 90,001-100,000	5
—— 6 per cent. Cumulative Pref.	10
—— 5 per cent. Debenture Stock	100
City and South London Railway, Consolidated Ordinary	100
—— 4 per cent. Debenture Stock	100
—— 5 per cent. Pref. Shares	10
—— " " " '96	10
County of London and Brush Provincial Co., Ordinary	10
—— " " "	4
—— 6 per cent. Cum. Pref.	10
Crompton and Co., 7 per cent. Cum. Pref. Shares	5
—— 5 per cent. Debentures	—
Crystal Palace District, Ordinary 5 per cent. Stock	100
—— Preference 5 per cent. Stock	100
Edison and Swan United Ordinary	3
—— 5 per cent. Debentures	5
—— 4 per cent. Deb. Stock, Red.	100
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	2
Electric Construction, Limited	2
—— 7 per cent. Cumulative Pref.	2
—— 4 per cent. Perp. 1st Mort. Deb.	100
Elmore's Copper Depositing	1
Elmore's Wire Company	3
W. T. Henley's Telegraph Works, Ordinary	10
—— 7 per cent. Preference	10
—— 4½ per cent. Debentures	100
House-to-House Company, Ordinary	5
—— 7 per cent. Preference	5
India Rubber and Gutta Percha Works	10
—— 4½ per cent. Debentures	100
Kensington and Knightsbridge Ordinary	5
—— 6 per cent. Pref.	5
London Electric Supply, Ordinary	5
Metropolitan Electric Supply, Limited, Ord. No. 101-50,000	10
—— " " " 50,001-82,500	10
—— 4½ per cent. First Mortgage Debenture Stock	100
National Telephone, Ordinary	5
—— 6 per cent. Cum. First Pref.	10
—— 6 per cent. Cum. Second Pref.	10
—— 5 per cent. Non. Cum. Third Pref.	5
—— 3½ per cent. Deb. Stock, Red.	100
Notting Hill Company	10
Oriental, Limited, £1 shares	1
—— £5 Shares	5
—— £4½ shares	4½
Oriental Telephone and Electric Company	1
Royal Electrical Company of Montreal	—
—— 4½ per cent. First Shares Mortgage Debentures	100
South London Electric Supply, Ordinary	3
St. James's and Pall Mall, Limited, Ordinary	5
—— 7 per cent. Pref.	5
—— 4 per cent. Deb. Stock, Red.	100
Telegraph Construction and Maintenance	12
—— 5 per cent. Bonds	100
Waterloo and City Railway, Ordinary	100
Westminster Electric Supply, Ordinary	5
Yorkshire House-to-House	5

NOTES.

Honours.—Prof. Alexander Graham Bell has
cted president of the National Geographic Society,
gton.

oyal Electrician.—Prince Albert Leopold, of
, who is now visiting the United States, announces
of his chief objects is to study the electrical work

tution of Civil Engineers.—To-day, the
st., the students of this institution will visit the
unction waterworks, Hampton, at 2.30 p.m. The
ves Waterloo Station for Hampton at 1.18 p.m.

History of the Telegraph.—We notice in the
de la Société Belge d'Electriciens a well-compiled
f the history of the electric telegraph by Mr. J.
. As an illustration a good portrait of Prof. D. E.
is given.

Prevention.—We have received from the British
vention Committee a reprint of an excellent paper
Hugh Bonner on the New York Fire Department.
we gather that all hotels and theatres in New York
elled by law to have a fire-alarm fixed.

ricity is Life (?)—On March 22 a Bill to substi-
rocution for the gallows as a method of capital
nt in Massachusetts passed the House. The Bill
that all executions shall take place at the State
etween midnight and sunrise. It also provides
ewithal for a small building and the necessary
s.

Rates to Australia.—The Intercolonial
ce, sitting on April 3 at Hobart, agreed that in
nce of a satisfactory proposal from the Eastern
n Telegraph Company no fresh arrangement could
with the company. A motion in favour of the
onstruction of a Pacific cable was subsequently

gn Electrical Business.—We note from the
f the Allgemeine Elektricitäts-Gesellschaft that
e year ending June 30, 1897, the firm manufactured
tched some 5,189 electrical machines of an average
f about 20 h.p. The aggregate output of these
00 kw., or about 103,000 h.p. About 9,800 men
oyed by the firm.

Books Received. — "Alternate Currents in
" translated from the French of Loppé and
by Francis J. Moffett, B.A. "The Theory and
of Electrolytic Methods of Analysis," by Dr.
l Neumann, translated by John B. C. Kershaw,
nd "Radiography and the X Rays," by S. R.
All these works are published by Whittaker
of Paternoster-square.

l Meteorological Society.—At the ordinary
of this society, to be held at the Institution of
ngineers, Great George-street, Westminster, on
lay, the 20th inst., at 7.30 p.m., the following
rill be read: "Anti-Cyclonic Systems and their
nts," by Major H. E. Rawson, R.E., F.R.Met.Soc.;
of Observations on Haze and Transparency in
y the Hon. F. A. Rollo Russell, M.A., F.R.Met.Soc.

Punkah-Pulling Problem.—A leader under
rative head in *Indian Engineering* describes the
unsuccessful attempts at mechanical punkah-
The fact to be remembered by those who are
ng to apply electricity for this purpose is that
nkah has a definite period of swing. If the
pparatus is not timed to give impulses at the same
great waste of power will ensue. In fact, the machine must be capable of adjustment in respect to the number of impulses per minute.

The Chemical Society.—At the anniversary meeting of this society it was announced that the following past-presidents, Lord Playfair, Dr. A. W. Williamson, Sir E. Frankland, Dr. W. Odling, Sir F. A. Abel, Dr. J. H. Gladstone, Sir J. H. Gilbert, this year complete a connection of 50 years with the society. To mark its sense of the great services they have rendered to chemical science, the council has resolved to entertain them, in the name of the society, at a dinner on June 9, given to commemorate their half-century of fellowship of the society.

Telephone Fatality.—We regret to note that early on Saturday last William Roberts, of Chester, died at the Providence Hospital, St. Helens, from injuries received on Tuesday afternoon last. He was in the employ of the National Telephone Company, and on Tuesday was assisting in the alteration of the position of the telephone cables on St. Helens Town Hall. A staple near the roof of the building, to which the cables were attached, suddenly gave way, and Roberts fell a distance of about 25ft. to the ground. He alighted on his head, and sustained the serious injuries from which he died.

Death of Mr. Nelson W. Perry.—We regret to have to announce the sad death of Mr. Nelson W. Perry, the well-known American electrical journalist. He was experimenting, it appears, in lighting, at his house in Brooklyn, and by mistake, in the dark, took up, and drank from, a cup containing bichromate of potash, instead of one of water. He sent out at once for doctors, but they were unable to pull him through, and he died the same night. Mr. Perry was a graduate of Columbia, and a man of great ability. He was an active member and officer o the American Institute of Electrical Engineers, and was until recently the editor of *Electricity*.

A Preventable Fire.—In consequence of a telephone wire falling upon the overhead wires of the electric street tramways at Zürich, the central station of the telephonic service, which has 5,000 subscribers, caught fire recently and was completely destroyed. It was only with the greatest difficulty that the officials succeeded in escaping. The damage to the building is estimated at over £40,000, while the losses caused indirectly amount to at least the same figure. This is where the guard wires required by our Board of Trade regulations would have been advantageous. If such wires had been placed over the tramway conductors, there would have been no fire.

The Fernscher Again.—Mr. Paul Schmidt gives in a Vienna paper further details of Herr Szczepanik's invention with a diagram of connections which is unintelligible. The gist of the whole article lies in the last paragraph, which practically states that the inventor has abandoned selenium as unsatisfactory, and that he is experimenting on a more sensitive compound of his own. When this is a success more details will be given. We remember that the last time we prophesied that an inventor was stating his ideas as facts without first trying them, we were threatened with personal violence. In spite of this, we do not mind venturing the prophecy that so far Herr Szczepanik has carried out no successful experiment, but has confined his attention to romancing to untechnical reporters.

Excesses.—The saying that "Fire is a good servant, but a bad master," has been proved several times in English electric light stations. This applies to water for power plants, of which we have not in this country so much experience. In fact, where the ordinary river falls have to be dealt with for power and lighting purposes, too much water is more

often the cause of failure than too little. This fact is emphasised and the analogy brought out by the two adjacent paragraphs in the *Electrical Review* of New York, which read as follows: "A flood in the Scioto River caused a shut-down of the electric lighting plant at Columbus, Ohio, on March 24, and the city was without electric lights. The electric light plant at Corbin, Ky., was destroyed by fire a few nights ago. It was caused by a defective flue."

Indiarubber.—Dr. D. Morris, C.M.G., will deliver the first of his two Cantor lectures on the "Sources of Commercial Indiarubber" at the Society of Arts on Monday next, April 18. This lecture will treat of the following details: Distinction between caoutchouc and guttapercha—Occurrence of latex in plants—Constituents of latex—Natural orders yielding caoutchouc—Methods of extraction—Coagulation of latex—History of indiarubber—Progress of industry—Imports into United Kingdom—Relative production in foreign countries and British possessions—Uses—Value of total trade—Forms of commercial indiarubber—Present yield—Future supply—Para rubber trees—Geographical distribution—Conditions of growth—Yield—Quantity of rubber—Methods for collecting and preparing rubber—Commerce in Para rubber.

Traction in Japan.—Two or three electric tramway companies have now already made projects for lines in Tokio. The promoters were recently summoned to the offices of the Municipal Governor, and informed that they would have to conform to the following regulations: (1) the locomotive powers to be exclusively supplied by electricity, the use for motive purposes of men or horses being strictly prohibited; (2) a system of accumulator traction to be used, and no overhead electric wires; (3) the construction of electric tramways to be limited to thoroughfares of more than eight ken, about 48ft. in width, in the districts of Nikoubashi and Kyosbashi, but in the hill district the width may be anything over six ken (36ft.). In sections where lines are to be doubled for electric locomotives, the road must be two ken wider than the limits above specified.

Recording Voltmeters.—We have received details of a continuous recording voltmeter designed by Mr. John H. Barker, the electrical engineer for the Cambridge Electric Supply Company. The name of the instrument reminds us of the story of the clock that would go for eight days without winding, about which the query was raised as to how many days it would go if wound up. This recording voltmeter will give a record for seven days on the one sheet of paper. The seven 24-hour records come one under the other on the chart, and in this way a good idea of the week's working can be obtained at a glance. As the patents have not yet been fully completed we cannot give full information as to the details of Mr. Barker's device, but from a photograph he sends us it appears that the recording arm is movable on the spindle of the voltmeter, and that it is shifted to a different zero position each day. From curves sent us by the inventor, we see that at Cambridge the variations in voltage are not large.

Iron and Steel Institute.—The annual meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers, Great George-street, London, on Thursday and Friday, May 5 and 6, 1898. At this meeting the council will present their annual report for the year 1897, and a number of papers will be read and discussed. The annual dinner of the institute will be held on May 5 in the Grand Hall of the Hotel Cecil. The autumn meeting of the institute will this year be held at Stockholm, under the auspices of the Swedish Association of Ironmasters, on Friday and Saturday, Aug. 26 and 27. Excursions places of interest in the vicinity of Stockholm will arranged; but in view of the limited railway and ho accommodation in the mining districts there will be official visit to the ironworks and mines. It is anticipat however, that a limited number of members will rece personal invitations to visit, before the meeting, the i mines of the Arctic Circle, and, after the meeting, ironworks and mines of Central Sweden.

Stage Mechanism.—The paper on modern sta mechanism, to be read before the Society of Arts Wednesday, the 20th inst., by Mr. Edwin O. Sachs, w deal with practically a new subject, to which little or attention has so far been given in this country, althou important stages worked by hydraulics and electricity ha been used in the United States and on the Continent for considerable number of years. Mr. Sachs, after deali with the elementary equipment of the stage of to-day, wi indicate the lines on which modern science may be appli to the mounting of plays, and he will give particulars regards the general working of the theatre, and speak various ways of obtaining realistic effects or illusions the stage. A valuable series of photographs, sketch and drawings from modern stages will then be shown the aid of limelight views and explained by the lectur and among these will be all the more important exampl including those of the Paris, Berlin, Vienna, and oth Continental opera houses, as well as Drury Lane and Cove Garden stages. Special reference will be made to th hydraulic installation at Drury Lane and the electric tur table stage at Munich.

Police Signalling Systems.—The new system the London Police Commissioner of always keeping poli men at certain listed places much facilitates the call f help when in difficulties. We learn that Mr. McCullag the head of the police force of Greater New Yor proposes to go beyond this. He wishes to establish certain number of policemen at stated points all over th city, connecting their booths, or sentry boxes, up by tel phone with the police station of the precinct. No matt what happens, anyone who wants the help of the police c go at once to these well-known points and obtain th services of the officer there, he in turn notifying his hea quarters of the call, and securing a relay in the shape one officer or a dozen as the case may need. It will obvious that such a system not only gives instantaneo police help, but by establishing a series of "trochas makes it very hard for a fugitive criminal to brea through, as he is liable to interception in whichev direction he goes. Mr. McCullagh has arranged to pla at the electrical exposition at New York in May one these interesting booths. The city has recently made appropriation to help carry out this McCullagh system.

Obituary.—We much regret to have to announce th sudden death on March 31 of the Earl of Suffolk an Berkshire, a director of the City of London Electric Ligh ing Company, of the British Electric Traction Company and other electrical undertakings. Lord Suffolk may n have been personally known to many of our readers, b those who had the honour of his friendship have lost staunch friend, and his co-directors a wise colleagu As a director he was one of those rare men who nev missed a meeting, and never spoke unless he had som thing to say worth the saying, and even then a very fe words sufficed, and it is merely a truism to state that th directors of the companies with which he was connect have lost a wise and most valued colleague, whose pla they will find it very difficult to fill. No one who ca across Lord Suffolk could fail to have been struck by h

inaffected nature, his terse witticism, his kindliness and courtesy to all, or to recognise in him a true an English gentleman. His death has come most tedly, and as a great shock to his friends. We ith these few words to record our appreciation of its, and to offer our most sincere and respectful by to those near and dear to him, to whom the loss irreparable.

aber of Commerce.—At the recent meeting of trical Section of the Chamber of Commerce attention ected to the appointment of a Joint Committee of ses of Lords and Commons to consider the question rical Energy (Generating Stations and Supply), and r it was desirable to confer powers for the com- acquisition of land for generating stations within out the area of supply, when the following resolutions nanimously adopted: "That the Electrical Section London Chamber of Commerce is of opinion that ciple of the reference to the Joint Committee of ses of Lords and Commons on Electrical Energy ting Stations), should be supported." "That the municipalities and companies interested in electric be asked to support the principles contained in erence to the Joint Committee." "That the g be appointed a committee (with power to add to mber), to take such action with regard to the of the Joint Committee as they may deem le: Sidney Morse, chairman of the section; ler Siemens, deputy-chairman; Sidney Dobson, E. Albert Gay, and T. J. Walker." It was also to urge the council of the Chamber to make further tations to the Board of Trade on the subject of rpretation to be placed upon the provisions of the ailways Act.

North-East Coast Institution.—This institu- engineers and shipbuilders are proposing to make terations in the constitution and by-laws. At a meeting to be held at Sunderland on Monday next ident will announce this fact, and resolutions will gly be moved by him at the next meeting. The ticle of the constitution it is proposed to alter so nclude 18 vice-presidents on the council instead as at present. As is obvious, all the vice-presi- n then pass directly up to the presidential chair, so vided by a change in the tenth article of the con- that three at least shall retire each year after d of six years' service. No other changes of nce are proposed, but an addition is to be made to No. 33 to the effect that a synopsis of the subject- of each paper shall be forwarded to the secretary writer for insertion in the circular convening the at which the paper is to be read. At the meeting onday, the president, on behalf of the council, will te the following gentlemen to be balloted for to fill vacancies in the council: as president, Sir Benjamin rne; vice-presidents (if proposed alterations in the tion are agreed to 12 will be elected, if not three ll be elected), Messrs. G. H. Baines, W. J. Bone, k, Arthur Coote, John Dickinson, C. D. Doxford, lliam Gray, Messrs. G. B. Hunter, Arthur Laing, Morrison, John Tweedy, Colonel P. Watts, and Mr. stgarth; hon. treasurer, Mr. G. E. Macarthy; y members of council (five to be elected), . W. Hök, W. C. Mountain, H. B. Rowell, A. G. ler, G. W. Sivewright, and Henry Walker.

eet Watering from Electric Trolley Cars.— mployment of an electrically-driven sprinkler is finding favour in America, and doubtless will also d in England when the electric lines are more general. The *Scientific American* contains details of one of the latest forms of the electric road sprinkler. This trolley sprinkler has a capacity of 25,000 gallons of water, and by means of rotary electrically-driven ejectors the water is thrown out from the car to a distance of 50ft. if desired. The width of spray can instantly be reduced, and at the same time the mechanism permits the varying of the quantity of the water discharged, so as to give the operator complete control of the spray and quantity of water discharged, so as to meet instantly any changes in the width of the road or the speed of the car, and the spray can be entirely shut off if desired. Both sides of the car are equipped so that it can move in either direction. The ejector consists of a four-roller gunmetal rotary pump, with adjustable casing for regulating the flow of the water. The ejector is operated by an independent differential gear electric motor, and there is no connection between the movement of the car and the operation of the ejector. Two separate sprinklers of the ordinary kind are placed below the front and rear of the car for watering the space between the tracks. These are controlled by lock stops separate from those of the side sprays. The car is fitted with two 25-h.p. propulsion motors, the same as an ordinary electric passenger car, and can be run at any speed without interfering with the sprinkling device, which, on account of its adjustability, can discharge the same amount of water on the roadway, irrespective of the speed at which the car is travelling. The Miller-Knoblock Company, of South Bend, Indiana, are putting this sprinkler on the market, working on the patent of Mr. William H. Miller.

Competition in Electric Lighting.—The matter ventilated under this heading last week is still receiving attention in the columns of the daily Press. The *Times* published on the 13th inst. a letter by "A Burner of Electricity and Ratepayer of Marylebone" which shows very false argument. He says that "in order to supply electric light cheaply two conditions are essential—the one is to minimise the capital expenditure, the other to keep down the working expenses. Instead of doing this the effect of the vestry competing would be exactly to double the capital and nearly to double the working expenses. There would have to be erected and equipped costly generating stations, and there would have to be buried in the ground hundreds of miles of cable. The stations would be in close juxta-position to the existing works, while the cables would have to lie side by side with the present network, the existing works and cables being already amply sufficient. Then, when all the works had been constructed, the whole of the annual working expenses, maintenance, and supervision would have to be provided for. Now, who ultimately has to pay for all this useless expenditure? Undoubtedly the consumer will have to do so. Neither a vestry any more than a private company can afford to sell light at less than cost price; the only way, therefore, to benefit the consumer is to decrease the cost of production." Again, "the safety to the consumer consists, not in useless and expensive competition, but in the fact that every electric company is doing its utmost to produce cheaper, so that the price charged for electric light may compete successfully with gas and mineral oil." This is the old trades union argument that there is a certain definite quantity of work only to be done. The competition will by reducing the price still give ample load to the competitors, and at the same time leave a margin of profit.

The Shannon and Electricity.—A specially-convened meeting of the Limerick Fishery Conservators was held at Limerick on the 8th inst. to hear a deputation from the Shannon Electric Power Syndicate with reference to

the pending scheme for utilising the River Shannon as a motor in the production of electricity. Lord Lurgan, Colonel Sir Gerald Dease, Mr. H. J. Fuller (engineer), and other directors attended to explain modifications of the original scheme. That scheme proposed the impounding of Lough Allen and the conversion of the lake into a storage reservoir, the waters to be utilised on the gravitation principle. It was pointed out that during summer and seasons of drought the spawning beds and fisheries of the upper reaches of the Shannon might be adversely affected by the reduction of the ordinary summer level. Lord Lurgan explained that the syndicate desired to approach the conservators in a distinctly friendly spirit, and did not want to injure the fisheries or anyone's rights or interests. By the present scheme they did not propose to regulate the waters of the Shannon at ordinary summer level, but to take the overflow from the river in the winter months and maintain the present summer level by utilising steam power when necessary in the driest months. If the scheme were a success, it must lead to the development of business and the industrial resources of the district. Mr. John S. Place said they heard on a former occasion Lord Lurgan and Mr. Fuller declaring that the Shannon was a Niagara going to waste. The directors did not seem to know their own plans, so indefinitely were they put. First Lough Derg was proposed as a reservoir, then Lough Allen, and now they had a third scheme. The present scheme would, in his opinion, injure the spawning beds and impede the passage of fish in the river. In reply to questions, Mr. Fuller said the horse-power to be used all the year round at the works of Castle Connel would be 5,000, the maximum being 10,000. The matter was adjourned to the next meeting of the conservators.

Commutators.—Mr. George T. Hanchett is contributing a series of articles to the *Street Railway Journal* on electric railway motors. The following extracts from his chapter on commutators will be of interest: "Even after the advent of the carbon brush the commutator and brush-holder remain one of the most difficult parts of railway motor construction. Railway armatures of necessity operate with fixed brushes, for even if means for adjusting their angular position were provided, it would not be possible to manipulate them when the motor was operating, and at such times only is any benefit to be derived therefrom. The rapidly varying load on the railway motor is always shifting the line of sparkless commutation, and even though good design may reduce the shifting to a minimum, the conditions are very conducive to sparking. Cast or even tempered copper is not to be recommended for this commutator. Drawn or drop forged copper are the only suitable materials. Regarding insulated segments, continuous strips of mica are to be recommended. Built-up mica segments are not suitable, for they harbour conducting particles and frequently start a bridge between two bars, which results in the destruction of the two coils connected between them. The mica which may be used in commutators is of two kinds—namely, amber and Indian mica. Of these the India mica is the best electrically considered, but amber mica has advantages that renders it more suitable. A mechanical consideration enters here. The commutator should wear down evenly the segment as fast as the copper. The copper is subjected to an electrical gnawing action, due to small sparks as well as simple wear. If the mica segments are made too thick, the bar will wear faster than the mica. Modern railway commutators require a segment at least $\frac{1}{32}$in. thick. If this be made of amber mica it will wear down with the commutator fairly evenly, but in order to secure equally even wear with Indian mica the segment must be thinner, about ·025in. or ·02in, and either of these latter widths of segment are too bridged by carbon and copper dust. Necessity d that India mica segments to give best mechanical must be thinner than is good practice electricall therefore railway commutators built with Indian mica invariably have faults."

Telephotos.—New words are coined so quickl it is difficult to identify their special meaning. I case, from what we gather from the extract in a paper, the telephotos is an old friend under a new Am name. Thus the telephotos consists of a series of four lanterns, lighted by groups of incandescent lamps, th double lanterns being hung vertically on a stron cable, the upper end of which can be run up to a ma or yardarm, while the lower end is intended to be fa to the deck of a vessel. The upper half of each l white, and has within it a group of three lamp rounded by powerful magnifying lenses. The lower red, and has four lamps in order to make the red the stronger, which are surrounded by heavy red The carefully insulated cable connects the lamps passes from the lower one to the deck or the bridge, a keyboard enables the operator to spell out th signals about as rapidly as a typewriter is manip and very much in the same manner. The keyb fixed to a standard and enclosed like a binnacl operator standing in front of it while manipulati keys. By a simple automatic arrangement, each depressed lights a combination of the four red a four white lights, making a letter or a number acc to the code of signals. All the operations are aut and the combination is made by one touch of th Another feature of the keyboard is that when one k down all the other keys are locked, so that another be accidentally pushed down, thus confusing the s Any key pressed down can be turned one quarte round like a screw, which motion locks it in pla leaves the signal burning in case it is desired to us a standing signal for an order in the secret naval Thus the keyboard can be used to telegraph or instructions by the usual letters, to send a cypher di or a special code order. Notwithstanding all this ap complication the keyboard is compact, and its mecha simple that it cannot be readily disturbed or got order. It is said that the United States Navy is rapidly equipped with this new signalling apparatus. also stated that the telephotos has been tried in the Navy, and that a number of sets of the apparatus h ordered for some of the largest English vessels. great mistake, however, to say that the signals can b out as quickly as a typewriter is manipulated. T always an appreciable lapse of time between the sw on of an incandescent lamp and its becoming incand

A Theory of Nervous Conduction.—Dr. Hedley, M.R.C.S. (Eng.), communicates an article above to the current number of the *Lancet*, ba analogy between the action of coherers and nerve calls attention to a paper presented to the Acadén Sciences on Dec. 27 last by M. Branly, who s certain points of possible resemblance between action and the conductivity of the nerves for n impulses. He points out that in reality there is n clear line of demarcation between continuous an continuous conductors; it is rather a question of Passing from artificial to "natural" conductors he that the use of the term "nervous current" sin earliest days of physiological research seems to p some recognised resemblance between nervous and el conduction. Until recently it was thought that the

s of the nervous system were continuous. Now, e advent of that trinity in unity known as the the nervous system may be regarded as composed ntinuous elements—*i.e.*, of elements contiguous but tinuous. It thus becomes possible to regard the as the counterpart of the metallic granule of discontinuous conductors. As a blow will weaken en abolish the conducting power in the latter, matism may produce anæsthesia and hysterical is—the latter due to a suppression of transmission, or motor, of the nervous influence consequent on tive contiguity of nerve elements. Again, as the on of electrical discharges establishes the conduc- f discontinuous conductors, so it is known that such ges act efficiently in the cure of paralysis and al anæsthesia. The possibility, therefore, suggests at in both cases the effect is determined by bringing he contiguity of the elements of the conductor or dification equivalent to contiguity. The parallelism the action of a blow and of sparks upon dis- ous conductors and upon the hysterical nervous may be carried further in the susceptibility common of reacting under a feeble stimulus when once a l action is produced as a first effect—a condition I. Branly has referred to in a former note to the y as "sensibilisation par un premier effet." The quency discharges and the electric oscillations ccompany them are specially apt to make discon- conductors conduct, and it is such discharges that en shown by d'Arsonval to have therapeutic effects ses due to perverted nutrition. If the latter s are of nervous origin and are due to imperfect sion of the nervous influence, it is permissible to that electric oscillations act by re-establishing in re a contiguity which had become insufficient. The riter has recently shown that continuous currents ficient E.M.F. produce in discontinuous conductors e effects as discharges at a distance. It would be ing, he suggests, to enquire if the mode of action inuous currents in diseases of the nervous system hey have proved useful presents features similar to hich occur in discontinuous conductors. It is not by M. Branly that anything more than a mere has been shown, but he thinks it possible that nsiderations may prove a useful guide in determining dality in which electricity is to be employed in a ase and perhaps furnish the electro-therapeutist good working hypothesis. So far it is evident that eculations fall very far short of this. All that can ned is to have made out a case for further enquiry. line of investigation has already been foreshadowed article by Dr. Hedley which was published in the May 4, 1895, and in which the following sentence : "It seems even conceivable that other histological ments—*e.g.*, those nerve fibrils which conduct yet ouch and do not anastomose, those motor nerve s which are only in contact with the sarcous substance; , any conducting arrangement in the animal body may be classed as a 'bad contact'—may constitute ysiological analogue of what would be electrically as 'a coherer.'"

itution of Junior Engineers.—At the meeting institution held at the Westminster Palace Hotel on t inst. a paper on "Mechanical Refrigeration" was y Mr. J. T. H. Ledicotte-Burrell, of Peterborough. ducing the subject, the author stated that though portance of mechanical refrigeration as a branch of ring was only just beginning to be recognised in ntry, it had long received attention abroad, notably in Germany and America. Refrigeration might be brought about in three different ways: (1) by the liquefaction of a solid (*e.g.*, freezing mixtures); (2) by the evaporation of a liquid (*e.g.*, water, ammonia, etc., in vacuum, compression, and absorption machines); (3) by the expansion of a gas (*e.g.*, cold-air machine). The first method by freezing mixtures, such as iced salts, was scarcely adapted to use on a large scale, and where ice was employed depended on another system of refrigeration. Of the third class the cold-air machine was the sole exponent. In this the air was compressed, the heat of compression being removed by cooling water, allowed to expand in another cylinder doing work. The air so cooled ventilated the chambers to be cooled, and in some cases was used over and over again, while in others fresh air was taken in at each stroke, and the refrigerant rejected along with the refrigeration. On account, however, of their low efficiency and huge dimensions, these machines were not so much used as they otherwise doubtless would be. The principle which formed the basis of most systems of refrigeration was that which took advantage of the latent heat of evaporation of liquids with low boiling points. Machines whose working was governed by this principle were of four classes—viz. (1) vacuum, (2) compression, (3) absorption, and (4) mixed absorption and compression machines In the vacuum machine water was the medium, its evaporation at low temperature being effected by a vacuum. The simple vacuum machine was comparable to the ordinary compression machine, the vacuum pump corresponding to the compressor. In another type the vacuum pump was assisted by H_2SO_4, which absorbed the water vapours as soon as formed, this making the principle that of a mixed absorption and compression system. In all the other vaporisation machines the medium was some other than water, and owing to its high latent and relatively low specific heat ammonia was that employed in the majority of instances. Carbonic acid, requiring the smallest size compressor, but working at very high pressures, was also somewhat largely used, though with condensing water above 90deg. F. it was incapable of liquefaction, and so then came under the heading of gas expansion machines. Other liquids to be found in use were sulphurous acid, Pictet's liquid, ether, etc. In ammonia compression machines, liquid anhydrous ammonia (NH_3) was evaporated in the refrigerating coils, causing a loss of heat equal to the latent heat of evaporation at that temperature. Thence the vapour passed to the compressor, where it was compressed into the condenser. Here it again liquefied, and thence passed to the refrigerating coils to re-evaporate, completing the cycle. Calculations of refrigeration produced, work of compressor, ammonia to be circulated, size of compressor for a given capacity, lost work, coal per hour, efficiency, work of condenser, piping required, cooling water, jacket water for compressor in "hot-dry" compression, and extra amount of ammonia to be circulated in "cold-wet" compression, were dealt with by the author. The absorption system was then described. A description of the Simplex machine was then given as an example of the latter type of machine. It had the advantage of not requiring skilled attention, there being no pump or other moving parts, and there was no increased consumption of steam for lower temperatures, as was the case in compression machines. The modifications of the general absorption formulæ in regard to the Simplex machine were referred to. The discussion which followed the reading of the paper was opened by Dr. Hampson, who gave in the course of his remarks an interesting account of his liquid-air apparatus. Mr. H. G. Christ, Mr. A. H. Tyler, Mr. W. J. Tennant, and the chairman also spoke.

THE PRESENT USES OF AND FUTURE PROSPECTS OF ELECTRICITY ON BOARD SHIP.*

BY E. GEORGE TIDD, A.M.I.C.E., ETC.

(Continued from page 439.)

Another point to which attention must be given in considering the engines is the steam pressure available. As a rule, it is necessary that the electric light machinery shall be able to be worked off the donkey boiler, as it would be uneconomical to keep one of the main boilers under steam when the vessel is in port. As the steam pressure for donkey boilers generally averages from about 80lb. to 120lb. per square inch, it means that this is the pressure at which the electric light engine has to work frequently. This necessitates, therefore, when the electrical machinery is working from the main boilers with their higher pressures, the introduction of a device called a reducing valve between the boilers and the engine; the principle of this is that, whatever the steam pressure on the generating side of the valve, the pressure on the other side is always constant; in practice the steam from both the donkey and main boiler is passed through this valve, and it is generally set at a little below the working pressure of the donkey boiler, so that slight variations in the steaming of the boiler will not affect the electrical machinery. One of the most satisfactory is Ogden's valve, which has been extensively used by the author with very satisfactory results.

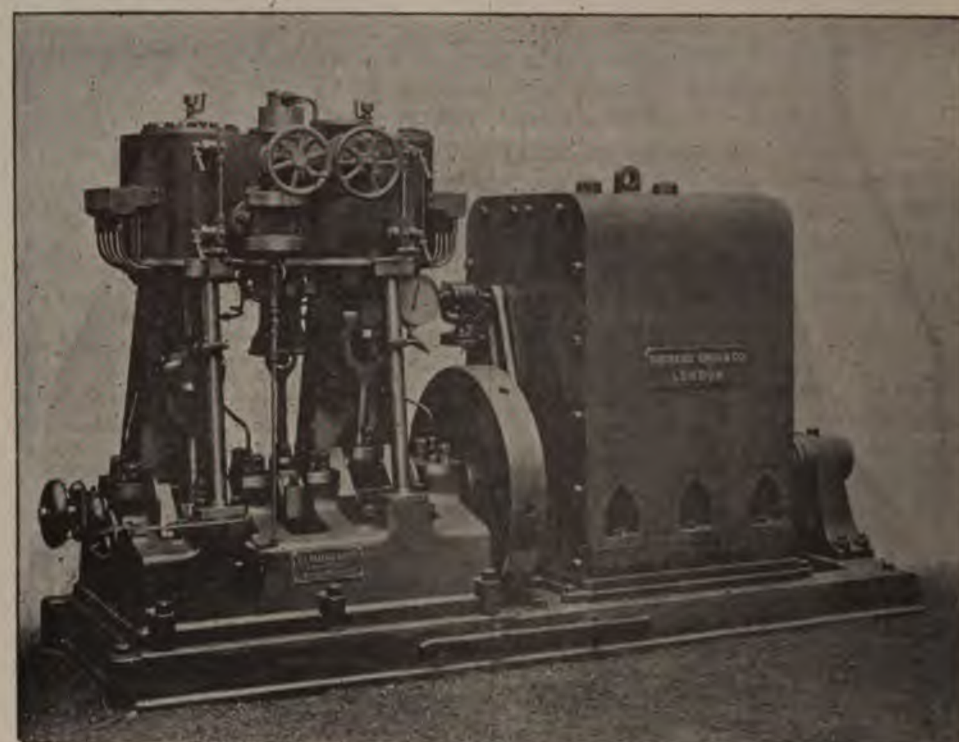

FIG. 6.—Belliss Compound Engine and Iron-clad Dynamo, as made for the Admiralty.

Another point in connection with the steam and exhaust of the electrical engines must have careful attention. This is the arrangement of the connections of these pipes with the general system of pipes in the ship. First, as regards the steam supply. It must be insisted on that this is taken direct from the boiler, and not from a branch pipe that supplies other auxiliary machinery, such as starting gear, winches, etc., as the working of these is bound to cause varying steam pressures, and therefore unsteady light. The same thing applies with even greater force to the exhaust pipes, which are generally led both to the condenser and to the exhaust box, open to the air, a two-way cock being fitted to change from one to the other.

The dynamos next claim our attention. Although the author believes that in the very early days one or two of the Atlantic liners fitted with the electric light used alternating-current dynamos, now without exception continuous direct-current machines are used for this purpose. The machines are always compound wound, unless in exceptional cases, such as when accumulators are used, when they are shunt wound, or are a combination of both. The almost universal practice with makers is to build them of the inverted vertical type, with armature at the bottom, and with either wrought-iron or cast-steel magnets and yoke. There are several advantages belonging to this type of machine. In the first place, it adapts itself more readily for direct coupling on to the engine cra[...] although if either wants raising it is the dynamo, [...] tends to keep it higher up out of wet, etc., that [...] be about the engine-room floor. Ship-lighting dyna[...] built with either drum, bar, or Gramme ring arm[...] according to the different makers' practice. The dr[...] bar show certain advantages over the Gramme ring, [...] now the most generally used. The author, at any rate for [...] sized machines, has still a preference for the Gramme ri[...] of winding, provided that it is thoroughly well desig[...] built, on account of its simplicity and the far greater [...] there is of a non-technical engineer being able to re[...] breakdown, should such occur when an electrician o[...] appliances are absent. As has been before mention[...] most general is the two-pole inverted type, but menti[...] be made of the most recent Admiralty practice, alth[...] is not yet to any extent used in the mercantile marin[...] is what is known as an iron-clad dynamo (Fig. 6), [...] supposed to have no stray external magnetic fiel[...] generally built either two-pole or four-pole, and t[...] practically forms a box entirely surrounding the mag[...] and armature.

A few words may now be devoted to the commutato[...] etc. Although mica is generally used by most maker[...] insulation of the commutator, yet the author has co[...] commutators on board ship insulated with fibre; this [...] no account to be permitted, but mica should be insis[...] in all cases. Various brushes are advocated by different [...] and sometimes when one kind of brush does not g[...] results with a particular machine, another kind will do [...] rule, the author prefers copper gauze cut on the cross. [...] are sometimes made of brass or copper wire, thin copp[...] plaited fine copper wire, etc., and even sometimes of [...] although this is more often used with motors.

The outside dynamo bearing is now generally fit[...] automatic ring or chain lubricators, which consists of [...] chain hanging on the shaft within the hollow pedes[...] latter forming an oil reservoir into which the ring dips [...] as it revolves, carries oil up on to the shaft and so [...] bearings.

Almost all dynamo builders in the country have, [...] supplied machines for shop work, and seeing that a shi[...] machine is no different to a high-class land machine [...] that a faulty one is more likely to cause trouble sooner [...] ship, there is no reason why they should not. At t[...] time the following firms may be considered to have [...] made a name for shiplighting machines—viz.: Siemens [...] Crompton and Co.; J. H. Holmes and Co.; Clarke, C[...] and Co.; W. H. Allen and Co.; Paterson and Coop[...] Laurence, Scott, and Co.

We pass now to the consideration of the main swit[...] This should be placed as near as possible to the dyna[...] in such a position that the instruments can be convenie[...] from the engines when adjusting the governors or [...]

* Paper read before the Glasgow Students' Association of the Institution of Civil Engineers, Jan. 10, 1898.

Care should also be taken that as far as possible the s not against the side of a coal bunker, just under the where it would be likely to get violently shaken. Each has his own ideas as to the best arrangement for a ship but the general principle is the same. For an installa-h a single dynamo there is no need to have a main switch, although there must be main fusible cut-outs, each pole. From these the currents divide into a number its, one running to each section of the ship, and each tted with a double-pole switch and double-pole cut-out. this all that is needed on the board is an ammeter in n dynamo circuit and a voltmeter across the dynamo ls. With two machines the arrangement of the an be similar, except that the circuit switches be two-way throw-over switches, so that any can be put on to either dynamo. It is also e to have two ammeters, one for each dynamo, as heavy currents any arrangement of a change-over plug costs very little less, and is not nearly so satis- One voltmeter is, however, quite sufficient with a -way voltmeter switch. With an installation consist-ore than two dynamos a more elaborate switchboard is . In the first place, each dynamo, besides its main must be fitted with a main switch. In a case where but three dynamos, and where only two are needed to

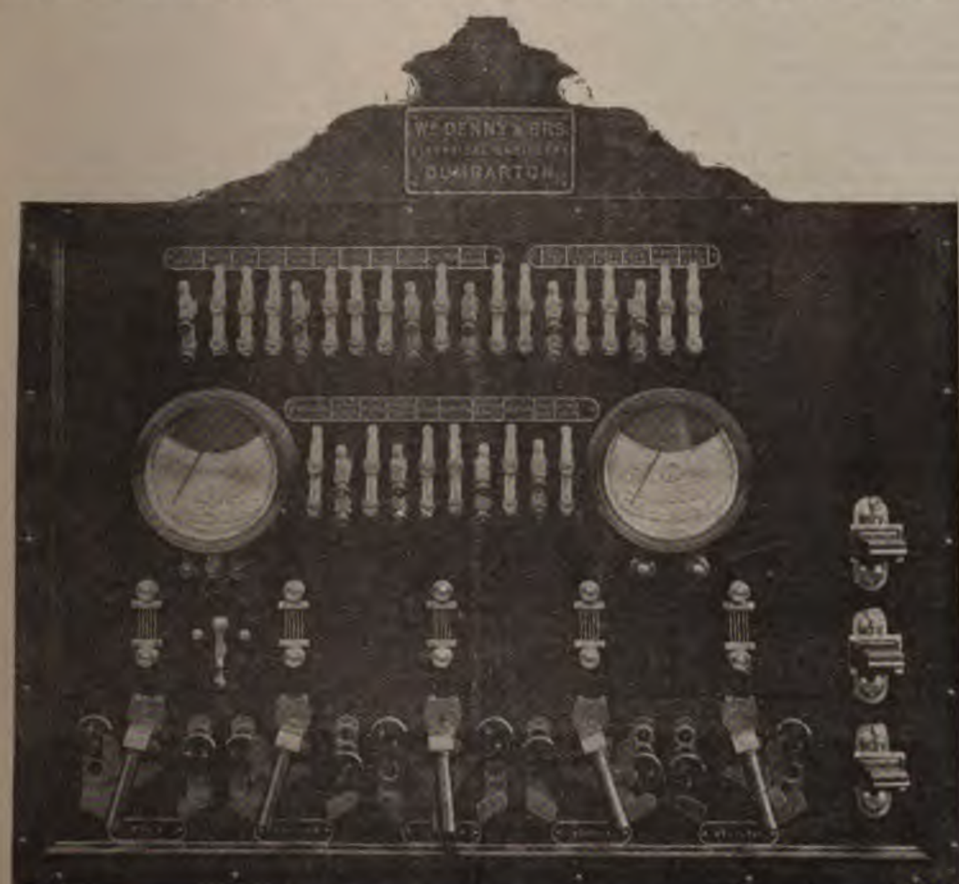

FIG. 7.—Switchboard for Three Dynamos, as made and fitted by Wm. Denny Bros.

he same time, a convenient arrangement is to make the tches in the form of throw-over switches with an "off" with these switches either dynamo can be put on to two 'bus bars, the circuits being distributed between desired by means of the throw-over circuit switches. are more than three dynamos it is best to adopt a plug place of throw-over switches, putting a throw-over the circuit only.

shows one of Messrs. Denny Bros.' boards for a ship ree dynamos. The dynamos are connected to bars at and according to the position of plugs one can connect he circuits to any of the dynamos, and then switch over dynamo to the other by means of the butterfly switch. ments are on the left and the right, the voltmeter three-way switch. The small switches at the top are e of the circuits that were sub-divided on the main In selecting switches for the boards it must be borne that they are to be used by engineers who will pre-know the proper way to use them, so that it is better a good mechanically strong plain switch than one ted by the introduction of numerous special details to quick break; no intermediate position, and so on, pre-that are necessary when the switch is to be placed in nced hands. Another point to remember is that the switch will always on board ship be subject to a certain amount of jar, so that a switch must be selected that has no spring tending to "break" the circuit. As regards the instruments, these must not, of course, be of a gravity-controlled type, but must be controlled by a strong spring or magnetic field. The scales should be as long as possible, and especially the voltmeter scale should be very open about the normal working voltage of the machine. In making up a board, the author prefers slate to mount the fittings on, the objection to this being the low insulation sometimes experienced owing to the metallic veins contained in it; this difficulty is overcome by bushing all the holes through which conducting pins pass with ebonite and mica washers between the bolts and slate on either side.

Accumulators are so little used that there is no need to enter into details about them; they are practically only found on yachts for running the lights when the boat is at her moorings, and when the possible noise of the engines might cause annoyance, not to mention the uselessness of keeping up steam all night to run the plant for perhaps only one or two lamps. Another case where they are sometimes found on board ship is in the case of electric launches.

THE WIRING AND INSTALLATION.

In deciding to fit a vessel with an installation of electric light, perhaps one of the most controversial points that comes up for consideration is the system of wiring to be adopted. There are three chief systems to select from, all of which have their advocates amongst people whose experience is not to be gainsaid. These three systems may be stated as follows:

(1) *Double Wire with Insulated Return.*—This is the system most generally in use for land work, and a large proportion of ship work is also done on this method, and which in the author's opinion shows decided advantages over the other systems in vogue. In it the whole of the electrical conductors are well insulated from the ship, and therefore from the earth, this applying to both flow and return leads, so that there is a double security from breakdown, as a leakage on one lead only would not necessarily cause a failure of the light.

(2) *Double Wire with Earthed Return.*—The best example of this method is the well-known concentric system, which has been brought to such perfection by Messrs. Mavor and Coulson. In this there is a metallic sheathing entirely surrounding the single conductor, this sheathing forming the return lead, and which is naturally in contact through the skin of the ship to earth. The advantages of this system lay in its absolute safety from any danger of fire, if properly fitted; while, in the author's opinion, its disadvantage consists in the special and more intricate manipulation required for the fixing and repairing, and also the greater liability of breakdown.

(3) *Single Wire with Ship Return.*—In this system there is only one ordinary wire carried to each lamp, the other pole being attached to the skin of the ship. The merits of this system undoubtedly consist in a greater simplicity, there only being one-half the number of conductors used on a double-wired job, besides which the fittings are much simplified, there being but one pole to insulate instead of two. On the other hand, the risk of breakdown is doubled. The danger of fire is not reduced, as in the concentric system, but is, rather, increased, owing to the number of joints that have to be made to the skin of the ship, each of which is a source of danger unless most carefully done.

This paper is not intended to take up the often-fought battle between the various systems, but rather to set forth what is actually being done in each method. One point must be mentioned, however, that tells strongly in favour of the first method, and that is the effect that the single-wire or earthed return system has upon the compasses. To so great an extent is this admitted that any installation carried out on these lines has to have all work carried near the compasses done with two insulated wires. In practice, also, it is generally found more convenient to run double wires for all the accommodation lights, as owing to the panelling and woodwork it is often difficult to obtain a good earth connection near the lamp.

As to the conductors themselves, these can either consist of single copper wires insulated with vulcanised rubber, or these two wires can be laid up side by side to form a twin cable, and this is of special advantage where they are to be armoured, as one armouring does for the two conductors; or they may be in the form of concentric cables, either, as previously described, with the outer sheathing forming the return wire, or with a second conductor surrounding but insulated from the first, this being in its turn suitably insulated and protected. The advantage of the single wires over any of the other systems is the simplicity of the work of installation and repairs, as if the work is done on a distribution system there is no need of joints of any kind, so that should anything go wrong with a lamp, if the fault could not be found or repaired, any ordinary man could take out the damaged length of wire and put in a new piece. Twin conductor is very convenient where no switches are needed and the two wires require to run side by side from one point to another, but if a branch has to be taken off to a switch, their advantage is gone. As regards safety, however, they approach more nearly to the concentric ideal. Concentric wiring, as has been before intimated, has its chief advantage in the fact of its safety, it being very much more difficult to instal in the first instance, also to localise faults and to repair them when found; special fittings are also required, and also an experienced man to do the work of repairs.

The method of arranging the circuits in the early days was on what is known as the "tree" system, which consisted of running a pair of main cables fore and aft from the dynamo, and from these cables taking branches wherever lights were needed. Now, however, amongst all the better class of installations, at any rate, this arrangement has been quite replaced by the "distribution" system. Briefly, in this method, mains leave the main switchboard and run direct without branch to the various parts of the ship, where they terminate in multi-circuit distributing boards; from these boards circuits again run without joint to fuseboards. The author's practice is to make each pair of fuses on these fuseboards control one lamp only, so that from these boards the wires run direct to each lamp again without joint. The advantages of the system are many and obvious, the chief being that instead of having fuses dotted all over the place they are all kept together in clusters; further, it being almost impossible by accident to run a circuit unprotected by a fuse; also, the fuses being in a few clusters, and easily accessible, they can be periodically examined to make sure that they are in proper order and have not been tampered with. The greater ease with which faults can be found and repaired is also greatly in its favour.

There are various types of distributing and fuse boards, but for ship work the author prefers plain terminals to the various kinds of clip fuses, seeing that they are always supposed to be under the charge of experienced men. The most popular type of switch now on the market is undoubtedly the tumler, and there are perhaps as many of them in use now as of all other types put together.

Special fittings have been designed to meet the needs of various positions, but time does not admit of a detailed description of these. As regards the engine-room and so on, the most general style consists of plain fitting with clear-glass jars fixed on with a screwed washer, either fitted with a guard or not, according to the position in which they are to be placed. In the saloons and stateroom, etc., the fittings are of a more ornamental type, many owners having their own particular patterns. In some cases they can be combined with oil lamps, but do not present a neat appearance, and with the present state of electrical machinery it is not necessary to anticipate that these will be needed. The holds are not often fitted with fixed lights unless they are likely to be used for carrying cattle, emigrants, etc. When they are fitted it is either with a deck

pendant from which, when not in use, the glass and
removed and an iron cap screwed on in their place
fitting with a heavy cast-iron hinged door is used,
be fastened over the lamp to guard it from damage
in use. The most convenient form of fittings for li
deck are bulkhead lamps placed against the deck hou
it must be noted, should always be arranged as far a
on one switch, so that they may be switched off whe
through the track of other shipping, else there is a
mistakes being made in the signal lights by passing v

Masthead and Side Lights.—On most ships that
electrical installation these are fitted for electric
although the authorities insist upon oil lanterns bein
vided. The author prefers, where possible, to arrang
set of lanterns, one for the oil lamps and the oth
electric light, but this cannot always be done conveni
the case of the masthead light, however, it can
arranged, and should be insisted upon. A bracket i
the mast, generally a little above the shrouds, just ab
reach when standing on the collar of the mast, a
bracket the lantern is firmly secured. The best wa
the leads is up an iron pipe clipped to the mast. S
use armoured cable, but this is rather liable to sag be
fastenings, and chafe. The author has heard of firm
the leads down the inside of the mast, but this is a
mistake, as the rolling of the vessel is certain to ru
insulation off the wires in a very short time. In ca
pipe up the mast it should be carried on the f
should run straight into the bottom of the lant
jecting an inch or two inside, so that should
get inside the lantern it will not run down. The p
fitted with a lock nut both inside and outside th
so that when screwed up tight everything is secu
side lights, arranged as fixtures, should be fitted in
way, care being taken that the pipe enters from th
and not from the side, otherwise the lantern will not
be removed without unshipping the pipe. In the
swinging screen being fitted it will be necessary to car
of Sphincter hose from the termination of the pi
lantern. Where it is impossible to get a position for
of independent lanterns, the wires must be carried to
box. The form which the author prefers is made of
with an hinged lid and a screwed nozzle, to which
carrying the wires are run. Inside the box is mount
or porcelain tablet carrying the two terminals. This
box should be fitted quite close to the lantern, and
possible, be arranged on the underside of a deck so as
all risk of water accumulating in it. From this box sh
of lead are carried to the lantern. This is fitted wi
carrying an incandescent lamp, which fits into the sl
oil lamp. It might be remarked that Lloyds do not
passing this method with loose wires, and to try and
the author has arranged them in a piece of armoured
unions at both ends screwing into the terminal box an
respectively. As for, however, as the Board of Tra
cerned, it is necessary to have independent lantern
have a special tint of green glass that they insist up
used for electric light, and which is of a more bluish
the glass used for oil. Another point to be borne in
connection with the Board of Trade Survey is the fa
the side lights only one lamp is allowed in each lantern,
no limit is made as to the masthead lamp; the objec
stipulation is on account of screening them to the cor
required, which would be impossible did the light ema
more than one point. The best arrangement to mak
four ordinary 16-c.p. lamps in the masthead light, an
32-c.p. lamps in the side lights; these special lamps
filaments in parallel in the same globe, so that should
the light is not entirely extinguished. Care should,
be taken to daily examine these lamps to make sure
filaments are all right, and the lamp must be change
one of them gives out.

While on the subject of the signal lights, mention
made of the various types of indicator that are used
that they are burning satisfactory. One of the most
of these is Martin's mast and side light indicator;
trivance not only indicates when a side or masthead
but automatically replaces it with another. There a
other similar contrivances in the market, but this is
the most generally used.

Cargo Lights.—Another important item in connec
an electric light installation on a merchant vessel is th
arrangement of the lights for working the cargo.
companies have different ideas as to these, some super
preferring arc lamps, some high candle-power inc
lamps, and some clusters of small incandescent lamp
rally speaking, the author is inclined to prefer the
they are far more easily handled than an arc lamp, an
a much less risk of breakage than with a high can
incandescent lamp. The latter are very liable to be brok
necessary more or less rough usage they are bound to
to; but a cluster of small lamps, on the other hand, c

ide a guarded reflector, and even a comparatively heavy not likely to do them much harm. At the same time, ertain conditions, there is no doubt that arc lamps are of at service, and they are being largely used now. For , in a vessel where the holds themselves are fitted rith fixed lamps or with separate portable lamps for use there is not the need to so arrange the cargo cluster as r a light down the hold. Further, should the quay itself r lighted, then under these conditions an arc lamp or two ith very great advantage be hung well up so as to give a light over the whole of the loading or unloading opera- The connections for the cargo lights, whatever kind to be fixed, consist of well-insulated cable, either twin eparate conductors; these must consist of a number of ie strands, so as to render them more or less flexible, there is no need to have them so fine as what is ly understood by term "flexible wire," as this would hem so much weaker mechanically. Some form of it connector box is fixed, generally one (or two) at h; in some cases this takes the form of some kind of iection. The author, however, prefers a pair of heavy , with butterfly nuts, mounted on a slate tablet with id fuses, the whole contained under a watertight iron

SUEZ CANAL PLANT.

some eight or ten years ago the directors of the Suez imated to the shipping world that, if suitably equipped necessary electric lighting gear, vessels would be per- pass through the canal at night, shipowners that used rway at once largely took advantage of the permission. is understood that there is sometimes upwards of a in this way, it will be at once seen what an important i it was.

ief requirements of the company as issued in their tice was as follows: (1) The vessel must be provided electric projector, suspended over the bows, and as ie water's edge as possible. This projector must be of throwing a beam 1,200m. ahead. (2) There be provided an electric lamp and shade suspended upper deck, and powerful enough to light up a circular 200m. diameter. Beyond the above regulations, 1, 1893, a further notice was issued, specifying a ype of lense that was from that date to be fitted ips navigating the canal at night. In the words notice, the advantage to be derived from the his additional fitting will be made clear by the short description of the conditions under which ross one another in the canal at night. In the of the canal where the widening is still under progress is now completed throughout, the author believes.) s one another at the Gares only and by signal from the ie ship which is ordered into the siding being permitted er electrical projector alight, while, on the contrary, which is presently to pass her extinguishes her own , so as to avoid blinding the crew of the ship that is ay for her. In the widened portions of the canal ships d to cross one another at any point without signals Gare, one ship stopping and making fast and then hing her projector while the opposite coming ship slows ass her; certain rules being laid down as to which of ships shall stop and moor. The only difficulty that r experience in crossing each other under those condi- in a correct estimation of the distance which separates estimation being somewhat impeded by the blinding he two projectors as they near one another. In order this, the beam of light from the projector should be into two portions, each of 5deg. opening, leaving a ark portion, the effect of this being that, while the l sides of the channel continue to be lighted, no direct rown on the approaching ship herself, and her mast- its remain clearly visible, thus enabling the distance the two ships to be much more quickly and accurately l. In the great majority of ships navigating the canal by means of the electric light, this result may be readily by the addition of a panel of prismatic diverging lenses he ordinary panel cylindrical diverging lenses with se electrical projectors are already provided. In the ips using other kinds of projectors, some other equally d effective method of producing a dark interval of ning on the centre of the beam of light must be

anner in which these requirements are carried out are . First, as to the power: If the vessel is fitted with ic light, arrangements are almost certain to be made ng the necessary gear from the ship installation, even the projector and lamp might not be carried. The ents required are suitable terminals for connecting the lamp to, which may consist of a connecting box, as for cargo lamps, and, in fact, one of these might them- used, although the author always prefers to fit an ent connection, and in this case he generally fits the resistance permanently in the main engine-room near the switchboard, or some other convenient position; the connector box itself can very conveniently be fitted under the bridge deck or against the deck house. Besides this there must be a connection arranged for the projector, and the author generally prefers to fix a suitable resistance and switch with two heavy terminals on the forecastle, and in the deck overhead and as far forward as may be convenient a deck tube with screwed cap through which the connecting leads may be carried over the bows to the projector. On the other hand, should the vessel not have its own installation of electrical machinery, it is customary to hire a set of plant complete from some of the numerous firms who cater for this kind of work and who will send a man along with the vessel to work the projector. The plant generally consists of a direct-coupled single-cylinder engine and dynamo, similar to those previously described, and there are generally mounted on the dynamo the necessary switches, instruments, resistances, and terminals; this will be slung aboard complete, and put down on deck near one of the forward winches, from which a steam connection will be made.

Then the way the second of the two canal requirements is met is by means of an ordinary arc lamp, which is generally wound to take 12 amperes. It is always fitted with either a clear-glass globe or clear-glass lautern. Wires are led directly from this down to the terminals provided. The first requirement with the further conditions is met by a special form of arc lamp known as a projector. The general size as used on the Suez Canal is a 20in. one, or one having a mirror of 20in. diameter. The projector consists of a cylindrical metal body suitably ventilated, with at the back a parabolic mirror, and in the front a diverging lense giving a beam of light of about 15deg. Inside this projector is placed an arc lamp, which is generally fed by hand, although they are sometimes arranged to be worked automatically in the same way as an ordinary arc lamp, and sometimes they are arranged to be fed by hand, but to automatically strike the arc themselves. For this purpose the author prefers the hand-fed lamp. Although the automatic striking of the arc is very handy and convenient, still it means slightly more complication, which an ordinary quartermaster or engineer (and it is generally one or the other of these two who runs the projector through the canal) will not understand. On the other hand, with one of the hand-fed lamps he can see and understand all there is of it, and knows that he has to work the hand feed so as to keep the two carbon points a certain distance apart, and after a little practice he can do this, and keep every bit as steady a light as with an automatic lamp. The projector case is provided with small sight-holes of black glass at the sides through which to observe the adjustment of the arc. Some makes are fitted with an arrangement of small mirrors so as to bring the image of the carbon points to the back of the projector, where the attendant sits to work it. The projector itself is supported in trunnions on a swivel frame, the whole arrangement being bolted to a small railed platform or cage, which can be hung over the bows of the boat (Fig. 8). This cage is fitted with clamping screws, by means of which it can be clamped to the cut-water of the boat, and it is lowered as near as possible to the water's edge. It can be conveniently slung from the small anchor davit, which most steamers have now fitted in the bows. The projector is fitted with horizontal and vertical swing, worked either by hand or by worm gear. The lamp is fitted with an hand-wheel adjustment to centre the arc in the focus of the mirror, and also with the feeding gear by means of a right and left handed screw on which the carbon-holders work, and by means of which they can be approached or opened out. The carbons incline towards the lense at an angle of about 45deg.; a small metal disc is fitted in front of the arc so as to reflect all rays back into the mirror and to prevent any direct rays being projected through the lense. In adjusting the carbons it is also best to bring the centre line of the lower carbon some 3-16in. to ¼in. nearer the mirror than the top carbon so that the crater tend to face towards the mirror, and the greatest effect be obtained from the incandescent crater. The quality of the lense is very important, a good Mangin costing as many pounds as an inferior one does shillings. The lense is composed of a number of strips of specially-prepared cylindrical glass lense held in a gunmetal frame hinged to one side of the front of the projector. This gives a fan-shaped beam. In order to enable the bifurcated beam to be used, on the other side of the projector is hinged another gunmetal frame holding another similar lense, but with a middle panel of prismatic diverging lense instead of the cylindrical. When therefore it is required to change from a fan-shaped to a bifurcated beam on passing a vessel, the one shutter is opened and the other closed. There are some disadvantages in this arrangement—namely, amongst others, the risk of breakages, the inconvenience of the attendant having to move from his seat and come more or less to the front of the projector, and also the possibility of the arc being blown out while both doors are open. This is overcome by an arrangement that the author fitted on the last few boats that he had pass through h is hands, in which the front of the projector was fitted with the bifurcated lense, but on the black segment was pivoted a pair of further prisms, which in one direction

stood at right angles to the lense, and in the black section, and so had no effect on the beam, but which when turned in the other direction tend to redirect the rays, and to, as it were, fill in the dark section of the beam, thus producing the full fan-shaped beam. Seeing that this alteration can be effected by the turning of a small lever, which can be led to the back of the projector, it seems a much simpler manner to effect the required alteration of the beam.

Besides boats that make the Suez Canal passage, a large number of other boats carry projectors for purposes of river navigation, entering harbours, picking up moorings, etc., at night. In this case the projector is not placed over the bows, but either on the forecastle or on the bridge; the former position is the most suitable, as it does not interfere with the steersman to the same extent, it being almost impossible to see anything clearly through the beam.

Other Possible Uses of Electricity on Board Ship.

Up to the present we have been practically dealing with electricity as an illuminating agent, but the time is not very far distant when this will only be one of its many duties, as every day more and more is being done by means of electricity. Time will not permit of going fully into the various applications that electricity can be put to, but to touch roughly upon a few of them.

Fig. 8.—Suez Canal Projector on Bow Cage.

Electrically-driven ventilating fans are already very largely used in almost all important passenger boats trading to the tropics. They are also used for ventilating the holds of petroleum vessels, and for engine-room ventilation (Fig. 9). A further use, to which at present they have only been put to a very limited extent, but which gives an extensive field, is for forced or induced draught. At present a small auxiliary engine is used, but an electric motor requires less attention, can be put in a more or less inaccessible position, and is also more economical, especially if the steam-pipes are of any great length.

Then there are the pumps and condensing apparatus. As regards a centrifugal pump in particular, an electric motor is the ideal motor for driving it, as the motion is generated as a rotary movement at a high speed—exactly the conditions required. A ram pump is not of quite such simple adaptability, as the speed of the motor has in some manner to be reduced, and this has to be done through either worm gearing, pinion wheels, etc.

Coming to the uses of an electric motor on deck, as, for instance, the winches, capstan, steering gear, etc., it is astonishing that in this direction, at any rate, electricity has not made greater headway, seeing the enormous waste of power there must be in the network of steam and exhaust pipes that run all over the decks of a cargo steamer. It is obvious that with electric motors the cables could be much more easily run, in a far tidier manner, and in positions where they would be

exposed to far less risk of damage. As regards th
motor most generally employed, these can be of t
closed-in type. The author, for most cases where th
not exposed to any risk of damage, either from th
the weather, dirt, or dust, or any purely mechani
prefers the ordinary open-type machine, which i
appearance is exactly like a dynamo. The reaso
preference is on account of the easier dissipation o
generated in the machine, and also the fact that th
and commutator are open and more easily looked
kept in proper condition. On the other hand, in m
owing to the nature of the work they have to d
positions they have to be placed in, it is imperative th
or even watertight motors must be employed. In th
motor, although the general principle is the same, th
the motor is enclosed in a cast-iron box, this box
forming part of the magnetic circuit of the ma
before mentioned, an objection to these motors are t
of heat that is retained inside this box, and also
venience of adjusting the brushes.

Another use that passengers would find of very
venience, but which the author believes has not to
at any rate been introduced on board ship, alth
beginning to be largely used elsewhere, is electric h
cooking. How many ladies are there who chafe
necessarily stringent rules laid down by all the stea
panies, prohibiting the use of methylated spirit

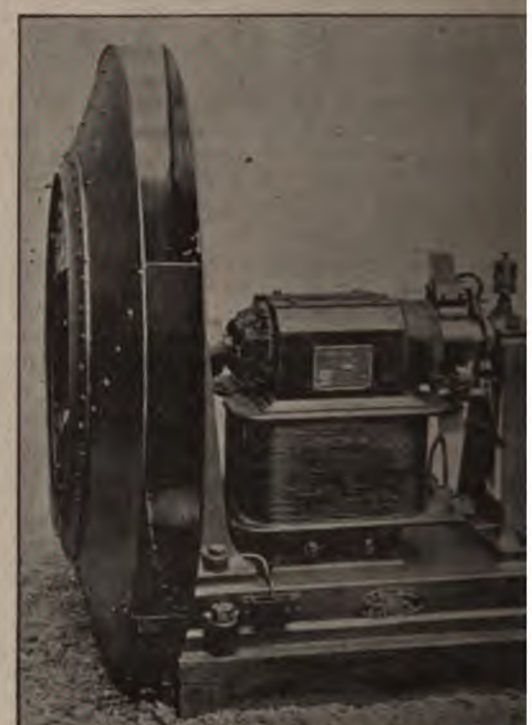

Fig. 9.—Electric Fan.

heating curling-irons, etc., who might so easily be m
having an attachment in their stateroom for an elect
Apart from these small personal uses, there is
extended possibility of the more or less general heat
entire vessel; it would certainly have advantages wh
has not, in the way of more easy handling, neater a
and so on. Then, again, as regards cooking. If, as
by certain restaurants, that they can effect a saving by
electric cooking, even when they have to purchase th
from a supply company, why should not the same hol
board ship, when a staff of engineers are always the
after the plant in the most economical manner.

A year or so ago the author had something to do with
for using the electric current for providing a very
disinfecting agent for flushing purposes and general use
out the ship. This process, called by the name of its
the "Hermite" system, generally consists of passing
of electricity through what is termed an electrolyser,
being filled with salt water. The action of the electr
decomposes the magnesium chloride, and the water an
chlorine and nascent oxygen or ozone is formed at th
pole, this chlorine compound being soluble in the liquid
it is formed. This liquid is perfectly harmless, and
residue when it is used for washing. It can be used to
and bleach clothing without any damage to it. The di
solution also completely deodorises all putrefying matt
system has to a limited extent been adopted by th
Government on some of their troopships with very co
success, and it is astonishing that some of the large

ompanies have not adopted it, especially those trading out to he East, where such an unlimited supply of an harmless but owerful disinfecting agent would sure to be much appreciated.

The question of electric pinnaces or launches is one that has eceived more attention from the river navigation point of iew than from their aspect as an adjunct to the equipment of n ocean-going steamship. Nevertheless, such an addition ould often be found of very great service for running ashore t a moment's notice, or for other uses where it would not be orth getting up steam in a steam pinnace.

Another thing that all boats that have an electric plant should arry is a supply of such small tools as electric drills. The sefulness of such tools cannot be understood unless it has been ctually experienced. An electric drill can be used in positions here it would be almost impossible to use a hand drill, and requently breakdowns could be repaired in a fraction of the ime. There is no doubt that in such a case as that of the ell-known breakdown of the "Umbria" some years ago, if ectric drills had been available the repairs would have been ffected in perhaps one-fourth of the time. A similar tool to he above is the electric deck plane, which is used to a certain tent in shipyards.

FIG. 10.—Saloon of ss. "Ophir," from a Photograph by John Stuart, of Glasgow.

spection Requirements.—When first electric lighting began introduced on board ship, Lloyds took notice of the fact ssuing a set of suggestions; within the last few years these gestions have been revised and made into rules. All installa-s, therefore, that are fitted on boats classed by Lloyds have mply with their rules, and the contractors have a form that to be filled up and signed to this effect. The contractor also to satisfy the Board of Trade as to the signal lamps being perly fitted, that the tint of the glass is correct, etc.

When on the subject of wiring, the question of the effect on compass was touched upon, and this is one of the points t has to be very carefully ascertained before a ship leaves. e is put on her various courses with and without the dynamo ning, and also with the various combinations of lamps near compass on and off, and the effect on the compass noted. wiring near the compasses has to be on the double-wire tem, and sometimes it is found advantageous to go even ther than this, and to twist together the wires so as to minate any possible stray magnetic lines.

I fear that you will think that some points have been too utely dwelt upon, and others of perhaps equal importance sed over with a few words, but an endeavour has been made dwell mostly upon the points that are rather out of the inary run of electrical work, while other points of perhaps ater importance, but which are better known, are passed over.

THE BALANCING OF ENGINES.*

BY JAMES WHITCHER, A.I.E.E.

Within the last decade the problem of engine balancing has taken a prominent place in the programme of engineering politics. The demand for higher piston speed in engines for marine and electrical work has forced it much to the front, so that the scope of interest in it, instead of being practically limited to locomotive circles, is extended over almost the whole art of motor engineering. The subject has already a considerable history; for the closing years of the century that has witnessed the triumph of the engineering instincts have brought some eminent and practical men to its study, and it is inevitable that the practice of the coming one will bear the impress of their thought.

I have found it difficult material to form into a paper for public discussion; and on that account I hope you will excuse all shortcomings. It is essentially a question of mathematics: and as you are aware, the language of mathematics is confusing and tiresome to talk, and yet more confusing and tiresome to listen to. At all costs I have striven to eliminate the algebra; so that if at times I appear a little too general or dogmatic, you will understand the reason.

The whole science of balancing is founded on one small axiom in dynamics, which I may state thus: "No motion of mass can occur without a compensating motion of mass in an opposite direction so that the common centre of gravity shall remain undisturbed." Which is as much as to say that there can be no absolute translation in space of mass in the aggregate, but simply interchange of position governed by the law of one immovable centre of gravity.

Coming now to the case of a simple reciprocating engine—for instance, a direct-acting steam-pump—we have in the operation of it the mass of the pistons and attachments vibrating regularly to and fro. Imagine the pump to be quite free in space: then, in accord with the above axiom, it must oscillate likewise, and in time with the piston oscillations, but oppositely in direction. The amplitude,

* Paper read before the Manchester Association of Engineers.

relative to a fixed point in space, of the oscillations of the pump frame must, furthermore, be to that of the piston oscillations as the mass of the pistons is to the mass of the frame. By bolting the pump down to a foundation we can restrict the counter oscillation, but by no means can it be entirely constrained. The amplitude merely is reduced, for the fixing is simply the mathematical equivalent of adding the mass of the foundation to that of the pump frame and thereby diminishing its oscillation in proportion.

Hence we perceive that in a broad sense there can be no such thing as an unbalanced engine, for an engine which is not balanced in itself will straightway compel any mass to which it is anchored to perform this duty for it. In the narrow mechanical sense we define a balanced engine as one in which vibratory motion of the frame is non-existent; an unbalanced engine as one in which there are frame vibrations, which, although capable of reduction to infinitesimal dimensions by fixing to massive foundations, can never be completely suppressed. In other words, one balances its motions in response to the will of its designer; the other by its own strong will in the way that comes best to it.

Still, design can have a say in the latter case also, for suitable planning of the foundations brings the independent will of an unbalanced engine somewhat under control, so that the operation of its "automatic balancing" can be guided into safe ways. Solid foundations, well bonded together by the holding-down bolts and of suitable weight, will ensure the reduction of the vibration to amplitude innocuous to the steam-pipe and other connections; and isolating the foundations from walls and footings to a great extent guards against destructive effects on the buildings, which satisfies requirements of many cases. The magnitude of the vibratory effects exerted by a single-crank engine upon its foundations is easily calculated. For instance, assume that a horizontal engine of 10in. stroke has piston and attachments weighing 100lb., and is mounted on foundations which together with the engine make up a total weight of 10,000lb.; also suppose for the moment that the C.G. of the latter mass is raised into line with the cylinder axis; then the vibration amplitude or stroke will be $\frac{1}{10}$in.; for $\frac{1}{10}$in. : 10in : : 100lb. : 10,000lb. Since the C.G. cannot practically be in line with the cylinder axis, a tilting action will be produced which may be estimated by means of diagrams; and it must be remembered that movements are magnified at points the farther removed from the axis of tilting.

We assume in the above that the foundation is free from its surroundings, and where the vibrating forces are horizontal, this is practically the case for every foundation not bonded to rock or walls (which become in such event part of it). For it is evident the foundation block will free itself at the sides; and for such small movements, the friction upon the supporting soil is little or nothing. The tilting action adds vertical components to the motion, which do not isolate themselves from surroundings so readily. Yet in sand or gravel soils, the block will be almost as free as in the former case, for the rocking motion tends simply to shear the soil in cylindrical or spherical surfaces concentric with the centre of rocking. Therefore, in designing foundations for engines unbalanced in the horizontal plane, it is only safe to assume that the sole restraint on the vibrations is the mass in solid and rigid connection with the engine frame.

Now, vertical vibrations do not become thus isolated from surrounding masses, because gravity keeps the foundation in compressed contact with the ground supporting it. Therefore, more or less of the sublying ground must become involved in the movements. Here we arrive beyond the power of exact investigation; we cannot say to what extent the amplitude of the foundation vibrations may be reduced by the further mass involved. If the subsoil were absolutely without resilience the foundation would sink deeper at each stroke; but, of course, it has some resilience, and if in good measure we do not find the vibrations much diminished. I can explain this better by bringing on another section of my subject.

At the British Association meeting of last year, Mr. J. Swinburne read a paper advocating the "Mounting of Machinery on Springs." In a letter to *Engineering* I opposed the suggestion on theoretical and practical grounds. My practical objections were just enough; but [...] was wrong, absurdly so in fact, and I am glad of [...] tunity to rectify the error. I contended that it [...] sible to isolate vertical vibrations by springs or [...] alleging that the reaction of the springs on thei[...] would equal the force acting upon them. Whi[...] true: but I overlooked the fact that the orig[...] tends to vanish as the engine frame is allowed f[...] move. Thus the spring reaction is simply propo[...] the extent by which the springs restrain the [...] If the springs be of long range, the reaction is com[...] small. For instance, suppose we have a singl[...] engine of 10in. stroke, reciprocating parts weighi[...] and the bed loaded up to 10,000lb. total, and sup[...] springs which compress 1in. for every 1,000lb. They would be compressed 10in., and with a mo[...] $\frac{1}{10}$in., which is enough to complete the balance, t[...] reaction would vary only from 9,950lb. to 10,050[...] springs of very short range—say sheets of in[...] requiring 100,000lb. to compress them 1in.—we [...] ordinary conditions, with foundation resting [...] ground. The spring reaction varies then from 5[...] 15,000lb., assuming the support remains immovab[...]

Here we have a clear illustration of the effect of [...] sub-basis for foundations. Sometimes, though [...] fortunately, we are brought to face the problem o[...] vibrations caused by unbalanced engines from [...] property. From the foregoing we perceive that [...] promising procedure is to make our foundations [...] and solid as can be, carefully isolated, and borne [...] sub-bed of faggots or the like. Then if the sub-b[...] drained, the trouble ought to be scotched; b[...] foundations become partially waterborne, the tra[...] of vibration is as liable as not to be greatly facilit[...]

There is a perplexing phenomenon occurring [...] in connection with the transmission of such vibra[...] is found that in the aggregate immense mass[...] vibrated in an appreciable manner, although the o[...] cause is comparatively small. The explanation i[...] transmission is by wave motion. A complete [...] waves is a balanced mechanism in itself, since th[...] the momenta having regard to direction is nil: [...] the disturbance may be spread through immens[...] without much restraint being exerted on th[...] vibrations.

For this reason, in situations favourable to wa[...] mission, vibration may become very troublesom[...] This is the case in ships, where it sometimes hap[...] the natural vibration periods of the hull are in a[...] with the vibrations set up by the underbalance[...] at the working speed. For example, if the [...] perfectly rigid the whole mass would mov[...] taneously by the engine vibrations: theref[...] posing, for the sake of clearness, the eng[...] single one, the stroke or amplitude of th[...] tion : the stroke of engine : the mass of the [...] the whole mass of the ship. However, as th[...] not so rigid, the vibration travels from the engin[...] to the stem and backward to the stern. Thus wav[...] is propagated through the structure, and if t[...] length be the equal or a multiple of the wave-le[...] vibratory momenta of the ship's mass balance th[...] and only the momentum of the engine frame re[...] balance that of the piston, therefore the vibra[...] greatly augmented in amplitude compared with th[...] a rigid hull, and in less degree with one where t[...] length is not a sub-multiple of the ship's length. [...] latter event part only of the momentum of the hu[...] in balancing the piston momentum.

I must proceed now to what is perhaps the mo[...] tant section of my subject: the effect of the [...] effort upon the bearing pressures on the journals a[...] It is so at least from the point of view of th[...] designer, for it is the most formidable obstacle in[...] of continued response to the call for higher sp[...] think you will agree with me that the most wei[...] sideration we have before us to-night, is the [...] whether we cannot by balancing our engines imp[...] working conditions of the bearing surfaces.

Consider the case of a single engine. At comm[...]

ke the inertia pressure of reciprocating weights the steam pressure, and consequently the pressure itted to main bearings through the connecting rod nk pin is less by this amount than the pressure on linder cover. Wherefore, there is an excess of e forcing the engine frame in an opposite direction motion of the pistion. It is this force which es the counter and balancing oscillation of the frame already alluded to. Having two masses in we have two inertia forces which are equal and in irection that they add their effects on the bear- The value of their sum depends on the proportion n their two motions. For suppose the mass of frame and foundation is $M_1 = a\,M_2$; M_2 being piston. The stroke in space of M_1 is $y = \frac{x}{a}$, where ke in space of M_2. The nominal engine stroke is ly $= (x + y)$. The value of the combined inertia on bearings is $M_1 \frac{d^2 y}{d\,t_2} + M_2 \frac{d^2 x}{d\,t^2} = 2\,M_2 \frac{d^2 x}{d\,t^2}$ $\frac{a}{a+1} \frac{d^2 (x + y)}{d\,t^2}$. If $a = 1$ or mass and motion e frame are equal to those of piston, the inertia bearing would be equal to that due to piston oving over its full nominal stroke. But if a is hich is the case with a fixed engine, the stress ates very closely to twice that value.

rinburne, I think, first pointed out this important establishes the very momentous principle that cing effort of a fixed unbalanced engine doubles a stresses if there be no cushioning either of the oke or frame stroke.

the first half of stroke the inertia pressure he steam pressure, in the second half it assists it. ite familiar to you, it is not an altogether evil of the engine mechanism. For one thing, it helps ract the explosive violence with which the steam comes into action. Were the parts devoid of e looseness in bearings would be taken up with a rk at each reversal of stroke, unless by suitable g of the exhaust it were taken up previously to nce of pressure. To minimise "knock" we want lashing" of the mechanism to take an appreciable e greater the arc of crank travel we can spread e better. Inertia helps towards this.

lly the best result obtains when the cushioning ly proportioned to the inertia that the piston t to rest slightly before the crank reaches the at as the piston speed is increased the inertia ws beyond control. Cushioning even up to initial becomes powerless to arrest the piston; and it s only the usual function of relieving the bearings the inertia stress. The initial pressure fails like- art the piston, which is accomplished by the fly- Yet even here, when there is plenty of flywheel have still a favourable condition for the suppression , since the piston must take appreciable time to to the crank. However, despite this, in quick- n engines, with alternating stresses, the period for tions is so shortened that, in what way accom- he negotiation of backlash (which cannot unfortu- diminished in proportion with the period) becomes y a blow.

is the speed-limiting condition in double-acting By means of forced lubrication and other devices to the reduction of backlash, the limit has been ut it keeps itself in evidence. The principle of thrust bearings, associated with single-acting has been very successfully invoked to open a way his limit; but having done so, another limit is met tively close on the first. The practical difficulties ming the idle return stroke, with the heavier oncerned, greatly countervail the apparent gain.

s diverges from the straight track of our subject, ds up to an important point of view. We have d bearings on which the stresses alternate in , and others on which the direction is constant. add a third class, those in which the direction of ates. These include bearings in which the stresses rotate continously and those in which they oscillate over an arc of the circle. An example of the latter exists in horizontal engines, where the weight of flywheel, etc., tends to keep the pressure on the bottom half of main bearings; also in vertical engines with belt pulling sideways. Now it is obvious that such bearings are proof against knock, particularly if the rotation of stress is regular, in which case they compare with constant-thrust bearings. No doubt some of you have noticed that in horizontal engines with heavy flywheels there is little knock in main bearings, also that vertical engines with horizontal drives, which have troublesome knock at light loads, sometimes run much smoother at full loads.

The principle of rotary bearing stress seems therefore to afford a feasible method of passing the speed limits I have above mentioned, providing it can be practically applied. It is outside the purpose of this paper to discuss that point, however, although it is of interest, as we shall see presently, in discussing methods of balancing, that alternating stresses can be transformed into rotary stresses by purely dynamical means.

We must pass on to the balancing proper of engines. Analysis of the motions of a simple engine shows that the piston movement is compounded of two—a primary component proportional to the cosine of the angle of crank from the cylinder axis, or cosine *pt.*, and a secondary component proportional to the cosine of the angle of connecting rod, or cosine ϕ. The former component is what we who are mathematically inclined call a simple harmonic motion; the latter is also a harmonic motion, but a complex one—that is to say, it is compounded of many simple harmonic motions into which it can be analysed if desired.

The presence of the connecting rod, or secondary, component greatly complicates the problem of balancing. The crank or primary component is easy to treat comparatively. For this reason the elimination of the connecting rod itself from the mechanism comes within the scope of our subject; but I fear the attempt to do so can only bring out the incomparable value for its purpose of the connecting rod in every respect but this. Not to weary you with devices which are practically impossible, I take it that the slotted cross-head is the only mechanism that could reasonably be applied as a substitute. And since there is a mechanical veto against subjecting slides transversely to heavy alternating stresses, and furthermore as there is much difficulty in providing adequate bearing surface, it falls far short of the splendid simplicity and aptitude of the link. It would be least objectionable in a constant-thrust engine.

An engine with a slotted cross-head, which is the mechanical equivalent of an infinitely long connecting rod, has only primary crank components in its piston motion. It is capable of perfect balance by several simple and practical expedients. The most obvious one is to produce an equivalent but exactly counter momentum in a weight by connecting to an opposite crank through a slotted cross-head. Two similar engines of such type, coupled side by side, with cranks at 100deg. are in balance as regards what is aptly termed "free force," or the tendency to vibrate bodily; but the forces not being in line, there is a "couple" or moment about a centre which rocks the engine lengthwise.

Unbalanced vibrating moments cause the masses involved to swing about their common centre of gravity. They are not generally regarded as of nearly so much consequence as "free force"; but consideration shows that they may have very similar effects, on a ship's hull, for instance. The skewing stress on the bearings is an undesirable feature; and the alternating deflecting stresses exerted on any shaft rigidly coupled to the crankshaft is a yet worse result of their presence. The prevention or balancing of such couples forms an especially onerous section of our problem.

A much-used, but misnamed, attempt at balancing a single engine is by means of a rotating counterweight set opposite the crank. Now, a rotary counterweight cannot balance a linear reciprocation. Although its motion in the direction of engine axis corresponds in counter sense with the piston motion of a slotted cross-head engine, its use introduces an equal want of balance in direction vertical to that which it annuls; for it has an equal motion in direc

tion vertical to engine axis, so that the result is simply to change or rotate the direction of the free force through a right angle. This is an important and interesting effect, especially with regard to its application to the transformation of alternating into rotary bearing stresses.

The journal effect of a counterweight or any rotary free force applied to the shaft is to produce corresponding rotary stress on the main bearings—a valuable property in the mechanism, as shown already. Bearing on this point it is, I think, an established fact that a rotating counterweight, although it cannot balance a single engine, has yet a valuable influence on its working. The true explanation of this influence is in the introduction of rotary stress, and if we agree to regard and design counter-weighting in this new light, I am sure we shall find it of immense practical service. The rotary stress in this case is the resultant of the steam pressure and the inertia pressure, the line of action of which is now transformed into vertical direction to the line of action of the former. This resultant rotation of stress is not of very regular character except under certain conditions of cushioning and cut-off; yet it is serviceable in a degree. The influence of partial, whole, and over counter-weighting on the bearing pressures, is well worth a careful study; but as I have only time in this paper to skim over details, I must not touch on it now.

A counterweight not in the same plane as the reciprocating mass, or counterweights, neither on same radius, nor in same plane as each other, cause rotary couples or moments, which act as rotary skew stresses on the bearings. For reasons evident from the foregoing, such stresses are of much less injurious nature than those due to simple alternating moments.

If a counterweight be set at other than 180deg. angle with the crank, or if its momentum be made greater or smaller than that essential for "transforming" (by which I mean the attempted balancing before mentioned) the reciprocating momentum, we have a resultant of linear free force and regular rotary free force. If the counterweight momentum be one-half of the reciprocating momentum acting on opposite radius to crank, the resultant is a constant rotary free force rotating in opposite direction to crank. Evidently this could be balanced completely by the momentum of another counterweight revolving in the same sense on the opposite radius. If practicable, this would form another method of balancing.

(To be continued.)

THE ELECTRICITY SUPPLY OF LONDON.

BY A. H. PREECE, A.M.I.C.E.

At the ordinary meeting of the Institution of Civil Engineers held on Tuesday, April 5, Mr. W. H. Preece, C.B., F.R.S., vice-president, in the chair, a paper was read on "The Electricity Supply of London," of which the following is an abstract.

The supply of electricity on a commercial scale had been started in London after the passing of the Act of Parliament in 1888, which amended the Act of 1882, principally by extending the date for compulsory sale to the local authority from 21 years to 42 years. In 1888 many companies applied for provisional orders, and, in determining which were to be granted powers, and the districts over which the powers were to extend, the Board of Trade decided that competition would be advantageous to the public, and that it was advisable to allow one direct-current system to compete with one alternating-current system.

There were now in London 11 important companies and five vestries supplying electricity, and three other companies and three vestries were taking steps to start works. The capital invested in the industry amounted to £6,000,000, and plant was installed to the extent of 80,000 h.p., the equivalent of 2,000,000 8-c.p. lamps being connected to the mains. The total annual revenue was £800,000, and the total annual expenditure £450,000.

Of the systems for supplying electricity in London, the alternating current was applicable to large areas where consumers were scattered, and it enabled the gener[illegible] works to be established by the riverside, or where land [illegible] cheap and coal was easily unloaded. The undertak[illegible] using this system were the City of London Comp[illegible] the Metropolitan Company, the London Electric Cor[illegible] tion, the County of London Company, the House-to-H[illegible] Company, the Hampstead Vestry, the Islington Vestry[illegible] the Hammersmith Vestry. The direct-current systems [illegible] divisible into two classes—the high-pressure and the [illegible] pressure. In the former rotary transformers were [illegible] to reduce the high pressure to a low pressure, while [illegible] latter produced and distributed electricity at the [illegible] pressure at which it was supplied to consumers. [illegible] direct-current systems were applicable to compact ar[illegible] and, with the use of high pressure, to scattered or isol[illegible] compact areas. The chief advantages of the direct-curr[illegible] system were the possibility of using storage batteries, wh[illegible] could not be employed with the alternating-current system[illegible] greater efficiency in distribution, and greater adaptab[illegible] to motive power. The undertakings using the system w[illegible] the Chelsea Company (high-pressure), Charing Cross [illegible] Strand Corporation (high-pressure), the Westminster Co[illegible] poration, the St. James's and Pall Mall Company, th[illegible] Kensington and Knightsbridge Company, the Notti[illegible] Hill Company, the St. Pancras Vestry, and the Metropoli[illegible] Company (at one works).

The generating works of the several undertakings [illegible] London contained many interesting features. No less th[illegible] 20 different works had been erected. The boilers [illegible] comprised the water-tube, marine, Lancashire, and misc[illegible] laneous types; but the preference for the water-tube boi[illegible] was very marked. The works were liable to sudden dema[illegible] through fogs, and the quick-steaming properties of this ty[illegible] of boiler were of great advantage. The boilers were fi[illegible] chiefly by hand with Welsh coal, but in the works of t[illegible] City of London Company and the County of London Co[illegible] pany mechanical stokers and cheaper coal were used. T[illegible] use of extensive systems of steam-pipes was now be[illegible] dispensed with. The multiplicity of valves was unne[illegible] sary, and the number of valves was being reduced, a[illegible] arrangements were made as simple and with as few j[illegible] as possible.

The present tendency was towards engines of the mar[illegible] type for large outputs. The high-speed engine was [illegible] used for larger powers than 750 h.p. Some engine[illegible] however, found engines of 350 h.p. sufficiently large a[illegible] the most convenient unit to adopt. The dynamos w[illegible] similar in most works, and were always connected dir[illegible] to the engines. Storage by secondary batteries was [illegible] extensively employed in London, as their maintenance h[illegible] hitherto proved expensive. But a few works used th[illegible] entirely for maintaining the supply after midnight and [illegible] the daytime in summer. The author gave the results o[illegible] test of a small marine engine and alternator, showing [illegible] combined efficiency to be 85·5 per cent. The question [illegible] vibration had been of great importance in many works; [illegible] cure had been found effective when once vibrations w[illegible] set up. High-speed engines must have three cranks t[illegible] free from appreciable vibration.

The favourite methods of distributing electricity w[illegible] to transmit current at a high pressure in heavily insul[illegible] cables in iron pipes, and current at a low pressure [illegible] insulated cable in stoneware conduits or in cables heav[illegible] armoured and laid direct in the ground. Rubber was [illegible] little used, paper and jute, impregnated with insulat[illegible] compounds, having been extensively adopted.

The usual system of measurement of the electric[illegible] supplied was by meter, and the average charge was 5[illegible] per unit. The average charge in 1890 was 7½d., so t[illegible] the price of electricity had been reduced in eight years [illegible] less than 25 per cent., equivalent to a reduction in [illegible] price of gas from 4s. to 3s. A curve was given to sh[illegible] the variations in the price of gas since 1870. The avera[illegible] price had varied between 4s. and 2s.; it was now 2s. [illegible] The cost of generating and distributing electricity h[illegible] been greatly reduced in the last few years. In 1892 it w[illegible] seldom supplied for less than 4½d. per unit. The [illegible] cost was now 2½d. to 3d. The actual cost of generati[illegible] was about 1½d. per unit, and the cost of management, e[illegible] about 1d. The direct current was everywhere produced

rate than the alternating current. The difference ›en ½d. and 1d. per unit, or 20 per cent. cheaper. 1888 an important enquiry had been held by the Trade regarding the maximum pressure permis- consumers' premises. The result of this enquiry, was to increase the pressure from 150 volts to

parison was made between the two largest com- London—namely, the City of London Company, pplied alternating current, and the Westminster n, which supplied direct current. Both companies the same number of lamps connected to their the number of 8-c.p. lamps connected being nd 269,939 respectively. The capital expended ctively £945,829 and £546,434; the annual er 8-c.p. lamp, 11s. 9d. and 7s. 9d.; the annual es per 8-c.p. lamp, 4s. and 3s.; and the costs ·6d. and 5·8d.

ustry was growing so rapidly that most under- d to seek new sites for generating works, and cy was to erect large works on the outskirts of here coal could be conveniently brought to the here water could be obtained for condensing. s granted under provisional orders were limited the compulsory purchase of land, and further e being sought by some companies from Par- that they might be placed on the same footing companies. No less than 40,000 h.p. was now lled in London in order to meet the demand ty in the immediate future.

TELEPHONE STATISTICS.

›wing table of comparative telephone rentals d to in our last issue. It is prepared by the elephone Company, and is said to be corrected this year:

		£	s.	d.	
rns vary from £1. 7s. to		2	15	7*	...No charge for instruments or erection.
897...	Pop. 151,239... Subs. 7,000	4	8	11*	...No charge for instruments or erection.
(third rway)	Pop. 30,000 Subs. 800...	2	10	0*	...No charge for instruments or erection.
	Second connection Private	1	5	0	
....		2	10	0	to £3. 10s.
....		2	18	4	
....	Pop. 260,000..	1	19	0*	...Limited number of calls.
....	Subs. 26,000..	3	6	0	Unlimited number of calls.†
		4	8	0	
		5	12	0	
.....		3	6	0	to £6. 10s.
, the average payment ears is only		1	17	0*	.. £5 first year; £3 second; 32s. after. 600 free calls.
up to 1897-8	Pop. 222,231 Subs. 1,400...	7	10	0	...Entrance fee, 33s.
(up to 1897-8	Subs. 2,140...	7	10	0	...Entrance fee, £2. 2s.
1897-8		5	0	0	
... .		2	10	0	to £3. 6s.
....		2	10	0	And ¼d. per call. Trunk lines fees only 1s. any distance.
....	Subs. 30,000...	2	10	0	
, Aaland Isles					One exchange telephone to every 13th person.
....		3	4	0	...Town or country.
Man- olton, and	was	4	12	2	...Plus royalty 10 per cent. and was profitable.
....		6	0	0	
....		20	0	0	...One to every 1,000 of the population.
ns generally, £8, £10, £12, £20...					One to every 1,000 of the population.
Isle of	Pop. 19,000 Subs. 315...	5	0	0	...One to 60 of population shows what a £5 tariff will do.
....		4	0	0	...In some towns.*
New Zealand		5	0	0	One to every 38 of population; earnings £183,000; outlay, £104,500; profit, £79,000; £54,000 of this has been handed over to the consolidated fund.
Wellington	Pop. 45,000 Subs. 1,200...	5	0	0	
Auckland	Pop. 70,000 Subs. 725				

* So much misrepresentation has been made about these places that where any extras are charged we have inserted them.

† For the first five years 11s. extra is charged per annum.

In conjunction with the above the statistics prepared by Mr. J. C. Monaghan, of Chemnitz, for the State Department are of interest. He says that the list leaves out Norway, Denmark, Finland, Great Britain, and Portugal, because these people put down no answers to the cards of enquiry. Turkey and Greece have no telephones.

Country.	No. of instruments.	Inhabitants to each telephone.
Sweden	42,354	115
Switzerland	23,446	129
Luxemburg	1,356	160
Germany	131,577	397
Holland	7,900	615
Belgium	9,400	682
France	31,681	1,216
Austria	18,950	1,318
Spain	10,810	1,597
Hungary	8,458	2,168
Italy	11,815	2,629
Russia	16,050	6,988
Bulgaria	243	13,616
Roumania	337	16,042

FORTHCOMING EVENTS.

FRIDAY, APRIL 15.

Institution of Civil Engineers. — Students' visit to the Grand Junction Waterworks, Hampton. Train from Waterloo to Hampton at 1.18 p.m.

MONDAY, APRIL 18.

Northern Society of Electrical Engineers.—At Palatine Hotel, Manchester, at 8 p.m., "Commercial Forms of Electrical Resistances for Lighting and Power Purposes," by Mr. Ll. B. Atkinson.

North-East Coast Institution.—At Literary Society's hall at Sunderland, paper on "Cylinder Ratios," by Mr. James Andrews.

Society of Arts.—At 8 p.m., Cantor lecture on "Sources of Commercial Indiarubber," by Dr. D. Morris, C.M.G. (first of two lectures).

TUESDAY, APRIL 19.

Institution of Civil Engineers.—At 8 p.m., discussion on "The Electricity Supply of London," by A. H. Preece, A.M.I.C.E.

WEDNESDAY, APRIL 20.

Society of Arts.—At 8 p.m., "Stage Mechanism," by Mr. Edwin O. Sachs.

THURSDAY, APRIL 21.

Institution of Electrical Engineers.—At 8 p.m., Discussion on "Cost of Generation and Distribution of Electrical Energy," by Mr. Robert Hammond.

Society of Arts.—At 4.30 p.m., "Recent Railway Policy in India," by Horace Bell, M.I.C.E.

FRIDAY, APRIL 22.

Royal Institution.—Albemarle-street, at 9 p.m., "The Recent Eclipse," by W. H. M. Christie, C.B., M.A., F.R.S., Astronomer Royal.

Physical Society.—At Burlington House, at 5 p.m., "On a Method of Viewing Newton's Rings," by the Rev. T. C. Porter.

Institution of Civil Engineers.—At 8 p.m., Students' meeting. "New Cut Swingbridge, Swansea," by Mr. M. W. Henty, Stud.Inst.C.E.

New Catalogue.—We have received from James White, of Glasgow, a new list of Lord Kelvin's electrical instruments for laboratory and central-station use. These instruments are generally so well known that individual mention seems unnecessary, but the list is most valuable as a price list and also for its explanation of the details and uses of the various instruments. We notice that in the present list instruments other than electric are included. Amongst these is the Thomson steam-engine indicator, which has a special parallel motion for the pencil, and is recommended for high-speed engines. Tachometers, speed indicators, thermometers, and pyrometers complete the catalogue. At the end will be found a table of fees charged by the Board of Trade for standardising and testing meters, etc.

THE

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TO CORRESPONDENTS.

 Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140, Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

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Vol. XX. of new series of "THE ELECTRICAL ENGINEER" *can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.*

ELECTRICITY AS A CIVILISER.

The electric telegraph, or a complete te
system, in an unsettled country gives e
advantages when organising the defence or
government. The value of electricity in this
has been most fully appreciated by the Britis
Africa Company, and, as their report for
two years shows, the directors are spa
expense in developing their telegraph syst
a modern civiliser the telegraph precedes th
making, and keeps the various outlying dist
complete touch with the headquarters of the c
Of course, in the event of a rising of the nati
as Rhodesia has had experience of, the wires
cut and communication interrupted, but ev
the interruption gives the signal that trou
occurred in a certain district. The f
extract, under "Roads, Telegraphs, Telepho
Postal," from the report in question, sh
growth of the various systems during the
years. Thus "The total mileage of publ
maintained by the company is 2,230. Ne
have been made between Umtali and Melset
between Umtali and Inyanga. The latter
being continued along the telegraph route
on the Zambesia, and will be intersected b
now being constructed from Salisbury, thro
Abercorn and Matoko districts. From B
a road is being made to Barotesland, vi
ma Tenka. The company's telegraph syst
increased by 126 miles in 1896 and by 200
1897. On September 30, 1897, 1,856 miles
and 2,583 miles of wire had been erecte
total amount expended by the company
graph construction up to March 31, 18
£139,677, and the net profit for the
year ending on that date, after deduction
of maintenance, was £13,391. Many
forts in Matabeleland have been connect
Bulawayo by telephone lines, all of whi
been erected by the company's police. T
mileage of these is 182 miles. A teleph
change has been erected in Bulawayo.
for an exchange at Salisbury has been s
and an order for material for an exch
Umtali is being executed. The section
African trans-continental line between S
and Tete was destroyed during the native
ances, and has been replaced by a secti
Umtali to Tete, which follows a more health
and is now completed. A portion of the old
has been restored as far as Mazoe. Con
progress is being made with the line thro
British Central Africa Protectorate towar
ganyika, which has been completed to Kota
distance of 263 miles north of Blantyre
miles north of Umtali—and is being
pushed forward. The section already
has been of the utmost service to the a
tration and to the Imperial representa
the British Central Africa Protectorat
mail services throughout Rhodesia hav
greatly improved. Regular communication
Salisbury and Bulawayo and the outlying
and a monthly service with Barotseland ha

established. The time taken by mails to reach England has now been reduced to three weeks from Bulawayo and four from Salisbury." This extract shows the rapid development of the company under a strong and autocratic directorate. We trust that the forthcoming general meeting will endorse the previous policy of the Board by keeping them in office, and that the project of a complete telegraphic connection up to Egypt may thus be carried out.

EDINBURGH LIGHTING.

"The Progress of the Electric Light in Edinburgh" was the subject of an address delivered before the Edinburgh Association of Science and Art on Monday last by Bailie Mackenzie, the convener of the Electric Lighting Committee of that town. The night of the lecture was appropriate, as it was the third anniversary of the opening ceremony. Referring to the opposition met with when it was proposed to municipalise the electric lighting, the lecturer said there was no doubt now but that the right course was adopted. He then explained the great advantages the Edinburgh undertaking enjoyed, such as most extensive street-lighting, a large hotel and club population, and also good shop districts. All these have helped to give Edinburgh the lead in the way of low first costs, but apart from these the town obtained in the first instance the best professional advice, and also acted on the advice given. This last point seems, perhaps, a trivial one, but so many towns after consulting a good engineer pare down his schemes by refusing to grant funds, and otherwise hamper the undertaking. As regards Edinburgh, Bailie Mackenzie drew attention to the fact that the consumption of gas had increased in spite of the large amount of electric lighting done. He also pointed out that there were now an equivalent of one hundred and fifty-six thousand eight-candle lamps on the mains, as against two thousand on the opening night three years ago, and that the Corporation had been enabled to reduce the price of the current from time to time until it had just been proposed that the price should be threepence halfpenny per unit for lighting and three halfpence per unit for motive power.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

GAS v. ELECTRICITY.

SIR,—My reply to the note you append to my last letter is, if I found a Welsbach lamp giving 25 c.p. (the volume of gas required in England is 3½ cubic feet each), I would say it was giving 100 per cent. more light per cubic feet than could be obtained with the standard burner. But permit me to ask this question, what would you say if you found that an incandescent lamp after 500 hours' service took 25 per cent. more watts, and withal gave a candle-power 20 per cent. less than at the beginning? I would say it was giving 50 per cent. less light per watt.—Yours, etc.,

G. K. GRIEVE.

[We should say that if high-efficiency lamps had been used in the first instance, Mr. Grieve had still overestimated the cost of electric lighting.—ED. *E. E.*]

RE ALEXANDRA PALACE.

SIR,—In giving notices the last two weeks *re* tramway being laid at the above palace, evidently you forgot to mention that the lighting and motor power of the palace and grounds is being carried out by me on behalf of my company.

We are running at a voltage of 250 volts, and the work is being done according to the Phœnix Fire Insurance rules. The motive power employed includes two 10-h.p. nominal Crossley gas-engine and a 20-h.p. nominal compound Fowler undertype engine. The dynamos and motors are our own, and specially made at our works at Brentford.

The arc lamps used are by the British Blahnik Arc Light Company, Limited.—Yours, etc.,

(The Acme Motor and Traction Company).
PERCY HUDDLESTON.

THE PACIFIC CABLE QUESTION.

The following is a most valuable article on the question, which appears in the *Times* of Monday last. Many of the facts in it we have given before, but the *résumé* of them as below is of great interest:

The development of events in the Far East and the addition of Wei-hai-wei to the list of British posts on the Pacific lend special interest to the renewal of activity with regard to the construction of swifter means of communication between the scattered British communities. The Australian premiers in conference have agreed that if Great Britain and Canada will contribute two-thirds of the cost of a Pacific cable, Australasia should contribute one-third. In Canada an influential deputation has waited on the Premier and laid before him a proposal that a Pacific cable trust should be created under authority of the Parliaments interested in the scheme, with power to raise the necessary funds and proceed to the construction of the cable. In this country it is understood that as soon as the Australasian and Canadian colonies shall agree in manifesting a strong desire for the construction of the line, any proposal which they may make to that effect will receive at least favourable consideration.

The need for a Pacific cable is becoming every day more potent, and the rule which applies to all other commercial enterprise will no doubt hold good, that, when the advantages of a new opening have become fully apparent, if one man holds back another will certainly come forward to profit by the offered chance. That a Pacific cable will be made before long is hardly open to doubt. The question with which the Imperial and Colonial Governments are playing is whether that Pacific cable shall be in British or in foreign hands. The position, very briefly summarised, is as follows: Commercial civilisation has been spreading eastward and westward from its more active centres till at both extremities its extension has reached the shores of the Pacific. It finds the largest ocean of the inhabited world as yet untraversed by a single line of telegraphic communication. When the West wishes to communicate with the East or the East with the West across the dividing water, the message has to be sent backwards round two hemispheres. Yet swift communication is the soul of commerce, and commerce is the soul of every flourishing modern community established on the shores of the Pacific. The British communities of Canada, Australia, and New Zealand, the Western States of America, the scattered island populations now first coming to importance, are in their nature industrial before anything. The name of the East Indies is almost synonymous with trade. Japan has passed through an industrial second birth. Russia is pushing industrial enterprise on the northern Asiatic coast. France has not shrunk from heavy cost to establish a commercial footing on the south. Germany has made her latest move in the interests, we are asked to believe, of the protection of her commerce. Thus, north and south and east and west, the ocean is surrounded by rival nationalities. In presence of these waiting powers indications are given that the immense commercial field of China is about to be thrown

open. Instantly the waters of the Pacific are alive. The military and political movements which have taken place are but the forerunners of other intercourse. To suppose that the competing communities will remain indefinitely without the means of telegraphic communication so essential to the success of individual aims is to ignore all the teachings of experience. Under the protection of one power or another, a cable connecting the lines of the eastern with the western and of the southern with the northern continents will certainly be made. All that is doubtful is whether that power will be British. We have declared our policy in those seas to be commercial. Here is a step of evident commercial advantage to be taken, and as the matter at present stands the most decided utterance which appears to have been made upon the subject is to be found in a communication received by the Hawaiian Government in the first week of February, to the effect that the French cable connecting Australia, *viâ* New Caledonia, Tahiti, and the Sandwich Islands, with San Francisco will immediately be laid. If this information is correct, such a Pacific cable would, of course, be under the immediate control of France and the United States.

The cost of an all-British cable connecting Canada with Australasia would be about £1,500,000. The construction has been tendered for by competent contractors at that figure. It has been estimated that a diversion of less than half the existing telegraphic business of Australasia with the northern hemisphere to its line would render it fully self-supporting, and as the telegraphic business of Australasia, which is rapidly increasing, would of necessity be stimulated by increased facilities for communication with growing markets, the presumption is that a great deal more than the required quantity would in the course of a few years pass over the Pacific cable. The trunk line of cable once established, branch lines can easily be constructed to connect it with important points. One terminus under British protection in Australasia and another in Canada, one branch, if necessary, to join the San Francisco connection with Hawaii and another to Japan and the China ports, would create a British network of cable communication which would for a long time to come meet the principal commercial needs of the Pacific. Interest at 3 per cent. on the whole initial cost of the Canadian and Australian line would be covered by £50,000 a year. To guarantee working expenses and the necessary loan would in no circumstances entail more than a trifling expense upon the guaranteeing Governments, and if the apparently reasonable anticipation of commercial success prove to be well founded there will be substantial profit. The benefit to British commercial interests cannot be a question of doubt. The most practical proposal which has been formulated for consideration is that the five Governments of Canada, New Zealand, New South Wales, Victoria, and Queensland, or any four of them, shall enter into a joint arrangement for establishing an electric cable across the Pacific, sharing equally in costs and profits, and that the Imperial Government shall be invited to guarantee or lend one-third of the capital, or assist in such manner as the home authorities may determine. The original suggestion in connection with this scheme was that, if it were accepted, the official representatives of the Colonies in London should be charged with the duty of ascertaining how best to carry out the proposal. The present proposal would appear to be that, in the event of the acceptance of this or some alternative scheme, a trust should be formed for the purpose of carrying it into effect.

It has been the fashion to treat the Pacific cable scheme as one of impressive magnitude. As a matter of fact, it is scheme of wide utility, but of financial dimensions so modest that one rich man could proceed to the construction of the cable out of the resources of a private fortune. The matter might, indeed, be safely left to the operation of private interest but for the fact that in the present somewhat exceptional condition of affairs, when all eyes are turned to the Far East, time may become a question of importance. The first Pacific cable has not only the best chance of being successful in itself, it must also have the effect of delaying the construction of rival lines. If the British cable is to hold the field, it should be made without delay.

ELECTRICAL GENERATING STATIONS.

As an outcome of the recent meeting of the Electri
Allied Trades Section of the Chamber of Com
referred to in our "Notes," the following circular i
sent to all the London local authorities :

"ELECTRICAL ENERGY.

"*Generating Stations and Supply.*

"Dear Sir,—I am directed by the Electrical and
Trades Section of this Chamber to send you for you
mation an excerpt from the minutes of their meetin
on March 24, and to express the hope that you wi
such action in regard to this matter as you may
advisable. I shall be glad to hear from you as t
action, if any, will be taken by you.

(Signed) KENRIC B. MURRAY, Secreta

Excerpt from Minutes above referred to.

The Chairman called the attention of the section
appointment of a Joint Committee of the Houses of
and Commons to consider and report—

1. Whether, notwithstanding the provisions of Sec
(1) of the Electric Lighting Act, 1882, powers sho
given in any cases for acquiring land compulsor
generating stations; and, if so, under what condit
respects liability for nuisance, notices to surrounding
and otherwise.

2. Whether compulsory powers of acquiring la
generating stations, if proper to be given in an
should be given where the proposed site is not wit
area of supply.

3. Whether, in case of a generating station, h
acquired, not being situate within the area of
power should be given for the breaking up of
between the generating station and the boundary
area of supply.

4. Whether powers should be given in any case
supply of electrical energy over an area including d
of numerous local authorities, involving plant of exce
dimensions and high voltage; and if such powers
properly given, whether any, and what, conditions sh
imposed : (*a*) with respect to system and plant, and
construction and location of generating stations, in
the powers of purchase conferred upon local authori
Sections 2 and 3 of the Electrical Act, 1888; (
respect to the relations of the promoters to other
takers and to local authorities within parts of the ar

5. Under what conditions, if any, ought power
conferred upon promoters seeking to supply el
energy to other undertakers and not directly to con

After considerable discussion the following reso
were unanimously adopted :

1. That the Electrical Section of the London C
of Commerce is of opinion that the principle of the re
to the Joint Committee of the Houses of Lords and Co
on Electrical Energy (Generating Stations and S
should be supported.

2. That the various municipalities and co
interested in electric lighting be asked to supp
principles contained in the reference to the
Committee.

3. That a committee be appointed (with power to
their number) to take such action with regard to the
of the Joint Committee as may be deemed advisabl

TELEGRAPHY ACROSS SPACE.*

BY SILVANUS P. THOMPSON, F.R.S.

There is no such thing as wireless telegraphy. True,
send signals for a distance of a yard or two without an
but in all the recent successful attempts to telegrap
space, whether by electric waves or by other means, w
used. They do not, indeed, run from the sending st
the receiving station, but are used as base lines. For e
in the case of the longest distance yet reached in teleg
by electric waves—13 miles over open country—th
mum distance attained in the recent experiments of Pro
the length of the wires used as base lines at each end wa
1,000ft. As will be seen, in every case, wires or their

* Paper read before the Society of Arts, March 30, 189

it are used to serve either as base lines or as base areas in the nsmission.

Setting aside the mediæval myth of a sympathetic magnetic egraph with two mere compass needles to point to letters nged around a dial, there are three generic methods by which has been found possible to signal across space without any ectly communicating wire or cable. These may be conniently classified as follows: (1) conduction methods; (2) luction methods; (3) wave methods.

I.—Conduction Methods.

These methods depend upon the use of water or earth as a ans of conducting a fraction of the electric current from the e line at the sending end to the base line at the receiving end. From the earliest days of telegraphy it has been a familiar t that either earth or water might serve as a return circuit an electric current, and, under certain circumstances, that nals could be sent even with an absolute gap in the metallic e, if there were provided by means of earth or water a ficiently good path to enable current in adequate amount to received beyond the gap in the line. This method has somees been called the leakage method, since it depends upon circumstance that electric currents flowing in a conducting dium, such as water or moist earth, do not flow exclusively or n mainly along the path of least resistance, but spread out, se flowing along paths of greater resistance. If current enters conducting stratum at any point by a single electrode, A, d leaves it at some other point by another suitable electrode, some of the current will certainly flow straight from A to B; t the greater part will not so flow, but will stream around m A to B in long curving paths. If, then, two other electrodes, and D, are inserted in one of these stream paths at a distance m A and B, some of the current—perhaps only a small perntage of it—may be picked up by a metallic line joining C to . Hence it is possible, using A B as a sending base line, to nal to C D as a receiving base line at a distant place. The ly limits to this method of telegraphy across space are (1) the ngth of the original currents used in the sending base line, B; (2) the sensitiveness of the apparatus used in the receiving se line, C D; (3) the ratio between the space distance from B to C D and the lengths of the two base lines. This system telegraphing across space has been proposed at various times. has been used by Mr. Preece in several of those many periments which he has made from time to time, and which entitle him to be regarded as one of the foremost pioneers this entire branch of telegraphic enterprise.

Morse himself—as recorded in Vail's early work on telephy—workèd at this subject, and made experiments in on the Susquehanna river, about a mile wide. He engaged . Gale to investigate the best conditions, and came to the lusion that the base lines should be three times as long as distance to be crossed. Mr. Dering, an English telegraph neer, and Mr. Lindsay, of Dundee, have also worked in direction.

After the introduction in 1877-78 of the Bell telephone it found that the extraordinary sensitiveness of that instrut furnished a new means of picking up currents that would wise be too feeble to produce intelligible signals. The rtance of this circumstance in extending the possibilities distance telegraphy was not lost upon Mr. Preece. In 1882 conducted a series of researches upon the establishment of aphic communication between the Isle of Wight and the mpshire coast without any connecting cable across the Solent. account of these experiments will be found in the report the British Association for that year. Large metal plates to e as electrodes were immersed in the sea at the ends the two base lines. On the Hampshire coast the base line nded from Portsmouth through Southampton to Hurst le, a length of 20 miles. On the island the base line nded from Ryde through Newport to Sconce Point, and about 16 miles long. From Portsmouth to Ryde the dth of the sea is six miles, while Hurst Castle is only t a mile from Sconce Point. Hence in this case the length the base lines considerably exceeded the average distance to crossed. With this arrangement signals were passed in dot d dash which could be read on the Morse system with ease; t telephonic speech was not feasible. After many other periments to be mentioned under the next heading, Mr. ece established communication in the winter of 1893-4 oss the Kilbrannen Sound between the Isle of Arran and tyre, a distance of over four miles. He also maintained onic speech across Loch Ness, a distance of 1¼ miles.

he experiments from Arran to Kintyre, parallel wires three miles long were used as base lines along the coast, in some of the experiments two other base lines were sing insulated wires laid along each coast at a height of 300ft. above sea-level. A detailed account of these ments will be found in the report of the British Associar 1894.

r earlier Mr. Preece had made some striking experin the Bristol Channel between Lavernock Point on the Wales coast and the islands of the Flat Holm and the Steep Holm, the distances of which are respectively 3·1 and 5·35 miles. His base line on the shore at Lavernock Point was a pair of copper wires weighing 400lb. per mile, suspended on poles for a length of 1,267 yards, their circuit being completed through earth. An alternating current was sent into this base line by an alternator worked by a 2-h.p. steam-engine, the voltage being 150 volts, the frequency 192 periods per second, and the current (maximum) 15 amperes. These alternations were broken up into dots and dashes by use of a Morse key. The signals were read on a pair of receiving telephones inserted in the distant base line, which in each case ran across the island and dipped into the sea. The length of these is not stated. Mr. Preece received messages easily over the three miles separating the mainland from the Flat Holm. But at the Steep Holm, 5·35 miles away, though the signals were feebly perceptible, telegraphic conversation was impracticable, as the sound could not be differentiated into dots and dashes. Mr. Preece came to the conclusion that with two base lines, each 10 miles long, he could with ease signal across a distance of 10 miles.

Prof. Trowbridge, of Harvard, has also investigated the possibility of transmitting signals through the earth by conduction, using a rapidly interrupted primary current and a telephonic receiving apparatus.

Many experiments have been made under accidental circumstances, all tending to prove the possibility of this mode of transmitting signals through the earth itself. The instruments in Greenwich Observatory are affected by the stray currents that escape into the earth from the badly-insulated return circuit of the City and South London Electric Railway, 4½ miles away. Another example is afforded by an accident which occurred some 10 years since at the Ferranti electric lighting station at Deptford, when one night one of the dynamos by some derangement became connected to earth. The whole of the railway telegraphs in the signal boxes of the railways in South London were temporarily put of order and rendered inoperative, while the currents flowing in the earth were perceived in the telegraph instruments so far northwards as Leicester, and so far south as in Paris. If this could occur as a mere accident, it is obvious that with properly-thought-out arrangements signals could easily be sent from one part of the globe to another by conduction through earth or water.

Most striking of all the cases of distance signalling by conductive methods is that presented by the transmission of signals over nearly three miles, which was carried out in 1894 by Dr. W. Rathenau, Mr. E. Rathenau, and Prof. Rubens. They selected as a suitable place for operations the open water of the Wannsee, which opens into the Havel, near Potsdam. Here at the south end, near the Friedrich-Wilhelmsbrücke, they immersed two metal electrodes, each having about 15 square metres of surface, at the two ends of a base line about 550ft. long. With 75 accumulators and a rotating interruptor giving about 150 currents per second, and a Morse key, they injected signals into the base line. At a distance of 4½ km., or nearly three miles across the water, near the shore at Neu Cladow, they set up the secondary base line, having electrodes of about four square metres each. These were hung in the water from two boats between which the connecting line—about 330ft. long—was stretched. In this line was inserted a telephone receiver of usual pattern. The current used was about three amperes, and there was not the slightest difficulty in hearing the dot-and-dash messages. Several situations for the receiving base line were tried, and it appeared that the interposition of a large sandbank between the two stations made very little difference.

II.—Induction Methods.

Induction methods are of two varieties. An electric charge upon a conductor may induce another electric charge upon another conductor at a distance by influence, or electrostatic induction. An electric current in a wire, during such time as it is increasing or diminishing, may induce another electric current in another wire in its neighbourhood by electromagnetic induction.

So far as I am aware, the only case in which electrostatic induction has been used in electric signalling is that of telegraphing (or telephoning) to trains in motion, as suggested about 13 years ago by Mr. Wiley Smith, of Kansas City. If a wire suspended over a train is electrified, either positively or negatively, charges are induced upon the metallic roofs of the cars, and if these are suitably connected to instruments on board the train, signals may be exchanged between train and wire without any metallic connection between the two. This suggestion was further developed, about the year 1886, by Mr. Phelps, and by Messrs. Gilliland and Edison. Descriptions of their methods will be found in the American electrical journals of that date. The system was successful both for telegraphing and telephoning, and was, indeed, adopted for a time by the Lehigh Valley Railroad Company. But it has been abandoned for a very simple reason. One of the consolations of railway travelling is that one is free from being disturbed by telegraph or telephone. No one on board an express wants to telegraph or be telegraphed to.

Electromagnetic induction has played so important a part in distance telegraphy that it must receive a more extended notice. Very early after the introduction of the commercial telephone, troubles arose from the exceeding sensitiveness of the instrument. Conversations in one line were overheard in another, while the ear was disturbed by an incessant buzz or rattle from the interference of stray currents from neighbouring telegraph lines. All these were at first attributed to induction—that is to say, to the electromagnetic influence of the currents in one line upon the neighbouring line. No doubt in some cases this is a cause, but unquestionably in many of the cases the disturbance was due not to induction at all, but either to leakage of currents across the surfaces of the insulating supports, over films of dirt or moisture, or else to leakage of currents from one line into the other through the earth-plates or earth connections. Unless circuits with metallic returns are used it is certain that the earth return will afford a means for stray currents to find their way into the telephone lines. Mr. Preece has narrated many cases in which telegraph or telephone messages that are being transmitted along some line have been heard, or rather overheard, in telephonic instruments in some totally disconnected and distant line. Many of these are due doubtless to stray currents through earth, but some are unquestionably due to true induction. A line or circuit absolutely insulated from any earth contact or earth return may yet act inductively. During the brief instant while the current in it is growing that current is setting up a magnetic field in the surrounding region, extending indefinitely but feebly into space. As the current dies away again this magnetic field also dies away. If in its growth or decrease this magnetic field encounters other wires it sets up E.M.F.'s in them, and thus originates disturbances. For the propagation of this effect from wire to wire no contact is needed. It is an effect that is dependent upon the properties of the intervening medium, and is proportional to its magnetic permeability. The ether of space itself—air, water, soil, and rock—are all of about equal permeability. Hence this kind of induction may be propagated from circuit to circuit whatever natural material intervenes. Mr. Preece has made repeated researches with a view of utilising this effect for the purpose of distance telegraphy. He has erected parallel base lines, sometimes in South Wales, sometimes near the mouth of the Dee, sometimes in Scotland. He has laid out, flat on the ground, great squares of insulated wire to test the inductive transmission from one area to another. On Newcastle town moor, and on the sands at Penarth, he has thus operated. It is not always easy in his experiments, particularly in those where earth connections were used, to be certain how much of the effect was due to true induction and how much to earth conduction. But in some of the cases there can be no doubt whatever. An excellent *résumé* of his work was given by him at the Chicago Congress in 1893. In this he describes how in one series of experiments he laid out on a level plain two quarter-mile squares of copper wire insulated with guttapercha, the distances between the two nearest sides of the two squares being also a quarter of a mile. In this case, using rapidly-interrupted or vibratory currents, and a Morse key to break them up into Morse signals, and applying in the other circuit a receiving telephone, conversation in the Morse code could be held readily between the two operators. This arrangement precluded all idea of earth conduction. In effect, Mr. Preece was working with a strange species of transformer, of which his two squares constituted respectively the "primary" and the "secondary," the "core" of the transformer being in this case partly of earth and partly of air. Mr. A. W. Heaviside has described an analogous case in which, wishing to establish telephonic communication to the bottom of a colliery in the North of England, he arranged a circuit in a triangular form along galleries about 2¼ miles in total length at a depth of 60 fathoms. On the surface of the colliery another circuit was laid out in triangular lines of equal size over and parallel to the underground line. Here, again, telephonic speech was perfectly clear by induction from line to line; or rather, in this case, from area to area. Each area enclosed something like 700,000 square yards, an ample base area when the distance to be penetrated was but 120 yards.

Earlier than the date of either of these experiments, the late Mr. Willoughby Smith had shown how, using two coiled circuits of wire at a distance of some yards apart, telephonic messages could be sent across air, or even through walls and floors.

The greatest distance to which Mr. Preece's experiments upon telegraph lines have been carried is 40 miles—namely, between the telegraph lines that run across the Scottish border by the east and west coasts respectively. Sounds produced in the Newcastle and Jedburgh line were distinctly heard on the parallel line at Gretna, though there was no line connecting the two places. Here, however, since both lines used earth returns, it is probable that most of the effect was due to conduction, not to true induction.

Instruments which operate by means of alternating currents of high frequency, like Mr. Langdon-Davies's phonophore, are peculiarly liable to set up disturbance in other circuits. A single phonophore circuit can be heard in lines 100 miles away. When this first came to my notice it impresse[d] greatly, and, coupled in my mind with the Ferranti in[...] mentioned above, caused me to offer to one of my fi[...] friends in the City, some eight years ago, to undertake ser[...] to establish telegraphic communication with the Cape, pr[...] £10,000 were forthcoming to establish the necessary [...] circuits in the two countries, and the instruments for cr[...] the currents. My offer was deemed too visionary for a[...] ance. The thing, however, is quite feasible. The one n[...] sary thing is the adequate base lines or areas. All the r[...] detail. *(To be continued.)*

BROWN'S PATENT LOW-WATER ALARM.

This ingenious electric low-water alarm for use on b[...] is being put on the market by Messrs. Arthur D. S[...] and Co., of Kettering. The construction of the alarm [...] be readily understood by reference to the sectional [...] ings (Figs. 1, 2, and 3). A mercury-tube, similar [...] thermometer tube, is encased in a metal fitting, whi[...] attached to the boiler front by a pipe and elbow ins[...] at low-water level; two platinum wire ends are insert[...] the sides of the mercury-tube above the normal pos[...] of the mercury, one of which is attached to the fi[...] thus forming the earth part of circuit; and the [...] to the insulated binding screw at the top. T[...] is, therefore, only one wire to the bell and ba[...] So long as the water in the boiler is above the [...] water level, it is forced up into the pipe and body of fi[...]

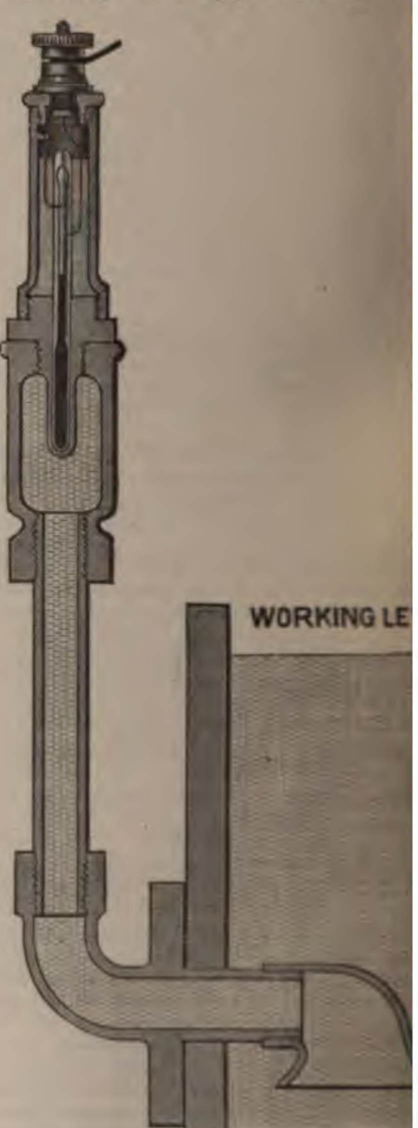
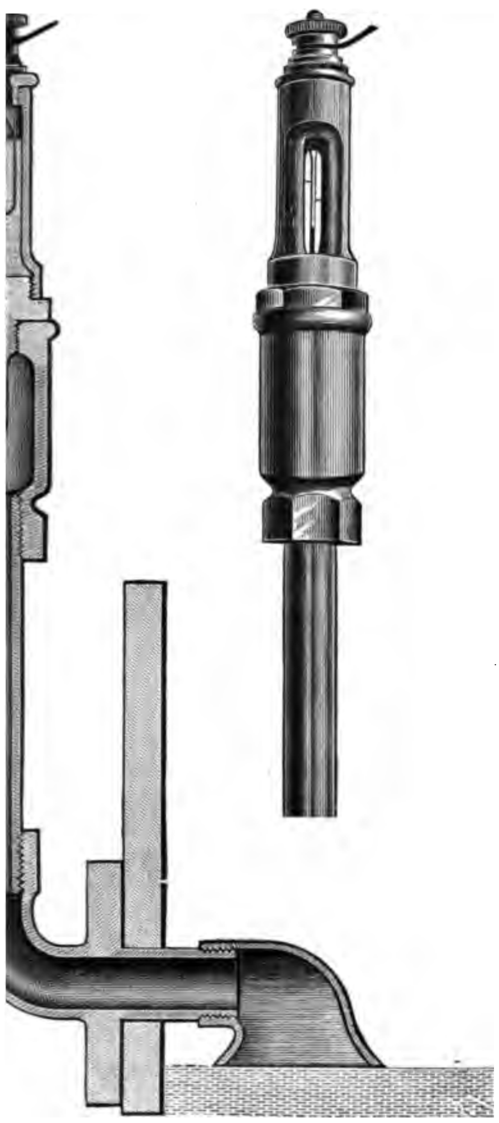


FIG. 1.

The temperature, by the cooling action of the atmos[...] quickly falls below boiling point. This keeps the m[...] below the wire end, which completes the alarm c[...] Should the water fall below the low-water line it wi[...] back out of the pipe and fitting, which is then [...]

illed with steam. The higher temperature of the causes the mercury to rise above the two wire making a connection between them, completing c circuit, and causing the alarm bell to ring. ɜ water is added to the boiler by the feed pumps



FIGS. 2 AND 3.

ll quickly fill by condensation, and the mercury gain to its normal position, breaking the circuit.

QUESTIONS AND ANSWERS.

ais heading we insert questions and answers cal character relating to central-station work, ork, or construction work; and for each suit-ion offer *one shilling*, and for the best solu-y question we offer *ten shillings*. We also *illings* for every other answer we print. The any question should be sent within 10 days uestion has appeared, and should be written on the paper only. We would call the attention nding in answers to the fact that the neatness ches sent in is considered when marking the lues of these answers. Questions may be sent a.

QUESTIONS.

the advantages and disadvantages of expansion nd expansion bonds for long steam-pipes. What of expansion do you want to allow for in a steam-ft. long working at 180lb. pressure steam?—J. F. M.

uildings are sometimes wired with three mains irectly from the three mains of the supply circuit, ne main having its separate fuse. If the fuse of dle house main goes, there is danger of lamps being up if the two sides of the three-wire supply in the unequally loaded. How can this danger be best ?—J. C. R.

ANSWERS.

Question 49.—What are the arguments for and against a 220-volt supply from the consumer's standpoint?

Best Answer to No. 49 (*awarded* 10*s.*).—The advantages of supplying electricity at 220 volts are: (1) A reduction in the cost of wiring. It will be perfectly clear that only half of the current will be required for the same number of lamps as would be required on the 110-volt system; thus only half the section in cables is required, and no higher insulation than that used with cable on the 110-volt system. This means a large reduction on first costs, which is generally a big objection against the adoption of electric light by the public. (2) The fall of potential is reduced. This may not seem at first sight a good argument for the adoption of the 220-volt system, but where a large number of lamps are in use it is very important, as the following instance shows: At the Great Northern Hotel, in Bradford, where something like 525 lamps are in continual use, the manager wrote the electrical engineer stating that a better light was obtained, and a reduction of about £50 in the lighting accounts was experienced on the first year of the change over from 110 to 220 volt system. This was due to the substitution of some 8-c.p. lamps for 16-c.p., owing to the fall in potential being reduced.

The disadvantages of the system are: (1) The fittings, which have to have better insulation than on the 110-volt system.

In Bradford the same fittings are used on the 220-volt system as were used on the 110-volt circuit, and no trouble has been experienced, but the cut-outs should be made with longer fuses, and, in some cases, a special kind of cut-out is used. It will be seen that this is no practical objection to the system. The incandescent lamps are supposed to be a serious disadvantage, but it cannot be argued that making the lamp bulbs a little larger is a serious drawback; and if this is allowed, lamps can be manufactured equal to lamps at 110 volts. When the bulbs are the same size, a type of filament known as an unflashed filament is used; and this gives rise to the opinion that lamps at 220 volts burn well for a short time, and then the candle-power decreases and the lamp requires more current, but if one of these unflashed lamps is placed on the 110-volt circuit, similar results will be obtained. The following tests of two lamps with slightly larger bulbs than those used on the 110-volt circuits show results in all respects equal to 110-volt lamps:

Hours in circuit.	No.	Mean volts.	Actual c.p.	Amperes.	Watts per c p.
New	1	230	9 1	·141	3·56
—	2	230	9·3	·137	3·50
1,000	1	230	7·6	·141	4·26
—	2	230	7·5	·141	4·32

Taking 1,000 hours as the average life of a lamp on Corporation mains, these lamps (selected at random out of a box) show equal results to those used on 110-volt circuits. The lamps in the above test were marked "8 c.p. 230 volts." The only objection against these lamps are larger bulbs and a slightly higher cost.

Arc lamps at 220 volts were at one time a source of trouble to the supply companies, but this trouble has been successfully combated, and in Bradford, where nearly 500 arc lamps are connected on the mains, very little trouble is experienced. A lamp which takes the form of a double five-ampere lamp is used instead of the ordinary 10-ampere lamp, and some of the enclosed varieties are used on the mains. The objection to the system, series grouping, is a great fault on the 110-volt system, but when used on 220-volt circuits it becomes very serious, for should the carbons in one lamp run short or stick, the carbons of the other lamps close together, and full voltage is maintained across the shunt of that particular lamp. The result is the coils of the lamp are burned up or the carbon-holders of the other lamps are damaged by excessive flaring. No reliable cut-out for this kind of arc lamp is on the market, and I have seen lamps come to be repaired which have the holders and shunt coils burnt like a cinder. Arc lamps on the 230-volt circuits must be worked at a higher E.M.F. than when on the 110-volt circuits, or pumping will ensue. It will be seen that this means more watts per candle-power. The arc lamps at Bradford work very steadily and give a good light.

Motors used on 220-volt circuits require higher insulation and thinner wire to make up the required resistance used. Sometimes longer lengths of the same gauge wire is used, thus avoiding the use of thin wire and possible breakdowns.

Whilst the 220-volt system is undoubtedly the best for several reasons, it leaves much to be desired in the way of fittings and arc lamps, with which there is no doubt with time and experience our manufacturers will provide supply companies. That the 220-volt system is a good one, from the consumer's point of view, is shown by the large number connected on the Bradford mains since the change over to the 220-volt system.—F. M. M.

Answer to No. 49 (*awarded* 5s.).—From the consumer's point of view, the advantages accruing from the use of high-voltage supply are not quite so numerous or apparent as in the case of the central-station engineer. There are undoubtedly some very real advantages, but these in a great measure are counteracted by difficulties which up to the present have been only partially surmounted. One of the chief of these is the lower efficiency often coupled with shorter life of the high-voltage incandescent lamp. While it is quite general to obtain 100-volt lamps, three watts, and even less per candle-power, the highest efficiency at 200 volts is probably about four watts. In comparing the performances of the two types, the falling off in candle-power of the 200-volt lamps is considerably more than with 100-volt lamps. The initial cost of the high-voltage type is somewhat greater than the others by about 15 to 20 per cent. There is also a great difficulty to obtain a really good 8-c.p. high-voltage lamp, which is a matter of some moment to a residential consumer, who would in certain situations, such as basements, etc., burn an 8-c.p. lamp when a 16-c.p. would be obviously too big. Then, again, taking the efficiency of the two types at three and four watts, light for light, a consumer's bill would be about 30 per cent. higher in the 200-volt case. But, of course, it may be immediately said that the saving effected (quite apart from the consumer) would make it possible for the supply company to reduce its price in the latter case. Another difficulty with high-voltage supply, from the consumer's point of view, is the arc lamp question. There are plenty of people who require a single lamp for lighting their premises, but naturally do not care to pay the same amount for energy as someone else who has twice the number of lamps. Of course this applies to a certain extent in the case of 100-volt circuits, the only difference being that the difficulty is twice as great. There are two partial solutions to it: One is the use of small-current lamps, substituting, say, two five-ampere lamps for one 10-ampere, but this has the disadvantage of both extra initial cost and the inferior efficiency and regulation of these smaller lamps. The other solution is the enclosed arc, which has a good deal to recommend it, notably the fact that its maintenance is much less than with the open type of lamp; in inaccessible places this is of considerable importance. One of the arguments often urged against high-voltage supply is the extra fire risk entailed, but it is probable that with properly designed fittings the risk is, if anything, less. As a rule it has been found that it is not want of insulation that has caused fires, but inadequate carrying capacity of conductors and fittings, etc., causing them to overheat badly and thus be a direct source of danger. As the current in the case of high voltage is halved, this tendency is only a quarter as great. If by any means an arc should occur between two conductors placed some distance apart, a 200-volt supply would cause the fuse to blow sooner than with 100 volts, preventing the arc from spreading along the conductors. It is true that in all switches, fittings, etc., somewhat greater length of break is required and greater precaution taken generally in manufacture, making them, perhaps, a little more expensive in first cost; on the other hand, the expense entailed in wiring any premises would be smaller, owing to the reduced quantity of copper required. The greatest advantage of high-voltage supply is the increased steadiness of pressure. Nothing lessens the candle-power of a lamp or reduces its life and efficiency so much as varying pressure at its terminals, as the following will show:

104 volts	....	equivalent candle-power	20
103 ,,	....	,, ,,	19
102 ,,	....	,, ,,	18
101 ,,	....	,, ,,	17
100 ,,	....	,, ,,	16
99 ,,	....	,, ,,	15
98 ,,	....	,, ,,	14
97 ,,	....	,, ,,	13
96 ,,	....	,, ,,	12

That is, 1 per cent. difference in pressure make 5 to 6 p[er] cent. difference in light, or the Board of Trade allowanc[e] 4 per cent., makes a difference in candle-power of 20 [to] 24 per cent. With 200-volt supply these variations [in] candle-power will be reduced by about one-half. Suppo[se] with 100 volts declared pressure there was a drop of tw[o] volts—that is, 2 per cent.—with double the pressure tw[o] volts would only be 1 per cent. variation. Again, if [a] large motor were switched on, causing, say, four vol[ts] drop—that is, 4 per cent.—if 200 volts supply th[e] motor would only take half the current, causing the vol[ts] to drop only 2 or 1 per cent.—that is, only a quarter [as] much as in the first case.

Therefore, in summing up, it is for a consumer to deci[de] whether the disadvantages of high-voltage lamps (with th[e] probability of their improvement), which no doubt is t[he] chief disadvantage from his point of view, is count[er]balanced by the increased steadiness of supply which [he] gets, tending to augment the life of his lamps, and by t[he] fact that the many advantages which the supply compa[nies] receive from the increased pressure (quite apart from hi[m]) will permit of them lowering the price. In fact, so[me] supply companies in changing over from one system to t[he] other adopt the policy of connecting a consumer at 2[00] volts on much more advantageous terms, either by allowi[ng] them a rebate on their bills or else by supplying th[em] with free lamps. This argument would appeal very forcib[ly] to most consumers.—H. BELL.

Question No. 50.—What are the advantages and disadvanta[ges] of using steam-turbines in a central supply station?

Answer to No. 50 (*awarded* 7s. 6d.).—There are t[wo] types of steam-turbines—the Parsons and the De La[val]. In the first, steam acts expansively upon one vane af[ter] another until it falls to a minimum pressure. The princi[ple] of working of the De Laval depends upon the imp[act] of a jet of steam for its power, and is simply an impu[lse] turbine. The De Laval is not, I think, in use in any el[ec]tricity station in this country, but a few are work[ed] entirely by the Parsons turbine. The chief advantage [to] be gained by the use of steam-turbines is the low steam c[on]sumption per horse-power hour at light loads. This lig[ht] load high efficiency is largely due to freedom from cylin[der] condensation. The metal of the steam-turbine is pra[cti]cally at the temperature of the steam in contact with i[t at] all times, and much loss is thus avoided, which can o[nly] be minimised in ordinary reciprocating engines by sup[er]heating. The following record of a test made by [Mr.] W. D. Hunter, of the Newcastle and District Electric Li[ght] Company, on a 150-kw. alternator, geared by helical s[pur] gearing to one of Parsons's standard compound turbi[nes,] bears out the above.

Units.	Vacuum at cylinder.	Total water per hour. lbs.	Water per unit. lbs. per hour.	Water per E.H.P. lbs. per hour.	Revs. per min.	Remark[s]
150·33	$26\frac{1}{2}$	3,484	23·17	17·28	4,700	Barometer [illegible] Pressure [illegible] steam at g[ene]rator 70lb [per] square in[ch]
72·84	$26\frac{1}{2}$	1,950	26·77	20·0	4,700	
38·97	$26\frac{3}{4}$	1,150	29·51	22·01	4,700	
·175	$26\frac{3}{4}$	437	—	—	4,600	

This test not only shows the low steam consumpti[on at] light loads, but a very high efficiency even at full [load]. The floor space required is another great consideration[:] the space taken up is only about half that taken up [by a] steam dynamo of the marine type. Moreover, no expe[nsive] foundations or holding-down bolts are necessary, t[here] being no reciprocating motion in the moving parts to c[ause] vibration. This fact has in many cases enabled old [and] otherwise unsuitable buildings to be adapted for gener[ating]

ı. The first cost of the turbine set is lower than the steam dynamo, and when considered with the saved in the foundations and buildings is of great t.

her point of vital importance is the fact that no r lubrication is required, consequently saving the of oil and the filtration of the feed water, and also preventing the evils arising from the presence of the boiler plates. The cost of oil for the lubrica- the bearings is a minimum, as it is continuously ed automatically by means of a force pump. The nce and upkeep comes out very moderate in stations use them throughout. The main disadvantage of the is that if it gets slightly out of order or if the ecome worn it is very wasteful of steam, which has y given it the term "steam-eater" by which it has signated. It has not yet been considered wise to bine-alternators in parallel, but I believe the makers pared to guarantee perfect parallel working of them red. They are rather noisy when in action, pro- a decided hum, independent of the hum of the or alternator. Then there are the drawbacks and ies of the gearing, which becomes necessary with y high speeds. The magnetic governor has also in ases given considerable trouble.—J. P. B.

er to No. 50 *(awarded 7s. 6d.).*—The application of urbines for driving dynamos in electric light stations od deal to recommend it, but in spite of this fact y been adopted in few central stations up to the notably Newcastle and District, Cambridge, Metro- Supply Company, and Portsmouth. Probably one or its limited adoption has been that up to quite it has only been in what might be termed an experi- state, and the advantages to be derived from it omewhat doubtful. It is generally conceded that ere for the steam-turbine is in crowded districts, ere vibration is of the utmost importance; in these undoubtedly is pre-eminently suitable for the follow- ons. Owing to the absence of reciprocating parts reedom from vibration is obtained, and it is a common see even large machines running without holding- olts and with comparatively little foundation, ly indiarubber blocks on a slight bed of concrete. vibration nuisance is one which has caused a good trouble in crowded districts and in situations where racter of the surrounding buildings would not permit ence, the true significance of this will be readily seen. pies less space than any other steam-engine, and o its exceptionally high speed admits of a smaller generator than is otherwise possible. In stations ave no room left for extensions, and whose only ive is to adopt some other means of distribution, l dimensions will rapidly recommend it.

team consumption the steam turbine beats most gines on the market, a consumption of 17lb. being mmon in sizes varying from 150 kw. to 200 kw.; ossesses the advantage of superior efficiency at light almost any other type of engine. This makes it itable in special circumstances, such as the running nators on separate feeders; in fact, in one station ctice was adopted for the very reason stated above. vantage of superheating can be fully realised any of its attendant evils, such as damage to r liners and all bright surfaces, rapid deterioration forms of packing, etc. The economy effected by a very easily amount to some 8 or 10 per cent. re not the losses that are usually present in most ating engines, such as clearance condensation losses the alternate heating and cooling of the cylinder k pressure losses. It is possible to use much higher es than is general with most engines without the nitial expense and subsequent maintenance of triple ruple expansion gear, as increased expansion in a rbine does not necessitate the same amount of ear, etc., as in an ordinary engine, but simply a bigger and more complicated casting.

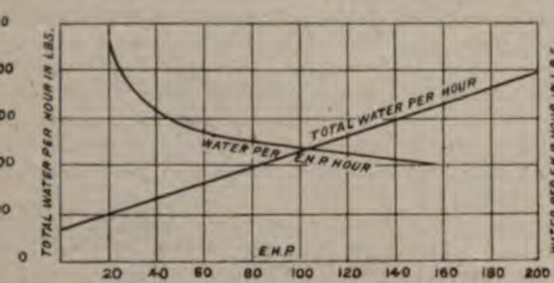
aintenance it also takes the lead, as there are ly only the two main bearings to lubricate; in a pply station this item is rather a serious one. Again, there are not the number of glands to keep tight, piston rings to renew, etc., nor the same amount of skilled labour required to keep them in repair, and the attendance generally will be much reduced. The absence of all cylinder lubrication is a great advantage, obviating the necessity for using all forms of oil extractors and strainers; and if surface condensers are employed, and the hot-well is used for feeding the boilers, there is no fear of damage to the crowns of the latter. As far as the dynamo is concerned, the exceptional speed permits of its being made with a very small number of poles—if an alternator, either two or four—thus reducing it in weight, price, and simplicity. For instance, in a Parsons 350-kw. turbo-alternator at one of the London stations the diameter of the armature is only 18in., and on it there are 40 conductors, making two coils with 10 turns in each; the machine is four-pole, and at a speed of 1,000 revolutions gives a frequency of 100 ∿. The copper in the armature weighs only 58lb., and the total weight of the combination is 12 tons. It is possible for the exciter to be coupled to an extension of the main shaft without making its dimensions unduly large, thus doing away with all belt drives, and making a very compact and complete set.

One disadvantage with some steam-turbines, chiefly of the impulse type, such as the "De Laval," is that their speed is too high, and some form of reduction gear has to be resorted to, which is decidedly objectionable. As far as governing is concerned, they compare very favourably with most engines. In the Parsons turbine an electrical governor is employed which actuates a double-beat valve closing every so many revolutions. In one or two stations it is the practice to run turbo-alternators in parallel with large slow-speed machines, as they will both synchronise and keep in step with them with no difficulty, conclusively proving that their governing is all to be desired. As far as price is concerned, without any definite data, it is impossible to compare the two types, but it is probable that the rotary engine, with its absence of all complicated valve gear, small size, and light weight, should be somewhat cheaper than the reciprocating class, and undoubtedly, when it becomes better understood and still further perfected, will have a very extended use in electric lighting work.—H. BELL

Answer to No. 50 (*awarded 7s. 6d.*).—Steam-turbines possess considerable simplicity, and as they run steadily at a high rate of speed, they are very suitable motors for driving dynamos. Both condensing and non-condensing are in use, and at present there are about 30,000 at work in England. An argument in favour of the steam-turbine is the absence of vibration from its foundation, there being no reciprocating motion from its working parts. This valuable property has led to its adoption in supply stations where vibration would be liable to cause a nuisance. Steam-turbines take up very little floor space, comparatively speaking, and the vibration being nil, they do not require bolting down. The cost of building and foundations is small. The machinery being easily managed and controlled, less attendance is required. The plant can be run up with ease and rapidity. The smaller first cost of plant enables more spare plant to be kept ready suitable for the load, and consequently effecting a considerable saving of fuel. Turbines claim the advantage of a small consumption of steam at average load in the larger sizes, especially in the condensing types. The governing arrangement is good. The steam admission valve is worked by a steam relay, the valve of which is controlled by a solenoid. The cost of repairs is small, the saving of oil is considerable, and with forced lubrication the wear and tear is reduced to a minimum.

A great disadvantage is not being able to indicate the turbine in the ordinary way. It is convenient to call the rate of total working of the steam on the vanes the indicated horse-power. Prof. Ewing, in a series of trials which he conducted on the steam turbine, estimated that with an electrical output of 100 kw. the total power was about 179 i.h.p. The consumption of steam per indicated horse-power per hour, at full load, was 15·7lb., measuring the feed water, and at half load 17lb. per hour. The steam was superheated to 400deg. F., the initial pressure on gauge being 100lb. Prof. Kennedy tested a steam-turbine direct

coupled to a continuous-current dynamo which ran at 4,500 revolutions per minute. The output was 150 kw., the steam on gauge 100lb. The diagram below is taken from his report, and shows the steam economy.



Excellent results are obtained from the use of superheated steam. With wet steam the turbine gives less satisfactory results, owing to the internal friction developed by particles of water. If the steam is superheated before admission, it will remain dry almost until the exhaust takes place. In this way the clogging action of the steam is reduced and a high degree of perfection obtained.—F. Bruton.

[The above three answers are uniformly good, and yet each contain distinctive matter. Hence we feel compelled to treat them as equal.—Ed. *E. E.*]

ELECTRIC LIGHTING OF SWANSEA.

The following abstract is taken from a local paper :

The Electric Lighting Committee of the Swansea Corporation has just received the report of Mr. E. Manville, electrical engineer, on the proposal to utilise their provisional order and establish a municipal system of electric lighting. Mr. Manville's report is one of the greatest importance, and in all probability will give rise to heated discussions both inside and outside the Council-chamber. The report should be considered in relation to the offer submitted to the Corporation by the British Electrical Traction Syndicate. The proposal of the syndicate was, we understand, £1,000 for the Corporation's provisional order for the eight years which will elapse before the Corporation can again treat for the purchase of the tramways, and also 10 per cent. of the gross takings.

In the course of his report Mr. Manville deals with certain technical alterations in the Board of Trade regulations and improvements in incandescent lamps, which, he says, "theoretically would enable the distance to which a given amount of current can be transmitted with the same efficiency as at the previous low-tension pressure of 220 volts, to be extended four times, and thus make the efficient limit of distance from the generating station for a low-tension three-wire system at 440 volts very much more practicable than it was four years ago. These are technical details in which the Corporation must, to a great extent, be guided by expert opinion, as also are the following points in the report" :

"(1) That the low-tension system for the compulsory area will be a good deal cheaper than the high-tension system ; (2) that when the distribution is carried to a radius of three-quarters of a mile from the generating station the cost of the modern low-pressure system and the high-tension alternating system will be about equal ; (3) that when the distribution is carried to a radius of a mile from the generating station, the low-tension system will exceed the cost of the high-tension system in cost of feeders only by about 50 per cent., and that above this distance it will probably not be wise to use the low-tension system at all. You will, of course, appreciate that a mile radius from the Strand site includes a considerable portion of the town, and will represent probably most of the lighting that you will do ; and as I understand you contemplate the supply of a good deal of current for small motors distributed over the town, this in itself will be a reason for deciding to adopt a continuous-current system at 440 volts distribution rather than a high-tension alternating-current system with transformers—for although single-phase alternating-current motors are now quite practicable machines, they are yet neither so simple to handle nor as inexpensive as continuous-current motors. If, then, you should decide to select the low-tension proposition, and finding that you ultimately require to carry your lighting much beyond a mile in any direction from the site, I would suggest that all lighting required to be done beyond this distance should be effected by motor-alternators situated in the generating station, consisting of a continuous-current motor coupled to an alternator, and receiving its current from the low-tension machines situated in the generating station. The alternating currents which would then be produced the motor-generators at 2,000 volts would feed into a former system in the outskirts of the town, similar alternative proposition for the inside of the town. It probably not be worth while installing separate engine alternators for this purpose, as by far the bulk of the li would necessarily be provided for by the low-tension sy and it could be but a small portion that would require dealt with by the high-tension system, and therefore it in my opinion be more economical to use motor-alternat the future for this purpose than to instal separate steam-en and alternators. Combined stations of this sort are in several towns. I myself am erecting such an one for the poration of Southampton, and on the same principle, with tension continuous-current system and motor-alternato the outskirts, are running satisfactorily at Sunderland elsewhere."

Capital Expenditure.—What interests the burgesses to greater extent than the technical details are the estima expenditure and revenue. In estimate No. 1 (low-tensio tinuous-current system) the plant provided has a total capacity of 525 kw. For buildings, consisting of engin boiler-house with foundations and chimney shaft 120ft. the sum set down is £5,800. The generating plant is, of c the largest item. The chief items of this are: eig travelling crane, a range of four Lancashire boilers, constr for a working pressure of 160lb. to the square inch ; econo etc., £9,200 ; two semi-slow speed engine generators, e 225 kw. output, consisting of horizontal compound coupled engines with multipolar dynamos ; one 75-kw. coupled high-speed steam-generator ; main switchboard connections and testing instruments, etc., £6,950, etc. item for feeder mains and low-tension network is £7,200, m in all £30,210. To this is added 7½ per cent. for conting engineering, etc., and the total estimate is put at £32,470

Estimate No. 1A is for the capital expenditure on the tension alternating-current system, with outfit as in the pr estimate. The details of this differ very slightly from given in Mr. Manville's report of June 18, 1894. The after adding 7½ per cent. for contingencies, engineering, £35,936.

The Revenue.—The second estimate is one of the reve be derived from the work. It is stated as follows :

Private Lighting.

The equivalent of 15,700 8-c.p. lamps joined up to the mains, each consuming 15·1 Board of Trade units per annum, equals 237,000 Board of Trade units at 4½d.

Public Lighting.

Current used on 48 arc lamps burning till midnight, say, 60,000 units at 2d...

Current used on 95 public incandescent lamps of 32 c.p., replacing arc lamps from midnight till dawn, say, 28,000 Board of Trade units at 2d.............................

Total ....

Total number of units, public and private lighting, 325,

Average price obtained per unit, public and private, per Board of Trade unit.

Cost of Maintenance.—The maintenance is estima £4,125, or 3·05d. per unit, and in this, it is to be note Manville provides for the interest and sinking fund 5 per on £32,470, which, amounting as it does to £1,623, for largest item in the maintenance. The cost for 325,000 of Trade units takes £541, or ·4d. per unit ; and wag repairs take ·4d. per unit—or £541 each. The managem ·3d. per unit, or £406. We thus get the following :

Financial Statement.

Average receipts	3·82d. per B.O.T. unit	...
Cost of maintenance, with interest and sinking fund	3·05d. " "	...
Balance	·77d.	

Commenting on the above details, Mr. Manville says : will notice that I now suggest that 15,700 lamps of 8 c. be joined up to the mains, although the machinery will capable of lighting more than 10,000 of these lamps taneously. This is a larger number of lamps connected was originally estimated for by me ; but you will see th consumption per lamp is reduced to 15·1 units per ann place of 22, as originally estimated." Having pointed o these changes have been made with adequate reason, Mr. ville states : "I have taken the price which you would for a private lighting supply at 4½d. per unit—a very low and which I do not propose you should charge to ever sumer alike ; but which I estimate would be the averag you would obtain on an equitable sliding-scale system. The prices allowed for maintenance are liberal, and above which should be incurred in practice." The balance of shown in the above statement will be partially to pay i

and sinking fund on the cost of the site, and the balance towards the reduction of the rates or otherwise.

Mr. Manville also reports on the question of combining a dust destructor with the electric power installation. He agrees with Mr. Bell's figures for the capital cost of a destructor, with the extra buildings required over those provided for the electric lighting only, and including the extra cost of the boilers, etc., at £11,000, or with the addition of the site on which it would stand, £13,000. Mr. Bell advises the Corporation to adhere to the Strand site, opposite Welcome-lane, which, he says, is admirably situated both for the disposal of refuse and the distribution of electricity. Mr. Bell estimates that the financial result of the scheme, so far as the scavenging work is concerned, will be a saving of £250 per annum, the cost of burning at the Strand being so much less than hauling and tipping to the Gorse-road or a tip at a similar distance. In a supplement, Mr. Bell estimates the financial result of disposing of 20,000 tons of refuse per annum at a destructor on the Strand site instead of tipping it on the Gorse-road, including capital charges on cost of works and site, and giving credit for refuse as fuel for electric lighting. It is supposed that 30 per cent. of clinker, or 6,000 tons per annum will be produced. Two-thirds could be used to advantage, and the remainder removed at a cost of 1s. per ton. Against the cost of haulage to Gorse-road, £2,250, is set the hauling to the Strand, labour and repairs, interest and sinking fund on cost of works (5 per cent. on £13,000), and the cost of disposing of 2,000 tons of clinker, showing in total £2,750. On the credit side, however, the value of the refuse as fuel, saving the cost of coal, appears as £937, and the saving in stokers' wages £195. The net result of Mr. Bell's estimate is a saving of £632 per annum, but in this no credit is given for the 4,000 useful tons of clinker. Mr. Manville disagrees with Mr. Bell's estimate as to the saving, and brings it down to £184, because he estimates the saving in coal at only £448 per annum. However, Mr. Manville agrees with the combination, which appears both on sanitary and economical considerations to be desirable.

LEGAL INTELLIGENCE.

CITY ELECTRICAL INSPECTOR'S FEES.

At Guildhall, last week, before Alderman Sir J. T. Ritchie, an application was made concerning the City of London Electric Lighting Company, Limited, by the City solicitor on behalf of the Corporation, to ascertain the fees and reasonable expenses of an electrical inspector employed by the City, claimed to the amount of £1,142. 2s. 7d. under Section 47 of the Electric Lighting Orders Confirmation Act, 1890. The late Commissioners of Sewers, in offering payment to the company of its charges for lighting, deducted the above amount as representing the expenses of the electrical inspector, and the company in return declined to admit the right of the late Commissioners to deduct those expenses. After a great deal of comment and correspondence, the Commissioners agreed to pay the company's charges, less the amount deducted for the inspector. The company refused to accept the sum, and sued the Commissioners for the whole amount, and judgment was given in favour of the company, it being held that the Commissioners should have paid the charges in the first instance, and then sued for the balance.

The proceedings were of a peculiar nature, the company being treated as the defendants. Mr. Rose-Innes represented the Corporation of the City of London, and Mr. Roskill appeared for the company.

Mr. Rose-Innes pointed out that so far as the public was concerned it was essential that the electric light supplied should be kept up to a certain standard. The electric lighting order of 1892 provided that an electrical inspector should be created by the local authority—in the present case the Corporation—and that all fees and reasonable expenses, unless agreed upon, should be ascertained by a court of summary jurisdiction, or, where appointed, the Board of Trade. The point which arose for determination was—apart from the salary which the Corporation saw fit to allow the electrical inspector—what were the fees and reasonable expenses in regard to inspection of meters.

Mr. Roskill said he did not dispute the scale of fees settled by the Board of Trade.

Mr. A. A. Voysey, electrical engineer to the Corporation, called by Mr. Rose-Innes, said that in respect of his employment as electrical inspector he received a salary from the Corporation. He found it necessary to have a testing office, the rent of which—£170—was paid by the late Commissioners of Sewers. His duty was to test meters with a view of deciding disputes between the lighting company and the consumer.

Mr. Roskill contended that "reasonable expenses" meant those incurred by the inspector travelling to test meters. The contention of **Mr. Rose-Innes** was this—that the Corporation appointed an inspector, supplied him with offices, instruments, and assistants at any cost they pleased, and then charged the electric lighting company for these things.

The **Alderman** said these were not reasonable expenses within the meaning of the Act. He did not think that the electrical company were bound to provide offices and so on for these inspectors. If a higher court held that the items mentioned should be included among "reasonable expenses," in order to save the parties coming before him again, he would fix an amount. Inasmuch as the inspector had said that he gave about two-thirds of his time to testing, he would reduce the amount to £937. 14s. 8d. This was merely a formal matter to save the case being brought before him again to settle this question should a higher court decide against him.

Mr. Roskill: Then the summons is dismissed, subject to a special case.

WHOLESALE DESTRUCTION OF INSULATORS.

Mr. M'Intyre, representing the Postmaster-General, attended the Marylebone Police Court on the 7th inst. to prosecute two boys, Henry Dale and Henry Reid, both of Treverton-street, Notting Hill, who were charged before Mr. Paul Taylor with maliciously damaging the insulator of an electric telegraph post, situated on the banks of the Regent's Canal, between Carlton Bridge and Lock Bridge, Paddington.

Both boys, said **Mr. M'Intyre**, were seen to break an insulator with a stone. These proceedings were taken as a warning to other boys, for as many as 1,600 of these insulators were broken in this district alone every year, which represented a sum of about £80.

The **Magistrate** ordered Dale to pay a fine of 9s., with 7s. damage and 3s. costs, or seven days, and Reid 4s. fine, 1s. damage, and 3s. costs, or five days.

COMPANIES' MEETINGS AND REPORTS.

BRITISH ELECTRIC TRACTION COMPANY, LIMITED.

The ordinary general meeting of this Company was held on the 7th inst. at Donnington House, Norfolk-street, Strand, under the presidency of Sir C. R. Wilson, who, in moving the adoption of the report and accounts (already published by us), said that they had under consideration no less than 50 different schemes, and the agreements and contracts entered into and the concessions obtained and applied for gave a total mileage of electric trams and light railways in the United Kingdom of over 200 miles, and the amount of capital outlay that would have to be incurred in connection therewith in the future would extend to something like £2,000,000 or £3,000,000. Owing to the spirit abroad among certain large corporations to municipalise the tramways and similar undertakings, the Board of this Company had on more than one occasion been discouraged from initiating undertakings within particular boroughs, which was a matter of regret, because he believed that tramway enterprise could be better served by a company than by a municipality, because a municipality was tied down to certain limits within fixed boundaries, and, inasmuch for the economical and efficient working of tramways it was necessary to have communication with outlying villages and towns, it was desirable that the line should be constructed on a uniform system. He then alluded in terms of regret to the death of the Earl of Suffolk, who attended a Board meeting of the Company only a fortnight ago, and who had been associated with it from the start. He concluded by moving the formal resolution for the adoption of the report and accounts.

Mr. E. Garcke seconded the motion, which was carried.

An extraordinary general meeting followed for the purpose of considering certain light railway orders. Resolutions approving the same, subject to such modifications as the Board of Trade might think fit to make or sanction therein, were adopted.

WINDSOR ELECTRICAL INSTALLATION COMPANY, LIMITED.

Directors: M. Drury Lavin, Esq., chairman; H. L. Prior, Esq., deputy chairman; Tonman Mosley, Esq.; Edward Riley, Esq.; A. W. Shipley, Esq., managing director; A. A. Somerville, Esq.; Rev. R. H. Whitcombe. Consulting engineer: Mr. A. H. Preece. Engineer-in-charge: Mr. A. E. Farrow.

Report of the directors to the shareholders (with abstract of accounts) for the year ended Dec. 31, 1897:

The directors in presenting their report are pleased to be able to state that the shareholders will find from the accompanying accounts for the year 1897 that the business of the Company is progressing satisfactorily. The number of lamps installed on Dec. 31, 1897, was equivalent to 4,985 of 8 c.p.; since that date 395 have been added. In the course of the year a new engine, twice the size of the original one, has been added, and the storage cell capacity has also been doubled. Extensions of mains have been made in St. Leonard's-road, Osborne-road, and King's-road. The net profit for the year is £1,256. 16s. 7½d., as shown on the net revenue account, and out of this sum the directors recommend that a dividend of 4 per cent., free of income tax, be declared on the paid-up capital of the Company, the dividend on the new shares being calculated from the dates of allotment and call. This will absorb £652. 7s. 4d., leaving a balance of £604. 9s. 3½d. to carry forward. The directors have now been in office for two years without any remuneration whatever, and in view of the very satisfactory progress of the Company, they will at the general meeting ask the shareholders for a vote on account of their past services. Mr. A. W. H. Good resigned his position of secretary of the Company in the early part, and your directors did not consider it necessary to appoint another permanent secretary, as Mr. A. W. Shipley, in addition to being a director of the Company, kindly accepted

the position of managing director, and the Board consider themselves very fortunate in securing his valuable services. It is proposed to issue the remaining capital—£5,000—during the current year. The directors recommend that the shares be issued at a premium of 2s. 6d. per share, and any shareholders desiring an allotment should apply at the Company's offices for a form of application. The allotment will be *pro rata* to existing holdings, but any shareholder not applying within one month of the date of this report will be deemed to have renounced his right to an allotment. Current is now being supplied at 7d. per unit, but the directors hope to reduce the price to 6½d. when 8,000 lamps or their equivalent are installed. This reduction in Windsor is equal is equal to 3d. per 1,000ft. of gas. The retiring directors selected by ballot are Mr. Tonman Mosley and the Rev. R. H. Whitcombe, who, being eligible, offer themselves for re-election.

REVENUE ACCOUNT, YEAR ENDED DEC. 31, 1897.

Dr.		£ s. d.
Generation of Electricity.		
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£463 4 2	
Oil, waste, water, and engine-room stores	83 9 11	
Wages and gratuities at generating station	182 14 9	
Repairs and maintenance: buildings, £28. 19s.; engines and boilers, £14. 15s.	43 14 0	
		773 2 10
Distribution of Electricity.		
Wages and gratuities to linesmen, fitters, labourers	3 14 9	
Repairs, maintenance, and renewals of meters, switches, fuses, and other apparatus on consumers' premises	1 3 7	
		4 18 4
Rent, Rates, and Taxes.		
Rents payable	35 8 4	
Rates and taxes	27 6 0	
		62 14 4
Management Expenses.		
Proportion of salaries of managing engineers, secretary, accountant, clerk, and messengers as certified by the chairman	177 5 3	
Stationery and printing	26 18 11	
General establishment charges	30 10 4	
		234 14 6
Law and parliamentary charges		7 0 9
Special Charges.		
Insurance, etc.	30 12 9	
Fees to auditors of Company	15 13 0	
Cost of temporary plant (see *contra*)	62 11 8	
		108 17 5
Total expenditure		1,191 8 2
Balance carried to net revenue		541 17 9
		£1,733 5 11

Cr.	£ s. d.
Sale of current per meter (52,095 units) at 7d. per B.T.U. less discount and bad debts	1,435 5 10
Sale of current under contracts	117 13 5
	1,552 19 3
Rental of meters and other apparatus on consumers' premises	33 11 10
Rents receivable	52 9 8
Transfer fees	0 18 6
Pupil's premium	33 6 8
Amount refunded by contractors against cost of temporary plant (see *contra*)	60 0 0
	£1,733 5 11

GENERAL BALANCE-SHEET, DEC. 31, 1897.

Liabilities.	£ s. d.
Capital account—amount received	19,969 15 0
Sundry tradesmen and others due on construction of plant and machinery, fuel, stores, etc., to Dec. 31, 1897	5,864 17 11
Sundry creditors on open accounts	142 6 10
Forfeited shares	1 7 6
Net revenue account—balance at credit thereof	1,256 16 7
	£27,235 3 10

Assets.	£ s. d.
Capital account—amount expended for works	20,468 18 10
Stores on hand at Dec. 31, 1897: coal, £4. 13s. 9d.; oils, waste, etc., £47. 12s. 9d.; general, £874. 2s. 10d.	926 9 4
Sundry debtors on account of contracts in course of completion	378 12 2
Preliminary expenses	418 15 2
Sundry debtors for current supplied to Dec. 31, 1897	924 10 0
Other debtors	2 128 5 3
Cash at bankers and in hand	1,989 13 1
	£27,235 3 10

INDO-EUROPEAN TELEGRAPH COMPANY.

The annual report states that the Company's revenue from all sources for 1897 amounted to £130,347, as compared with £123,540 for 1896, showing an increase of £6,807. The expenses were: on commercial and general account, £36,765; on maintenance account (expenses and charges), £32,613—total, £69 378, as against £68,105 for 1896, an increase of £1,273. Deducting the above expenses, taking credit for £7,704 brought over from 1896, and debiting income tax, there remains the sum of £66,573. From this amount £15,000 has been placed to reserve, and that sum, together with £10,625, amount of interim dividend, has to be deducted, leaving a balance of £40,948. The directors now propose the declaration of a dividend for the six months ending Dec. 31 of 17s. 6d. per share, making, with the dividend already paid, 6 per cent., and a bonus of 20s. per share, both free of income tax, making in all 10 per cent. for the year, carrying forward £9,073 to the credit of 1898.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Winchester.—The City Council invite offers to light the street lamps for a term of three or five years from November 1. Tenders are to be sent in by May 1.

London, N.E.—The Bethnal Green Guardians invite tenders for electric lighting plant. Further particulars appear in our advertising columns. Tenders by May 17.

Eccles.—The Corporation invite tenders from persons willing to undertake the free wiring of premises in the borough. Further particulars appear in our advertising columns. Tenders by April 22.

Bootle.—The Corporation invite tenders for the supply and erection of arc and incandescent lamps, lamp-posts, and accessories. Further particulars appear in our advertising columns. Tenders by April 25.

Sunderland.—The Corporation invite tenders for the supply of (1) high-speed 225-kw. steam dynamo; (2) Lancashire or Galloway boilers. Further particulars appear in our advertising columns. Tenders by April 29.

Accrington.—The Corporation invite tenders for the supply and fixing of various articles and engineering appliances in connection with their electricity works. Full particulars appear in our advertising columns. Tenders by April 19.

Ocana (Toledo).—Tenders are invited for a public electric lighting installation. The provisional deposit required is 6,250 pesetas. Specifications, etc., are to be obtained from, and tenders addressed to, the Administrator of the Province at Ocana, Spain, by April 18.

Madras.—The Secretary of State for India in Council announces that the time allowed for the receipt of tenders by the Chief Engineer for Irrigation, Madras, for the utilisation of water power of the Periyar Lake has been extended from Oct. 31, 1897, to July 1, 1898.

San Feliu de Llobregat (Barcelona).—Tenders are invited for the electric lighting of the town for 10 years. The provisional deposit required is 2,000 pesetas, and the final 4,000 pesetas. Specifications are to be obtained from and tenders addressed to the Ayuntamiento of the above town by April 18.

Esher.—Tenders are invited for the running and maintenance for five years of an electrical installation, comprising gas-engines, accumulators, dynamos, etc., and connected machinery at Millburn, Esher. Further particulars by application to Messrs. O'Gorman and Cozens-Hardy, 21, Embankment-gardens, S.W.

Glasgow.—The Corporation invite tenders for the supply of 66,000 pairs of carbons. Tenders by 21st inst. Also an overhead travelling crane for engine-room; two three-throw boiler feed pumps, driven by electric motors, complete with switches and resistances, and one spare armature for same. Tenders by 22nd inst. Particulars of these contracts will be found in our advertisement columns.

London, S.W.—The Secretary of State for War is prepared to receive offers, in writing, accompanied by competitive designs and specifications, for the supply of portable electric search-light apparatus. General particulars as to requirements can be obtained on application, either by letter or personally, to A. Major, director of army contracts, War Office, Pall-mall, S.W. The offers and designs must be delivered at the War Office, Pall-mall, London, S.W., by April 27, addressed to the Director of Army Contracts, and marked on the outside "Designs for Search-Light Apparatus."

London, N.W.—The St. Pancras Vestry invite tenders for the erection of buildings in connection with the extension of Regent's Park generating station, 47, Stanhope-street, N.W. Specification, conditions of contract, and form of tender may be obtained upon application to the Chief Clerk, Electricity Department Offices, 57, Pratt-street, London, N.W., on payment of a deposit of £1, which will be returned on receipt of specification, accompanied by a bona fide tender. Tenders to be sent to Mr. C. H. F. Barrett, vestry clerk, Vestry Hall, Pancras-road, London, N.W., endorsed "Tender for Buildings," by 12 noon on April 19.

Edinburgh.—The Mid-Lothian and Peebles Lunacy Board invite tenders for the installation of electric light in their asylum at Rosslynlee, near Edinburgh, including generating plant, wiring, fittings, lamps, etc. Plans, etc., may be seen at the office

. Baily, Heriot-Watt College, Chambers-street, Edinburgh. cations. etc., can be obtained from Prof. Baily or from Mr. dison Smith, clerk and treasurer, 19, Heriot-row, Edin- on payment of £1. 1s., which will be returned after receipt enuine tender. Separate tenders may be accepted for (1) ierating plant, including accumulators, switchboard, etc., wiring, fittings, lamps, etc. Tenders by April 23.

oria (Australia).—Tenders are invited by the Council of y of Hawthorn for the supply and erection, or for the only, of: (Section A) buildings only; (B) boilers, water- pumps; (C) engines, dynamos, switchboard, mains, sub- transformers, meters, arc lamps, insulators, testing nents; (D) supply of poles and their erection; running of int for three years. Specifications and forms of tender can ained at the office of the Agent-General for Victoria, Lieut.- l Sir Andrew Clarke, G.C.C.M., Victoria Office 15, ia-street, Westminster, London, S.W., on payment of , which will be returned on receipt of a bona fide tender. tenders, endorsed "Tender for Electric Lighting," and sed to the Mayor of Hawthorn, Victoria, Australia, on 4, at 5 p.m.

ast.—The Belfast Harbour Commissioners invite tenders for pply and erection in the electric light station, Abercorn Belfast, of three compound, two-crank, self-lubricating, valve, quick-revolution vertical engines, each capable of ping 70 h.p., with a steam pressure of 130lb. per square also for the supply of three belt-driven, continuous-current, wound dynamos, capable of giving 15 amperes, 2,850 volts, eed not exceeding 800 revolutions per minute for 18 hours' nous running, without undue heating. Copies of specifica- orm of tender, and any further information required may be ed from the harbour engineer, Mr. G. F. L. Giles. Sealed s, on the special forms provided for the purpose, to be sed to Mr. W. A. Currie, secretary, Harbour Office, Belfast, ed "Tender for Engines" or "Tender for Dynamos," and by 18th inst.

ton, S.E.—The Vestry of St. Mary, Newington, invite s for erection of an electric lighting station in Penrose-street, orth-road. Bills of quantities, with specification and form ler, may be obtained from the Vestry's consulting engineers, . Kincaid, Waller, and Manville, 29, Great George-street, minster, upon payment of £5. 5s., at whose office the drawings seen during business hours. The deposit will be returned he tenders are opened by the committee. The contractors e required to sign the following declaration: "We hereby e that we pay to the workmen employed by us not less than cognised trade union rate of wages in each branch of the " Sealed tenders, endorsed "Tender for Electric Lighting n," together with specification and priced bill of quantities, be received by Mr. L. J. Dunham, clerk, Vestry Hall, orth-road, S.E., before noon on 18th inst.

llasey (Cheshire).—Tenders are invited by the Urban Dis- Council for the erection and completion of extension to engine oiler house at their electric supply station, Seaview-road, d, in the parish of Wallasey. The drawings can be seen on ation to the engineer, Mr. J. H. Crowther, at his office, Float, near Birkenhead, and copies of the specification and quantities obtained either on personal application at that s or by letter on and after 13th inst. on payment of £3. 3s., will be returned on receipt of a bona fide tender. Sealed s, on the proper form, addressed to the Chairman of the Water, and Electricity Committee, and endorsed "Tender ection and Completion of Engine and Boiler House," to be the office of Mr. H. W. Cook, clerk, Public Offices, Church , Egremont, by 4 p.m. on 21st inst. The contractor will be ed to enter into a bond, with approved sureties, for the mance of contract.

RESULTS OF TENDERS.

mbledon.—The Urban District Council have accepted the r of Messrs. Sharp and Piper for switchboards at £721. 10s.

ley.—The Electric Lighting Committee have accepted the r of the English Carbon Company for carbons at £1. 6s. 6d. lid and £3. 17s. for cored per 1,000ft., and that of W. T. ey's Telegraph Works Company for low-tension cable, in- ng boxes, at half-mile 7s. 7½d. per yard, one mile 3s. 3¾d. per .

swea.—The following tenders have been accepted by the Gas Electric Lighting Committee: Steam dynamos with Belliss s, Siemens Bros. and Co., London; steam-pipes, J. Spencer, lesbury; accumulators, Tudor Accumulator Company, lon; switchboards, T. Parker, Limited, Wolverhampton; s, Callender's Cable and Construction Company, London; lamps and pillars, W. Lucy and Co., Oxford.

ckpool.—The Town Council have accepted, subject to the ction of the Local Government Board to the requisite loan, tenders of the firms undermentioned for extensions at the ation electricity works—viz.: Babcock and Wilcox, Limited, r and superheaters; Cole, Marchant, and Morley, condensers storage tanks; S. Z. de Ferranti, Limited, rectifiers; Chas. J. on, boosters; British Insulated Wire Company, cables; Nalder Hilton, Limited, transformers.

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ance.—The formation of an electrical trust, with a capital of ,000, composed of the Union Financière and several London India banks, is said to have been almost completed.

BUSINESS NOTES.

Perth.—The draft provisional electric light order has been issued by the Board of Trade.

New Address.—Dick's Asbestos Company, Canning Town, have taken offices at 51 and 52, Fenchurch-street, E.C.

Barrow.—Mr. H. R. Burnett, assistant electrical engineer to the St. Pancras Vestry, has been appointed borough electrical engineer.

Hereford.—The provisional order for the electric lighting has been referred to a special committee of eight members for consideration and report.

Carlisle.—The Local Government Board have sanctioned the application of the Corporation to borrow £30,000 to defray the cost of the installation of electric lighting.

Brighton.—The reduction of price proposed by the Electricity Committee was rejected at the meeting of the Town Council on the 7th inst. by one vote, the voting being 18 to 17.

Cheltenham.—A new Belliss engine coupled direct to a Siemens alternator, of a capacity of 250 kw., has been laid down by the engineer, and was successfully tried a few days ago.

Warminster.—The Lighting Committee has been instructed by the Urban District Council to consider the advisability of either utilising or realising the plant, and report to the Council.

Barnsley.—The Town Council have received a report from Mr. Miller, electrical engineer, upon the system of electrical supply to be adopted in the borough, which is to be considered at a meeting on the 23rd inst.

Ossett.—At the last meeting of the Town Council it was reported that a provisional order had been received authorising the Council to lay down electric lighting plant and supply electricity within the borough.

Plymouth.—Major-General Crozier, R.E., Local Government Board inspector, held an enquiry on the 6th inst. into an application of the Corporation for sanction to borrow various sums, including £2 500 for public lighting.

Share-List.—Application has been made to the Stock Exchange Committee to allow the further issue of 8,000 ordinary shares, Nos. 32,501 to 40,500, of the Chelsea Electricity Supply Company, Limited to be quoted in the official list.

Felixstowe.—Telephone business has increased here so rapidly that the 24-line board at the exchange, which was considered likely to meet the requirements of the district for several years, has now to be replaced by a 50-line board.

Dewsbury.—The Electricity Committee are still considering the preparation of the specification for the supply of the necessary additional electric lighting mains and plans for the necessary extensions of the buildings at the electric station.

Sunderland.—The electric supply station is to be extended, and additions made to the plant and mains, and the Finance Committee have been directed to apply to the Local Government Board for £26,000 for the carrying out of the scheme.

Settling Day.—The Stock Exchange Committee has appointed Wednesday, April 20, a special settling day in British Electric Traction Company. Limited, 10,000 6 per cent. cumulative preference shares of £10 each £4 paid, Nos. 30,001 to 40,000.

Parliament.—In the House of Commons last week Mr. Ritchie introduced Bills to confirm the provisional orders made by the Board of Trade under the Electric Lighting Acts of 1882 and 1888 relating to Chichester, Lewes, Hove (Aldrington), and Leatherhead.

Rand Central Electric Works, Limited.—The fourth ordinary general meeting of this Company was convened for the 7th inst., at Winchester House, but a quorum not being obtained, the proceedings stood adjourned for a week, at the same time and place.

Douglas Southern Electric Tramway Company, Limited.—The directors report a profit for last year of £736. Out of this sum, with the balance brought forward, a dividend of 3 per cent. on the 7 per cent. preference shares is recommended, carrying forward £265.

The Cowper-Coles Electrolytic Process for the Manufacture of Parabolic Reflectors.—We are informed that a sole license has been granted to Messrs. Chance Bros. and Co., Limited, of Smethwick, for the manufacture of parabolic reflectors by this process for searchlights.

Hyde.—The town clerk (Mr. George Stevens) has resigned his position, having been appointed general secretary to the British Electric Traction Company, Limited, London, one of the subsidiary companies of which is laying the Oldham, Ashton, and Hyde electric tramways.

Eccles.—At the last meeting of the Town Council it was stated that the larger main cable than originally estimated for would not be covered in the estimates, and additional borrowing powers would be necessary. There would be no breaking of the contract in the proposed alterations.

Submarine Cables Trust.—On and after April 15, the coupon due on that date will be paid in full by Messrs. Glyn, Mills, and Co., of 67, Lombard-street, E.C., between the hours of 10 a.m. and 2 p.m. Coupons should be left with the bankers for examination four clear days before payment.

Bournemouth.—Mr. F. H. Tulloch, M.I.C.E., Local Government Board inspector, has held an enquiry into an application made by the Town Council to borrow several amounts, including £2,500 for lighting the pier and lower pleasure gardens with electricity and for generating the supply.

Leith.—The Town Council have instructed the Electric Lighting Committee to use the utmost economy, consistent with efficiency, in carrying out the electric lighting scheme, and not to incur new expenditure beyond that already sanctioned without first reporting and obtaining the authority of the Town Council.

Ayr.—An application made by Mr. Bickerdike, Montreal for permission to construct and work a service of electric overhead tramways for the town has been refused by the Town Council Application has been made to the magistrates for the licensing of four motorcars to run between Ayr and Prestwick.

Eastern Extension, Australasia, and China Telegraph Company, Limited.—This Company have extended their cable from Hong Kong to Manila direct, with a view to improving telegraphic communication with the Philippines by making it independent of the long land line between Cape Bolinao and Manila.

St. James's and Pall Mall Electric Light Company, Limited.—The amount of electricity sold by this Company for the quarter ended March 25, 1898, is returned at 1,016,642 units, estimated to produce £21,180, as against 907,919 units for the same quarter of last year, which produced a net revenue of £19,898.

Edinburgh.—The Cleaning and Lighting Committee of the Town Council resolved on the 11th inst. to adhere to their previous recommendation in regard to additional street-lighting by gas and electricity, with the exception of that portion of it referring to the thoroughfare from Donaldson's Hospital to Coltbridge.

Oriental Telephone and Electric Company, Limited.—The directors of this Company have resolved to recommend to the shareholders, subject to final audit of the accounts, a further dividend of 8d. per share, free of income tax, making, together with the interim dividend paid in October last, 5 per cent. for the year ended Dec. 31, 1897.

Liverpool.—The prices charged for the supply of electric energy at the pressure of 230 volts have been reduced as follows: for general lighting 5d. per unit for each unit up to 1,000 units per quarter, and 4d. per unit for each unit in excess of 1,000 units; for Corporation departments 4d. per unit; for street lighting 3d. per unit; and for power purposes 2d. per unit.

Stockport.—The Local Government Board have decided to comply with the Gas Committee's application so far as it relates to the borrowing of the sum of £24,600, and their formal sanction to a loan for that amount has been forwarded, together with their approval of the use of the site of the Millgate gasworks for the purposes of the Stockport Electric Lighting Order, 1891.

Balmoral.—It is stated that her Majesty has decided to light Balmoral Castle by electricity, and that an enormous quantity of large iron pipes has already been delivered. These pipes are intended to convey water power from the Gelder, a stream running into the Dee at a point about 1½ miles from Balmoral, and the current will be brought to the Castle by means of electric cables.

St. Martin's-in-the-Fields.—The opening of the streets and thoroughfares of the Metropolis by electric and telephone companies and similar bodies without the permission of the local authorities was discussed at length at the last meeting of the Vestry. A resolution supporting the views of the Corporation as expressed in their recent case against the Postmaster-General was passed.

Lewes.—The Council have authorised an application to be made to the Board of Trade for a license or a provisional order authorising the Council to supply electricity for any public or private purposes within the area of the East Grinstead Urban District Council or such other area as the Council may determine, such application not to be made until the cost to be incurred is reported to the Council.

Derby.—A 10-h.p. motor has been purchased at a cost of £35, subject to the same being tested. The following scale of reduced charge for day-load motors has been adopted—viz., on the demand indicator system, at the rate of 3d. per unit for the first 18 hours per week consumption; 2d. per unit for the next 18 hours per week consumption; and 1d. per unit for all electricity consumed beyond that time.

Bristol.—At the meeting of the Sanitary Committee last week the surveyor was requested to obtain the average time at which the option of the Corporation to purchase the tramways could be exercised, taking into consideration what were and would be extensions, and what might be considered connections only, showing how far the Sanitary Committee's estimate in the matter approached that of the tramways company.

Swansea.—Mr. Manville, in his report on the proposed electric lighting scheme, estimates the cost, after adding 7½ per cent. for contingencies, engineering, etc., at £35,936. The expected revenue is based on 15,700 8-c.p. lamps for private lighting, which would, at 4½d. per unit, bring in £4,444, whilst the public lighting would bring in £733, making a total of £5,177. The cost of maintenance he averages at 3·05d. per unit, which would give a surplus of ·77d. per unit, or a total of £1,052.

Multipolar Dynamos.—We have received from Messrs. Easton, Anderson, and Goolden, Limited—or rather from the United Ordnance and Engineering Company, Limited—their new catalogue of multipolar dynamos and motors. The general design of these machines is such as to give great stiffness and stability, securing at the same time a most elegant appearance. We welcome the type indicated by the above firm, and are glad to note that their dynamos are finding favour with the public.

Burnley.—The charge for electric light was discussed at the *last Town Council meeting.* In answer to the question why the *charges for current for motive* power had been reduced from 3d.
to 2d. per unit to consumers of not less than 48 hours p
was explained that it was for those who were using th
day, when the machinery was nearly stopped, so as to
users of motive power. An amendment that the matter
back was lost, and the minutes were passed.

Morley—The Lighting Committee's report, presente
Town Council at the last meeting, stated that the Loca
ment Board had sanctioned the loan of £22,500 for
works. The committee recommended that high and l
cables be laid from the present sub-station in Churc
Mr. Scarth's gate in Victoria-road, at a cost not exceed
and that the charge for the 11 electric lamps for street-l
£22 each per year. The report was adopted.

Wimbledon.—The Electric Light Committee have rec
the Council to issue circulars to the ratepayers stating th
to be made for current and a draft agreement. The
further recommended that a circular be given to buil
depositing plans for new buildings, and that the ch
current be 6d. per unit for the first five units consume
8-c.p. lamp per quarter, and 4d. per unit for all con
excess. The recommendation has been adopted.

Winchester.—At the last meeting of the City Council
Clerk produced the formal consent of the Board of Tr
carrying out of the works by the Winchester Electric
Power Company, Limited, and a copy of the regulation
the Board. A letter was read, in which the company s
they were prepared either to light a portion or the
the city with either arc or incandescent lamps The Coun
to advertise for tenders for the lighting of the streets
years from Nov. 1 next.

Burslem.—At a meeting of the General Purposes Com
the Town Council a letter was read from Mr. Sellon, engi
British Electric Traction Company, enclosing a pla
the routes along which the light railways have been aut
the Potteries Light Railways Order, 1897, and the pas
thereon, and enquiring whether the Council had any sug
make with respect to the passing places. He also stat
was instructed to proceed with the light railways as
possible. It was decided that the plan be referred to th
engineer to deal with.

Bootle.—The borough engineer has been instructed t
the necessary plans and specification for the central st
submit the same to a special meeting of the Watch C
The Local Government Board have sanctioned the bo
the sum of £33,594 for the purposes of electric lig
approved the use of the land in Pine-grove for this pur
sum of £1,406, the amount outstanding in respect of the
which is to be superseded at the town hall, is excluded fro
applied for. The extension of the electric mains on bo
Stanley-road has been approved by the Watch Committe

Blackpool.—The recommendation of the committee i
the introduction of the overhead system, as foreshadow
columns, has been ratified by the Town Council.
Council have resolved that the approved standard cla
by the Electrical Engineering Plant Manufacturers' A
and the Municipal Electrical Association for adoption
general conditions of specifications for electrical enginee
be referred to the town clerk and borough electrical en
inclusion, if they think so fit, in any conditions of spe
for electrical engineering plant issued by the Electric
Committee.

Appointments Vacant.—The Vestry of Lambeth
assistant engineer, qualified to work a high-speed elect
and to attend to storage batteries and electric lighting
at the new public baths, Kennington-road. Wages 35s.
Applications in candidates' own handwriting, stating
present and previous employment, to be sent to Mr.
Smith, Lambeth Vestry Hall, Kennington green, by 1
10 a.m. The successful candidate will be required
Vestry's superannuation and thrift fund.—A
attendant is wanted at once at Islington; one who ha
vious experience in a high-tension station preferred.
per week. Further particulars appear in our adv
columns.

Longton.—At the monthly meeting of the Town Cou
again referred to the sub-committee to appoint a
engineer to prepare a scheme and detailed estima
probable costs and results of the proposed electri
scheme, and to submit the same to the General Purposes
in due course. An explanatory letter from the engi
British Electric Traction Company, Limited, accompani
of the light railways and showing that it is proposed
certain passing places and asking for the views of the
adding that it was intended to push on the railways a
possible, was discussed. The sub-committee recomme
the plan as submitted be approved, subject to altera
location of two passing places.

Colchester.—The Electric Light Works Committee
in their report presented to the Town Council last
Messrs. Siemens, finding that they could supply more f
than was included in the Electric Construction Compan
had expressed a wish that the Corporation should have
and agreed to put in cables leading to the milita
capable of carrying current for double the number of
vided for in the original contract. In consequence of a
Major Tyler, R.E., it had been decided that the boroug
should fix pipes for the electric lighting of the new b
the military hospital under the roadway at once. The

ther to Messrs. Greenwood and Sons on their contract for the electric light station was recommended. The report pted.

rbury.—The erection of the new municipal electric works commenced by Mr. Brewster, the building contractor. is centrally disposed for the distribution of the light to ote points of the city. There will be more than sufficient r the electrical works, and it is the intention of the Cor- to combine with the electric works' site a central Cor- depôt, which will provide dwelling-houses for the Corpora- kmen and horses. The works are under the superintendence . Hammond and the city surveyor, Mr. A. H. Campbell, by a clerk of the works, Mr. Doré. We understand that le of the contracts for the electric plant are signed, and in state of preparation at the various works of the manu- , whilst the cable laying in the streets is intended to be d with early in May.

x.—We understand that the laying of the lines, so far as already sanctioned are concerned, has now been com- The fixing of the overhead cables will probably be finished k. The car which was delivered about a fortnight ago is th the whole of the undergearing with the exception of r. Others are ready to be forwarded from the makers at ad and some three or four, the Tramways Committee ll be running along the different routes by May 1. For a l trips simply will be run, in order to test the curves and iarise the drivers with the routes. The date for the will probably be deferred to Jubilee celebration day. A qual to 50 h p. has to be circulated to work a Halifax account of the steep grades. It has been decided to run s on Sundays, at least as an experiment.

port.—In the future no meter rents will be charged to s whose bills for current amount to 10s. or upwards per The report of the electrical engineer, Mr. C. D. Taite, at the existing arc lamps are spaced about 50 yards apart; llowed an average of about 80 yards space between each the extensions. The necessary arc light cables between s and the corner of Lord-street and Seabank-road, and in reet, Seabank-road, and Coronation-walk are already laid. double service rather less than 3¼ miles of cable will be . The streets are at present lighted by 195 gas burners, cost of gas lighting is approximately £333. 10s. He d the capital outlay required to instal the 42 new lamps 0. and the estimated annual expenditure at £735. It has olved to light the streets referred to in the report at a £786 per annum, and to apply to the Local Government r power to borrow £2,730 for the purpose of providing al mains, lamps, etc., for arc lighting.

llock (co. Limerick).—Mr. J. J. O'Sullivan, J.P., has rrangements with the Markets Committee for the public of this town, and is also putting down a plant for private rs. The mains extend in four circuits of about quarter ch. and the current will be delivered to the consumers volts. Hitherto the town has depended upon oil as its nt, but nearly all the residents are now wired for electric t, the greater number not having more than three lamps a fixed contract price per annum for current, which has tisfaction to the consumer and should prove remunerative O'Sullivan. We wish the enterprise every success, as the g of small towns by electricity would open a large field for ctrical industry. It has certainly given the lead to the uring city of Limerick, whose provisional order dates years back. The engine is being supplied by Messrs. J. Lees, Glasgow; dynamo, switchboard, wires, and general by the Edison and Swan United Electric Light Company, l.

ney.—The Vestry have received a letter from Mr. J. G. W. e, civil and consulting engineer, intimating his willingness s consulting engineer and to advise the Vestry as to s under consideration, or upon the whole question of lighting, dust destruction, tramways, etc., and submitting his undertakings; and also a letter from the County of and Brush Provincial Electric Lighting Company referring r application for the transfer of the Hackney Electric g Order, and making further proposals with regard to the be charged. The Public Health and Electric Lighting ttees (Joint) have reported that they have had under con- n the letter from Mr. A. T. Snell offering his services as ng electrical engineer in connection with the scheme before try, and recommend the Vestry to take no action in the at present. They have also had under consideration the m Messrs. Reeves and Son, Dalston Junction, asking how will be before the Vestry are able to supply electric current, are about to experiment with electric motors for driving ry, and recommend that the letter be received, Messrs. and Sons having been informed that the Vestry are not ition at the present time to answer their question.

ng.—Mr. R. F. Yorke has submitted his report on the power available at the Touch reservoirs for the electric g of the town to the Police Commissioners. Mr. Yorke t by utilising the available water power the Commissioners n a constant guaranteed output of 54 b.h.p. from the , which, after allowing for losses in the dynamo, cable, ic storage, is capable of producing a supply of 618 units which is sufficient for supplying the extended area of the ,000 lamps of 8 c.p. connected, or one lamp for every nts. If in the future additional power was required it ained from No. 4 reservoir, at present *untapped*, to the extent of 4,000 more lamps. The capital outlay is estimated at £13,500, and allowing £675 per annum for interest and sinking fund, which was 5 per cent. on the capital outlay, made the total annual cost on the undertaking £1,325. Taking 100,000 units as the number to be sold per annum, and charging at the rate of 4½d. per unit (which was considered to be equivalent to gas at 2s. 6d. per 1,000 cubic feet), the revenue produced would be £1,875 per annum, thus leaving a clear profit of £550. This profit, however, would not be realised until the full number of lamps had been taken up. It has been remitted to the Lighting Committee to see whether the necessary wayleaves could be obtained.

Sheffield.—The Tramways Committee have decided to purchase 404 yards of land for the purpose of widening Leaveygreave and Western-bank, in order to construct tramways at that point. A deputation has waited upon the Tramways Committee and presented a memorial signed by 1 200 persons in Park Ward, urging the great need of a tramway service for the Park district. The city surveyor has presented to the Tramways Committee plans for the proposed power station at Kelham Island. He estimates the cost of the builder's work at about £6,000, and of the ironwork at about £1,500. The committee have authorised the city surveyor to prepare the detailed plans, and obtain tenders for the execution of the work. The Highways Committee have recommended the Tramways Committee to pave the whole width of the Haymarket with wood. It has been resolved by the Tramways Committee that the city surveyor proceed with the lines to Walkley as soon as the Nether Edge to Tinsley route is laid, and that the Park section be taken in hand when the Walkley route is completed.—A special meeting of the Council has been held, at which a resolution was formally passed approving of the Council promoting a local and personal Bill in the present session of Parliament to confirm the agreement for the purchase of the undertaking of the Sheffield Electric Light and Power Company, and to confer borrowing and other powers on the Corporation.

Dudley.—At the last meeting of the Town Council, the Mayor, alluding to the electric tramway scheme, said that a deputation from the Midland Electric Corporation Company, Limited, had recently waited upon the committee, and laid before them an amended statement, from which it appeared that they were prepared to lay the mains to supply electricity for the first 100 hours at 5·5d. per unit per quarter, and at 2½d for subsequent use. If the Town Council laid the mains the prices would be 5d. for the first 100 hours and 2d. afterwards. With regard to the supply of electricity in bulk at a uniform rate the cost would be 3·25d. per unit if the electric corporation laid the mains, and 2·75d. if the Town Council laid the mains. The cost for public lighting would be 1·6d. per unit, and for traction purposes for not less than 100,000 units per quarter 1·33d. per unit. The latter proposals only related to the supply of electricity to a given point in the town. Alderman Bagott said he was convinced that with good management the proposed electric tramway in the borough would be a source of large profit. He trusted that the Corporation would insist upon making an electric tramway to Netherton, as he believed it would eventually return a very good profit towards the reduction of the rates. Alderman Garratt and Alderman Bagott were added to the Tramway, Railway, and Electric Lighting Committee, the Mayor stating that Alderman Bagott had now no connection with any tramway enterprise.

Dudley and Stourbridge Tramway.—The *Birmingham Daily Post* states that the British Electric Traction Company, who are virtually the owners of the Dudley and Stourbridge Tramway, having practically purchased all the shares in the company for £44,000, have entered into contracts for the conversion of the present line from Hart's-hill to Stourbridge into an electric system, and, it is stated, that within six months electrical cars will be running between these places. A site has been purchased near Canal-street, Brierley Hill, and plans for a power-generating station are now being prepared, whilst the contract for the alterations to the permanent way and for the electric equipment has been secured by Messrs. Dick, Kerr, and Co. The lease of the line from Dudley to the borough boundary at Hart's-hill expires in about four years, and the Corporations, as matters stand at present, propose taking over that portion of the tramway, and working it themselves by electric traction. The Dudley Town Council have also decided to construct and, as soon as circumstances will allow, electrically equip a new tramway from Queen's Cross to Cradley Heath, through Netherton and Old Hill, with the consent of the local authority of Rowley Regis, or, in case that authority should object, to the borough boundary in that direction—namely, Bishton's Bridge. The Corporation will, therefore, oppose the application of the British Electric Traction Company to the Board of Trade for an order to carry out a similar undertaking.

Croydon.—The Lighting and Electricity Committee of the Town Council have submitted the following report, which has been adopted: "The committee considered tenders received for the extension of buildings and other works at the electric light station, and recommended that the tender of Mr. S Page be accepted. The tender recommended for acceptance amounts to £3,795 The sums already sanctioned to be borrowed for building extension amount only to £1,480. The difference in the amounts sanctioned and the sum of the tender (£2,315) is in consequence of the buildings being so enlarged as to provide for the necessary increase of plant requisite upon the large extensions of mains contemplated to South and Upper Norwood and Thornton Heath. The cost of the foundations for the building extension is not included in the tender, and is estimated to cost about £400. The committee recommend that application be made to the Local

Government Board for sanction to a further loan of £3,000 in respect of the extension of the buildings and the cost of the foundations. The committee, having had under consideration the advisability of extending the supply of current to the South and Upper Norwood districts and the increasing of their present borrowing powers, not only to cover this, but to make certain additions to the station plant which are necessary in connection with the two large sets recently sanctioned, asked Prof. Kennedy to report to them on this question. He had reported accordingly, and estimated the total expense at £26,000, including £7,232 for the South Norwood extension, £4,953 for the extension from South to Upper Norwood £1,000 for the extension of the cable to Thornton Heath Pond, £2,272 for additional plans, etc." The committee recommended that a loan be applied for for this purpose.

Dundee.—Mr. W. Tittensor, city electrical engineer, last week submitted plans showing the old and new areas of supply in the city, together with the mains at present laid and the proposed extensions; also a statement showing that 8,470 lamps were connected and 66,228 units sold in 1893, and 22,897 lamps connected and 323,187 units sold in 1897, being an increase of 14,427 lamps connected and 256,959 units sold. The length of streets through which mains were laid for supply up to the end of 1897 was four miles, and the extended plan was eight miles. In these streets he anticipated a demand for 25,000 lamps after five years, exclusive of public lighting. He proposed to feed the distribution mains from their present generating station through four sets of feeder mains. The whole of the extended area could be supplied from the present station, but the following additions would be required: engine and boiler house to be extended on the spare ground to the south, and another storey added to the offices; additional boilers equal to 900 h.p., and engines and dynamos equal to 900 h.p., together with the necessary steam-pipes, pumps, economiser, and switching gear. The cost of these extensions was: distribution mains, £14,000; feeder mains, £400; plant, £16,600—making a total cost of £35,000. This included spare culverts along the existing tramway routes for the reception of feeder mains in the event of electrical traction for the tramways being adopted as recommended by Messrs. Urquhart and Small. He recommended that the laying of the mains should be proceeded with gradually as the demand arose, thus spreading the cost over several years. His recommendations for present requirements were: (1) to extend the present buildings at generating station; and (2) to lay down three feeder mains to the north, east, and west districts. It would also be advisable to order at once a boiler with necessary pipes and connections, and one engine and dynamo with the necessary switching gear. The cost of these he estimated as follows: buildings, £3,000; boilers, etc., £800; engine and dynamo, etc., £2,500; feeder mains, £3,000—total £9,300. They would then be in a position to gradually put down plant in the station and extend their distributing mains as required. The Gas Committee have resolved to take up and deal with the matter at a future meeting.

Salford.—The Local Government Board have sanctioned the borrowing of £13,000 for purposes of electric lighting, and have asked for further particulars as to the £50,000 required for additional works. At the last meeting of the Council, the Engineer recommended a battery sub-station for the Pendleton district (in addition to the two already decided for the Salford and Broughton districts respectively), and that the necessary low-tension mains should be laid thereto, in order to afford a sufficient supply of current to cope with the demands during the ensuing winter, which was agreed to. A sub-committee were requested to ascertain if there was accommodation in the Pendleton Town Hall, or any place in the neighbourhood, suitable for the purposes of a sub-station. The Engineer reported that as the present system would be in operation for some time, he recommended, in order to temporarily improve the same, that an additional service cable be laid to the Technical Institute, the Royal Hospital, and the Salford Town Hall, and the same carried into the sub-station which it is proposed to erect under the arch near Blackfriars road. He also recommended the erection of a distribution box in Frederick-street, Pendleton, the whole cost (excluding the sub-station) not to exceed £150. The Engineer further stated that if this work was carried out it would provide that those institutions could be switched on to either main in case of any further breakdown taking place. The work was ordered to be carried out forthwith, and the engineer was instructed to prepare plans and detailed estimates of the plant required at the proposed new generating station at Strawberry-road, capable of producing a current equal to 12,000 h.p. A deputation consisting of the chairman, deputy-chairman, and Councillors Jackson, Kay, Robinson, Smith, and Wheatcroft, with the engineer, were appointed to enquire into the systems now at work for the supply of current for lighting, power, and electrical traction, in such towns as might be decided upon, to enable them to report fully to the committee as to the best system in operation, for their future guidance. The committee expressed the opinion that it was desirable that a special sub committee of this committee and the Highway, Paving, and Tramways Committee should be appointed to confer on the question of providing current for working the tramcars on the expiration of the present lease to the Manchester Carriage and Tramways Company.

Reading.—At the monthly meeting of the Town Council a letter was submitted from the Board of Trade, enclosing the following copy of the amended description of the systems proposed to be adopted for the supply of energy under the Reading Electric Supply Order, 1893: (*a*) for the central portions of the town, a continuous-current supply at constant pressure on the three-wire system; and (*b*) for the outlying districts, an alter-
nating-current high-pressure supply at constant pre
transforming stations. The transforming stations to
structed beneath the level of the streets, and the transf
street boxes will be enclosed in cast-iron cases made p
gastight and watertight, the switching apparatus being
in similar cases in adjacent street boxes. It was resol
the plans submitted and the works proposed to be
thereunder by the Reading Electric Supply Company,
be approved, subject to certain amendments and conditio
in the surveyor's report on the subject. A letter from
vincial superintendent of the National Telephone C
Limited, was submitted, dealing with proposed alteration
and laying underground of metallic circuits. It was reso
the provincial superintendent be informed (1) that the Co
cannot consent to the proposal that the agreement made
South of England Telephone Company be annulled, b
subject to the National Telephone Company providing
poration with a plan showing the existing routes, poles, an
of wires within the borough, the Corporation are willing
agreement should be amended so as to relieve the co
the obligation of submitting plans for the placing of a
wires on existing routes; (2) that the Corporation prefer
system of payment by the company to the Corporation
and wires be abolished, and that the agreement be amen
to provide that the company shall pay to the Corporation
lump sum; (3) that the Corporation will not insist on
dition that the charge to Reading subscribers for a f
munication shall be £8 per annum, but they will insis
condition that the present rate of charge for the same
be not in any case raised; (4) that the Corporation p
to undertake the work of laying the underground wires
for the company, but will carry out works of reinstateme
with respect to such works, the usual 5 per cent. for admi
charges on the cost incurred will be made. It was p
"That having regard to the statement made in the
Commons on the 1st inst. by Mr. Hanbury, the Financial S
to the Treasury, on the subject of the telephone service, fr
it appears that the Government intend to appoint a Sel
mittee of the House of Commons on the subject, who
with—amongst other points—the question whether muni
should be empowered to engage in telephone undertak
negotiations with the National Telephone Company refer
the minutes of the Highways and Lighting Committee as
agreement with this Corporation, be not proceeded
present." The matter was referred back to the High
Lighting Committee.

Fulham.—At a meeting of the Lighting, Electric Ligh
Dust Destructor Committee held on the 7th inst. a repo
Electric Lighting Sub Committee was submitted, in whi
stated that the committee had treated with the County o
and Brush Provincial Electric Lighting Company and th
to-House Electric Light Supply Company as to the ter
which they would be willing to take over the Vestry's p
order for a term of years, or to supply current to the
mains. They have obtained specifications and prices
erection of destructors capable of destroying either 60
100 tons of refuse per day. The Vestry was recomm
accept the offer of the Electrical Development and Fina
poration. The latter are prepared to carry out the
electric lighting, refuse destructor, and disinfecting s
every particular, as recommended in Mr. Medhurst's repo
Vestry, for the sum of £55,250. This sum does not inc
Medhurst's remuneration, which would have to be pai
Vestry, in the event of the Vestry considering (as they
would) that a consulting engineer was necessary for the p
of their interests. They are prepared to work the whole
installation for a period of years, giving the Vestry the
taking it over in thorough working order at the expi
10, 15, or 20 years. During the period in which the
installation is worked by this corporation, it would re
whole revenue for electric lighting, and would destroy
of the parish at the rate of 2s. per ton, and it would
streets recommended to be lighted in Mr. Medhurst's
arc lamps for the sum of £1,000 per annum. The presen
lighting these streets by gas is £584 per annum, but by
the electric light in them the illumination would be from
times as brilliant as the present lighting for less than
cost. They would further undertake to work the disinf
the sum of £500 per annum for the first period of five ye
per annum for the second period of five years, £700 per a
the next period of five years, and £800 per annum for
period of five years. The Vestry is to receive for
year's working of the combined installation a sum
$5\frac{1}{4}$ per cent. on the capital outlay, and after that
equal to $6\frac{1}{2}$ per cent. on the capital outlay du
remainder of the corporation's lease of the undertak
will thus be seen that the Vestry runs no risk, and
addition, in the first year earn a profit of about £110 p
in relief of the rates, whilst during the remainder of th
during which the corporation continued to work the in
the profit to the Vestry would be about £750 per annu
guarantee that the work would be carried out to the sa
of the Vestry, and that the annual payments to the Vest
be promptly made, the Electrical Development and Fin
poration are willing to make a deposit of £5,500. The
2s. per ton would include the disposal of the residue.
pany could not undertake to do the work for less than th
named. The committee recommends the Vestry to ins
solicitor to forthwith enter into negotiations with the
Development and Finance Corporation on the basis of th

of the following amendment was on the agenda: "That stry be recommended to carry out the provisional order, and proceed to take steps for the erection of a suitable electric g station on the Townmead site, and an electrical engineer ointed by the Vestry."

ndudno.—A special meeting of the District Council was held ek, at which the sub-committee appointed for the purpose of aring upon what conditions it would be expedient for the l to assist the Llandudno and Colwyn Bay Light Railway ate in obtaining from the Light Railway Commissioners an to construct a light railway from Colwyn Bay through dno urban district, reported that the Council, before g to the application being made by the company and ng themselves to support the same, should insist upon the ng clauses for the protection of the interests of the Council embodied in an agreement to be entered into between the l and the syndicate—namely: (1) The lines within the ; to be constructed and worked only as tramways con d under the Tramways Act, 1870. (2) No heavy goods or goods of an objectionable character to be carried, ore than two cars run together, without the consent Council. (3) The company to make and keep in hat part of the road run over and now belonging to ncil which is situate between the rails of the line, and on either side, with such materials and in such a manner Council may require. (4) The work of construction and o be under the superintendence of the surveyor of the or as regards electric work an electrician to be appointed ouncil. (5) Section 43 of the Tramways Act, 1870, to be l in full in lieu of the purchase clause suggested by the s in their letter of Oct. 16, 1897. (6) The company under- mplete the line to Llandudno ready for the season 1899, to carry on any part of the work between May and (7) The company to take from the Council at a price ed upon the electrical power required for working the the system within the district. N.B.—The committee ion that the Council will be able to supply the required as reasonable rate as the company can themselves generate company not to run trams through the district on Sunday e previous consent of the Council. (9) The company lace any advertisements on the outside of any car which rough this district without the consent of the Council. mpany to pay to the Council the sum of £—— for the granted. (11) The company shall on each and every ays, Christmas Day, and Good Friday excepted—in during which the tramway and tramroad are opened traffic, run carriages available for workmen at such hall be agreed upon between the company and the sum not exceeding one penny per journey within the ict of Llandudno. (12) If any of the tramways require consequence of any improvement or alteration having in any road along which the tramway is laid, the hall at their own cost make such alteration as the ll deem necessary, and if the company fail to make ions within three months after being required so to ncil may themselves make such alterations and execute onnected therewith and recover the costs thereof from y. (13) The Council may cleanse any road without reference railway, but whatever cleansing owing to snow or other eding the traffic is requisite for the proper working of ilway shall be executed by the company, who shall, in the same, remove the snow or other matter from off of the road into the channel at the side, and any dirt or rial or thing removed by the company, their officers or om the grooves or rails of the tramways shall not be remain on the road, but shall at once be taken away by y. (14) The Council may from time to time make, under ing to the provisions of Section 46 of the Tramways ws for the purposes in the said section named. (15) ence which may arise between the company and the all be deemed a matter of difference within Section 33 nways Act, 1870, and the provisions as to arbitration of section shall apply accordingly. (16) The character of the whole scheme, including carriages, posts, and generally, shall be of the very best, and such as the ay be able to approve of. (17) The company to run a trains all the year round. After a lengthy discussion ick Webb, Mr. Dickenson (engineer), and another pro- admitted to the meeting, and the Clerk read over the he committee's report seriatim. Mr. Webb disagreed roposed clause, which meant that the Council would r to acquire the concern at "old iron price" at the of 21 years. The suggestion to take the electric power Council was not considered satisfactory, Mr. Dickenson that they could not have generating stations at both y and Llandudno. With regard to the Sunday trains' Mr. Webb expressed the willingness of the promoters Sunday trains during hours of Divine services. The said there was a strong feeling in Llandudno on this here were no railway trains on Sundays. What did the intend to do with regard to running trains all the year r. Dickenson replied that it was the intention to run , but in the winter to reduce the number of trains to m. After a short consultation Mr. Webb said the were willing that the purchase clause should be left to Railway Commissioners to decide as to whether 28 or uld be the period when the Council should have the rchasing the concern. They would consent to take power from the Council provided it could be supplied route of the railway There would be no Sunday trains. Inasmuch as four members were absent it was decided to adjourn the final decision to another meeting.

TRAFFIC RECEIPTS.

Dover Tramways.—The traffic receipts for the week ending April 9 were £119. 2s. 7d. The total receipts for the year 1898 are £1,514. 17s. 2d. The mileage open at present is 3 miles.

Bristol Tramways.—The traffic returns for the week ending April 8 were £2,810. 9s. 0d., compared with £2,078. 0s. 3d. for the corresponding period of last year, being an increase of £732. 8s. 9d.

Birmingham Tramways.—The traffic receipts for the week ending April 9 were £3,763. 1s. 3d., as compared with £3,311. 13s. 8d. in the corresponding week in 1897, being an increase of £451. 7s. 7d.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended April 10 amounted to £1,539, as compared with £1,353 in the corresponding week of the previous year, being an increase of £186.

City and South London Railway.—The returns for the week ended April 10 were £884, compared with £1,021 for the corresponding period of last year, being a decrease of £137. The total receipts for the half-year amount to £15,826, compared with £15,839 for the corresponding period last year, being a decrease of £13.

South Staffordshire Tramways.—The traffic returns for the week ending April 8 were £609. 6s. 9d., as compared with £597. 16s. 0d. in the corresponding week of the previous year. The aggregate receipts for the year are £8,081. 10s. 1d., as against £8,041. 3s. 0d. in the corresponding period of the previous year.

Dublin S.D. Tramways.—The traffic receipts for the week ending April 1 were £358. 12s. 8d., as compared with £367. 11s. 1d. in the corresponding week in the previous year, being a decrease of £8. 18s. 5d. The number of passengers carried was 62,971 in 1898 and 60,701 in 1897. The aggregate returns up to date are £5,152. 1s. 8d., as compared with £5,514. 4s. 9d. last year, being a decrease of £362. 3s. 1d. The mileage open is the same as last year—viz., 8 miles.

PROVISIONAL PATENTS, 1898.

APRIL 4.

8019. Improvements in or relating to alternating motors. Alfred Julius Boult, 111, Hatton-garden, London. (O. Patin, ——.)

8036. Improvements in or relating to electric batteries or the like. Arthur John Ward, 111, Hatton-garden, London.

8037. Improvements in the manufacture of the peroxide elements of secondary batteries. Desmond Gerald Fitz-Gerald, 53, Chancery-lane, London.

8043. Improvements in sockets or holders for incandescent electric lamps. John William Mackenzie, 40, Chancery-lane, London. (Allgemeine Elektricitäts-Gesellschaft Germany.)

APRIL 5.

8054. Improved means for fixing or fitting incandescent electric lamps into lanterns. James Moores and Henry Oliver Farrell, 4, St. Ann's-square, Manchester.

8059. Improvements in apparatus for lighting miners' safety lamps by electricity. Benjamin David Williams, Lloyds' Bank-buildings, Bristol.

8070. Improvements in electric trolley wire section insulators. William Wood, Power Station, St. George, Bristol.

8085. Incandescent electric light decorations. Alexander Abercrombie Pollock, 70, Wellington-street, Glasgow. (Complete specification.)

8097. A medical electric generator or hot-air bath for the application of heat to the human body. Arthur Edwin Greville, 2, Staple-inn, Holborn, London. (Complete specification.)

8104. Improvements in electrical measuring instruments. Frederick Melville Bennett, 11, Broadway, New York.

8140. Improvements in switches for electric circuits. Gilbert Wright, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Sept. 18, 1897, being date of application in United States.)

8142. Improvements in systems of electrical distribution. Benjamin Garver Lamme, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Sept. 18, 1897, being date of application in United States.)

8149. Improvements in electric welding machines. Christen Nielson, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

APRIL 6.

8179. Improvements in and connected with means for electrically lighting railway carriages. Emil Dick, 4, Corporation-street, Manchester.

8192. **Improvements in electrical connections, switches, and terminals.** Robert Frederick Hall, 24, Temple-row, Birmingham.

8202. **Apparatus for quickly and tightly closing and quickly opening portable electric batteries.** Sydney Ferris Walker, Cardiff Electrical Works, Severn-road, Cardiff.

8222. **Improvements in clutches and brakes for arc electric lamps.** Gustav Byng and Arthur Ernest Angold, 73, St. Stephen's-road, Upton Park, London.

8233. **Improvements relating to electric tram and like cars.** Joseph T. Himmeger and James Crowley, 20, Bucklersbury, London.

8262. **An improved controlling device for electric motor vehicles and the like.** George Henry Rayner, 37, Chancery-lane, London. (Henry Leitner, France.)

APRIL 7.

8273. **Improvements in and connected with electric bells.** Hermann Oppenheimer, 55, Redcross-street, Barbican, London.

8274. **Improvements in and connected with electric bells.** Hermann Oppenheimer, 55, Redcross-street, Barbican, London.

8275. **Improvements in and connected with annunciator movements.** Hermann Oppenheimer, 55, Redcross-street, Barbican, London, (Actien-Gesellschaft Mix und Genest, Germany.)

8276. **Improvements in and connected with primary batteries.** Hermann Oppenheimer, 55, Redcross-street, Barbican, London.

8277. **Improvements in and connected with keys or switches for multiple switchboards.** Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actien-Gesellschaft Mix und Genest, Germany.)

8278. **Improved fuse box for electric light cables requiring resin oil or other compounds as an insulating material at terminal joints, etc.** David Stewart Strang, 77, Mallinson-road, Wandsworth Common, London.

8298. **Electro-photo telegraph.** Adolf Bein and Josef Breuer, 62, St. Vincent-street, Glasgow.

8301. **Improvements in the construction of Morse's registering telegraphic instruments.** Eugène Ducretet, 8, Rue des Princes, Brussels. (Complete specification.)

8314. **Improved electric pile.** Georges Rosset and Joseph Rosset, 8, Rue des Princes, Brussels.

8319. **Improvements in electrodes and in the method employed for producing them.** Karl Krebs, 171, Queen Victoria-street, London.

8328. **Improvements in or relating to electric arc lamps.** Arthur Ross, 111, Hatton-garden, London.

8341. **Improvements in electric alarm apparatus.** Heinrich Wigand, 70, Chancery-lane, London. (Complete specification.)

8348. **Improvements in electrical measuring and indicating instruments.** Arthur Cecil Heap, 101, St. Martin's-lane, London.

8371. **Improvements in electromagnets.** Maurice Bouchet, 53, Chancery-lane, London.

8374. **Improvements in arc lamps.** Guy Carey Fricker, 46, Lincoln's-inn-fields, London.

APRIL 9.

8393. **Improvements in electric arc lamps.** Henry Vincent James, 6, Bank-street, Manchester.

8398. **Improvements in electric motors.** Peter Smith Swan, 121, West George-street, Glasgow.

8438. **Improved apparatus for electrically illuminating or displaying letters, figures, designs, pictures, signals, and their like, principally adapted for advertising purposes.** John Thomas Gent, 11, Burlington-chambers, Birmingham.

8441. **Electric recording system.** Charles Ludwig Jaeger, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

8442. **Improvements in electric meters, cores, and circuit controllers.** William Dennis Marks, 23, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Sept. 10, 1897, being date of application in the United States. (Complete specification.)

8449. **Improvements in enclosed electric arc lamps.** George Hill, 17, St. Ann's-square, Manchester.

8477. **Improved electric accumulators.** Baptiste Alfred Bouvier and Guillaume Léonide Augieras, 8, Rue des Princes, Brussels, Belgium.

SPECIFICATIONS PUBLISHED.

1897.

3831. **Electric batteries.** Adams.

6545. **Composition for increasing the illuminating power of electric arc lamps.** Merch. (Date applied for under International Convention, Feb. 19, 1897.)

6787. **Electric telegraphic systems.** Wise. (Cr
Squier.)

7314. **Accumulator plates or electrodes for s
batteries.** Everard.

7421. **Electric lighting of buildings or other areas,
larly applicable to fire brigade stations,
hospitals, hotels, ships, and like institutions.**

8231. **Storage batteries.** Redfern. (Riordon.)

9387. **Means for lighting by electricity and incand**
Sinclair.

9456. **Secondary batteries.** McLean and Burnet.

9631. **Plate for accumulators or electric storage b**
Dunn.

9968. **Electric control of gas.** Kerridge.

12087. **Switch apparatus for the graduated inclus
exclusion of resistances in electrical**
Siemens Bros. and Co., Limited. (Siemens and

12126. **Arc lamps.** Stewart, Beanland, and Perkin.

13717. **Switches for starting resistance for electric
and other cases where resistances are r**
Gibbs.

18548. **Construction of electric motors and generators**

29379. **Uninterchangeable electric incandescence**
Wheatley. (Allgemeine Elektricitäts-Gesellscha

29615. **Electrical switches or variable resistances.**
and Mayes.

1898.

809. **Automatic calling devices for telephone ex**
Thompson. (The Strowger Automatic T
Exchange.)

1994. **Safety fuses for electrical conductors.** Fergus

2024. **Primary batteries.** Koenig.

COMPANIES' STOCK AND SHARE LIS

Name.	Paid.
Birmingham Electric Supply Company	[illegible]
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10
Brush Company, Ordinary	2
—— Non. Cum., 6 per cent. Pref.	2
—— 4½ per cent. Debenture Stock	100
—— 4½ per cent. 2nd Debenture Stock	100
Callender's Cable Company, Debentures	100
—— Ordinary	5
Central London Railway, Ordinary	10
—— " "	6
—— Pref. Half-Shares	1
—— " "	5
Charing Cross and Strand	5
—— 4½ per cent. Cum. Pref.	5
Chelsea Electricity Company	5
—— 4½ per cent. Debentures	100
City of London, Ordinary	10
—— Prov. Cert. 90,001-100,000	5
—— 6 per cent. Cumulative Pref.	10
—— 5 per cent. Debenture Stock	100
City and South London Railway, Consolidated Ordinary	100
—— 4 per cent. Debenture Stock	100
—— 5 per cent. Pref. Shares	10
—— " " " '96	10
County of London and Brush Provincial Co., Ordinary	10
—— " " "	4
—— 6 per cent. Cum. Pref.	10
Crompton and Co., 7 per cent. Cum. Pref. Shares	5
—— 5 per cent. Debentures	—
Crystal Palace District, Ordinary 5 per cent. Stock	100
—— Preference 5 per cent. Stock	100
Edison and Swan United Ordinary	3
—— 5 per cent. Debentures	5
—— 4 per cent. Deb. Stock, Red.	100
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	3
Electric Construction, Limited	2
—— 7 per cent. Cumulative Pref.	2
—— 4 per cent. Perp. 1st Mort. Deb.	100
Elmore's Copper Depositing	1
Elmore's Wire Company	3
W. T. Henley's Telegraph Works, Ordinary	10
—— 7 per cent. Preference	10
—— 4½ per cent. Debentures	100
House-to-House Company, Ordinary	5
—— 7 per cent. Preference	5
India Rubber and Gutta Percha Works	10
—— 4½ per cent. Debentures	100
Kensington and Knightsbridge Ordinary	5
—— 6 per cent. Pref.	5
London Electric Supply, Ordinary	5
Metropolitan Electric Supply, Limited, Ord. No. 101-50,000	10
—— " " " 50,001-82,500	10
—— 4½ per cent. First Mortgage Debenture Stock	100
National Telephone, Ordinary	5
—— 6 per cent. Cum. First Pref.	10
—— 6 per cent. Cum. Second Pref.	10
—— 5 per cent. Non. Cum. Third Pref.	5
—— 3½ per cent. Deb. Stock, Red.	100
Notting Hill Company	10
Oriental, Limited, £1 shares	1
—— £5 Shares	5
—— £4½ shares	4½
Oriental Telephone and Electric Company	1
Royal Electrical Company of Montreal	—
—— 4½ per cent. First Shares Mortgage Debentures	100
South London Electric Supply, Ordinary	2
St. James's and Pall Mall, Limited, Ordinary	5
—— 7 per cent. Pref.	5
—— 4 per cent. Deb. Stock, Red.	100
Telegraph Construction and Maintenance	12
—— 5 per cent. Bonds	100
Waterloo and City Railway, Ordinary	100
Westminster Electric Supply, Ordinary	5
Yorkshire House-to-House	5

NOTES.

nal.—Dr. Ph. Lenard, assistant professor of in the University of Heidelberg, has been called air of physics at Kiel.

's College.—The annual dinner of old students s College will be held at the Holborn Restaurant ay, June 13. The Lord Bishop of London, D.D., the chair on this occasion.

Linnæan Medal.—Mr. G. C. Wallich, who 40 accompanied Sir Leopold M'Clintock on a voyage e North Atlantic to survey the sea bottom for the the proposed Atlantic cable, has been awarded æan Society's gold medal for the year.

Books.—We have received, from the Institution rical Engineers, part 133, vol. xxvii., of the This part contains the paper by Mr. G. Bins-Byng "On the Manufacture of Lamps and other s for 200-Volt Circuit," and the full discussion on . There is also in this volume an original cation by Mr. H. N. Allen, B.Sc., on "Sparkless in Dynamos." This paper is a most interesting ommutation.

dar Reform.—The *Journal Télégraphique* of last month contains a long article by Mr. César le Quarenghi on the need of and best methods of a uniform calendar throughout the world. He that in the countries affected, such as Russia and etc., the present religious calendar might still ed, but that for other purposes the calendar of lised states" should be used. Projected laws for he changes in Roumania and Bulgaria are outlined thor.

ricity in Surgery.—A 4in. circular saw for the on of limbs at the Emergency Hospital at Boston fixed, and will be driven by an electric motor. will be mounted on a flexible shaft, like that dentist uses, only larger. The bearings, in which rbor runs, are attached to a handle, by which the s able to direct the saw at any angle. Not only does ut much faster than a hand tool, but the heat of cutting is said to sear the flesh and blood vessels, he healing processes of nature are advanced.

rically-Controlled Torpedoes. — Mr. H. writing to the *Electrical Review* of New York pect to a note in its recent issue to the following ys: "Engineer officers of the army and torpedo of the navy are said to be experimenting with a n of automobile submarine torpedo. Allow me lly to inform you, in the year 1882 I assisted the hony Reckenzaun to construct a torpedo; it was by an electric motor, current for which was from shore through wires trailing after the

ity of Projectors.—The strength of the Spanish torpedo boats makes it necessary that all United ssels and forts shall be provided with searchlights, found that it is no easy matter to purchase a suffi-mber of searchlights in the present emergency. A mber of mirrors have been bought by the Govern-nt an adequate supply of them cannot be had. the necessary reflectors, the electric companies rn out the projectors in a brief time, but the n the quarrel do not seem inclined to wait.

ew Educational Institute.—The *Electrical* of New York has established a distinctly new , "The *Electrical Engineer* Institute of Correspondence Instruction." It aims at enabling persons desirous of obtaining a thorough knowledge of electricity and allied arts to do so by printed lessons and confidential correspondence. The system is modelled on the Toussiant-Langenscheidt system of language teaching, which is so much in vogue abroad. The great benefit derived from this institute is that men who are employed all day, and are thus unable to attend an ordinary college, may get the same theoretical teaching and instruction as ordinary students. The management of the institute is entrusted to Mr. H. A. Strauss, E.E., who has great practical experience in teaching electrical subjects.

Municipal Electrical Association.—A general meeting of the association was held in the Westminster Palace Hotel on Tuesday last to confirm the proposed change in the *locale* of the June meeting. It will be remembered that Mr. Wm. Arnot was the president elected this year, and that the meeting was to be held in Glasgow. Mr. Arnot's resignation upset these arrangements, as by that step he ceased to be a member of the association. Hence a change was necessary. Under the articles of association a general meeting had to be held to confirm the new arrangements. The business, therefore, was purely formal, as London had already been selected as the place for the meetings of June 8, 9, and 10. A resolution was passed to that effect in 10 minutes, and the meeting then ended with the usual vote of thanks to the president for his arduous duties in the chair.

Paris Lighting.—Our contemporary *L'Electricien* has some hard words to say about the lighting of Paris, and on the delay in the negotiations now contemplated between the electric lighting company and the Council *re* the extension of the electric lighting concessions. The question is raised by the editor as to how the public lighting of Paris will be esteemed by the visitors to the 1900 exhibition. "Shall we," says the editor, "show them 'La Ville Lumière' lighted as if it was a city of the third order? Paris is now behind all the other capital towns in electric lighting. We are told that the good renown of Paris depends on them finding a Paris sparkling with light, a Paris resplendent with electricity, and not a Paris which will appear in darkness in comparison with the exhibition." Hence active steps are advised, but our contemporary does not take sides. It says, however, that under the present short tenure the companies do not care to lay another yard of mains, and that they demand an exorbitant price for electric energy.

Curative X-Rays.—The *Times* Vienna correspondent telegraphs: "Some interesting particulars of a new application of the Röntgen rays for curative purposes were communicated by Dr. Edward Schiff, lecturer at the Vienna University, at the last sitting of the Imperial and Royal Medical Society. A series of experiments conducted by Dr. Schiff and his assistant proved that these rays could be used for the cure of disease in a manner capable of perfect control by means of a more or less intense application for a longer or shorter period, producing reaction in the exact degree required. In this way it has been possible for the lecturer, on the one hand, to remove hair from parts of the body, where it constituted a disfigurement, without causing the slightest inflammation, while, on the other hand, he has been able to treat lupus with uniform success by means of an artificial inflammation, the intensity of which he was in a position to increase or reduce at will. The results secured by the new method, both in the removal of superfluous hair and the treatment of lupus, were demonstrated in the persons of some of Dr. Schiff's patients."

Iron and Steel Institute.—Mr. Bennett H. Brough, the secretary of the above institute, has forwarded to us

the following list of papers which are expected to be read at the London meeting on May 6: "On the Iron Industry of the Urals," by H. Bauerman, F.G.S., professor of metallurgy, Royal Artillery College; "On Lime and Limestone in Blast-Furnace Practice," by Charles Cochrane (Stourbridge); "On Coking in By-Product Ovens," by John H. Darby (Brymbo); "On the Use of Blast-Furnace Gases as Motive Power," by Adolphe Greiner, member of council (Seraing, Belgium); "On the Solution Theory of Iron," by the Baron Hans Jüptner von Jonstorff (Loeben, Austria); "On Steel Permanent Way," by R. Price-Williams, M.I.C.E. (London); "On Brittleness in Soft Steel," by C. H. Ridsdale, F.I.C. (Guisbrough); "On Allotropic Iron and Carbon," by E. H. Saniter (Seaton Carew); "On the Crystalline Structure of Iron," by J. E. Stead, F.I.C., member of council (Middlesbrough); "On Steel Forgings and Forging Tools," by F. Radcliffe (Woolwich). Members who intend to take part in the discussion will, on notifying such intention to the secretary, have copies of the papers forwarded to them a week in advance as far as that may be found possible. Visitors' tickets will also be forwarded on application.

Australian Overland Telegraph.—The South Australian Government has decided upon the desirability of duplicating the overland telegraph by the erection of a second wire to Port Darwin. This is a result of the recent interruptions in the existing wire, and the complaints they have entailed. The double wire, when the intended addition is completed, will have a working capacity nearly four times greater than the existing single one, and this will greatly facilitate the transmission of messages and prevent a block on the line. The cable company has two cables to Port Darwin, and as South Australia has only one wire, the cable has at present an advantage over the land line. There are over 2,000 miles to be traversed, and it is expected that the work will be completed about the end of the year. The total cost is estimated at something over £50,000. The Agent-General in London has been advised of the materials required for the work, and is now only awaiting the receipt of a cablegram to put the order in hand. This line once saved the life of a traveller in a curious way. Upon arriving at the track in Central Australia in an exhausted condition, he promptly cut the wire and laid down on the spot, where he was picked up a few days later by the line repairers, who had been sent out to repair the damage.

Punkah-Pulling.—A Mr. F. J. Agabry writes to *Indian Engineering* on the above subject, which was referred to in our last issue, to say, amongst other things, that "the great stumbling-block has been the motive power. Of late years, since electricity has come into use so largely in our daily life, electric revolving fans are being used with great success. The great drawback to these fans is that the area of air disturbed is so concentrated that, power for power, they do not give the same efficiency as a punkah does, especially when it is a case of cooling a very large room. For instance, a rotary fan with a 5ft. sweep, making 190 to 200 revolutions a minute, requires about 100 watts to work it efficiently, which is about $\frac{1}{7}$ h.p. Now, with $\frac{1}{7}$ h.p., or approximate 4,714 foot-pounds per minute, a number of punkahs could be pulled in more rooms than one. Therefore, power for power, the ordinary punkah requires less and gives better results than large rotary fans. We also have the small rotary fans of from 12in. to 15in. in diameter. These require from 10 to 12 watts, or approximate 500 foot-pounds per minute to keep them going. Fans of this kind have two objections. The first is the area disturbed, like the large fans, is too concentrated. The second is that one feels in a draught the whole time. These little rotary fans are capital things for bed placing one at the foot under the net the air can be to travel in such a direction that it would not be able."

Submarine Mines.—After the indignation in the American papers that Spain should have harbour at Havana, one might be surprised to New York Harbour will be little less than a deat any hostile fleet that attempts to enter it. Fro the main channel passes Sandy Hook to the anchorage off Tompkinsville, the "bulbs of de will be swinging in the tides. The mining of the is being done by the Manhattan Electric Compa the direction of Superintendent Frank Knig electric cables are connected with several of the forts about New York. Thousands of pounds of dynamite, and other high explosives were pu scows, which were towed out into the bay, and dropped attached to the cables. These mines var Those which will rest on the bottom weigh from 500lb., while those which are buoyant weigh fro to 250lb. The mines will be manipulated by entirely. By touching one of the connecting b any of the forts with which the cables connect, th current is made complete and the explosion fol has been suggested that the heavy mining of the would be dangerous to passing vessels, which tide might come in contact with one of th There is, however, no danger from this source, a mines are not used, and there is no possible any of them exploding except when the electric made complete.

Wars of the Future.—Under the e engendered by the trouble between Spain and th States, the *Daily News* trots out some chestnuts new American notions" and "destructive ma waiting." The editor hedges by the statement yet we have had no opportunity of deciding of what fighting value these appliances will be, and ind of them exist as yet only in the mind of the However, as Mr. Edison recently remarked, require but the impetus of war to develop such destructive appliances as would astonish the world gentleman in question is prepared to pump hosts out of existence by a jet of water exercisin of 5,000 volts, and the few left have to prepare th to stand against a fire of "electric chains." Mr. E also an "aerial infernal machine" up his slee S. H. Short comes next in order. This gentle use a beam of light as a telephone wire, using a cell as a receiver. We hope Herr Sczcepanik cornered all the selenium, as that would ha Short's plan. Mr. Short also suggests the equipm harbour or roadstead with an invisible battery of which would seize a hostile ship and hold her m in spite of the most frantic efforts of her crew, ri his guns. Mr. Short should take his new ide from the "Arabian Nights" in future. After t we come to hypothetical aerial and submarine shi we have not space to notice.

The "Holland" Submarine Boat.—This ne at submarine navigation is said to have pass successful trials in the States. The following i description of the boat and her machinery. T has a length of 55ft., a diameter of 10½ft., and a ment of about 75 tons. The steel hull is somewhat of shape. The sources of power are respectively a g when the boat is at the surface and electricity w marine journeys have to be undertaken. The accu

latter purpose are placed amidships, and so arranged spect to the centre of buoyance that the vessel n even keel at all times. We gather that liquid carried, and hence that this is vaporised before into the engine. The dynamo used to charge the ators is placed on the main propeller shaft, as is gas-engine. In this way the dynamo is used as a o drive the propeller when the boat is diving below ace of the water. At the trial made on March 27 of 10 knots was obtained when the boat was at ace. The diving test was made at about the same nd the inventor showed that the depth of the craft ater was quite under control. We understand that sed air is carried to keep the crew comfortable low the surface, and that the diving is effected by of vanes and not by increasing the water ballast ressel sinks. The buoyance previous to diving is, howduced to about 250lb. The "Holland" is intended nce work, and is well armed with torpedo tubes.

Szczepanik.—The *Daily News* has got even onderful news from this celebrated provider of ories of impossible inventions. The last news reads rs: It is announced from Lemberg that Herr Jan nik, the inventor of the telelectroscope, and his l partner, Herr Ludwig Kleinberg, have arrived negotiate for the purchase of the invention of a g electrician named Rychnowski. This electrician o have discovered the electric fluid, which he calls l. It appears that "the discovery has already caused sensation among German and French occultists, but so far, been scientifically examined. It seems that l is obtained by electrolysis, but is not identical ctricity. Its effects are declared to be startling. uces light, and causes Geissler tubes to show nt rays. It works photo-chemically, will rotate in mid-air, and produces whirlpools in water. ater is illuminated by it from below it rises and a. Electroid, so it is claimed, kills bacteria of By its means metal and glass can be charged with y, and the magnetic needle changes its direction s influence." Reading the above in the most ay, we fail to see any invention in the various its, except, perhaps the word "electroid" and the t it is obtained by electrolysis. In fact, but for claim amounts to a rediscovery of the various s of electricity, and we suppose that Herr nik will next, by the aid of his financial partner, t water is wet. He certainly has not up to the discovered any incredulity amongst the correspondents of the London daily papers.

rpool Motor-Vehicle Trials.—At a meeting of rpool and District Centre of the Self-Propelled Association held on the 14th inst. at the Royal on, Mr. E. Shrapnell Smith read a paper on "The ments for the May Trials," in which he stated that s would begin on the morning of Tuesday, May 24, ld conclude on the afternoon or evening of the llowing. At the beginning of January communications were addressed to about 60 firms of engineers in the construction of self-propelled road vehicles, engines, agricultural machinery, etc. The replies l were, taken as a whole, of great interest, and o indicate that there already existed amongst our t engineers the good intention at least to apply perience to the evolution of satisfactory motor-for heavy loads. The net result of these enquiries the conclusion that they would have at least 12 competitors taking part in the trials, but this estimate is too sanguine, for they had received entries from only six intending competitors, who had entered 10 vehicles. The majority, if not all, of the vehicles entered were steam propelled, with oil-fired boilers, ordinary paraffin being the fuel used. One of the vehicles was fitted with a boiler of the "instantaneous generation" or "flashing" type. As regards the routes, at present it could only be stated that two had been selected which came within the prescribed limits—between 30 and 40 miles—and that, presuming eight only to be presented for trial, four vehicles would be put upon each route, two in each direction. Thus when the runs were completed, each competitor—breakdowns, if any, excepted—would have traversed each route in each direction.

Canadian Competition.—It appears that a gentleman rejoicing in the euphonious appellation of "Bickerdike" is writing to various corporations setting forth the merits of the only American trolley system, and enjoining the civic fathers to cable him a franchise for a number of years, after which he would "immediately go over and complete arrangements." We have seen reports of such a letter being received by the Barrow County Council and the Waterford Corporation, both of which, however, did not bite. The letter is worthy of reproduction; it reads as follows: "I understand that you are at present considering, or are about to consider, means to provide greater facilities for the rapid transit of passengers through your city and districts contiguous thereto. It has been suggested to me to apply for a franchise to construct and operate a line or system of lines forming a complete service for your city on the principle of the 'American electric trolley system.' This system is to-day the only one in favour on this continent. American cities have witnessed the evolution of the present system through a series of experiments with various methods of transportation, omnibuses, horse cars, electric cars, both storage battery and trolley, and also the elevated and cable railways. To-day there is only one system—the 'electric trolley system.' Cable railways and steam traction or elevated roads are being rapidly replaced by the trolley system on account of greater cleanliness, certainty of action, avoidance of undue noise, and economy. If your Board are favourable to the system, and grant me a franchise for a number of years, I will undertake to immediately put our system in operation in your city on terms that I feel sure will be acceptable to you and of immense benefit to your citizens. If this is favourably received, kindly write to above address, or cable me, and I will immediately go over and complete arrangements." A copy of the Tramways Act and Light Railways Act would greatly assist the gentleman in question, and save him some postage stamps.

Electric Lighting in Darjeeling.—Our contemporary the *Indian and Eastern Engineer* gives a well-illustrated article on the electric lighting works at Darjeeling. The generating station is 3,500ft. below the level of Darjeeling, and some three miles distant from it as the crow flies. Water is collected from two *jhoras*, or hill streams, and lead through galvanised troughing to a reservoir. From this a 24in. cast-iron pipe leads to the pentrough. From the pentrough two steel pipes 15in. in diameter with flanged joints are carried down side by side to the turbine-house, some 300ft. below the pentrough level. Each of these pipes supply water to a Girard turbine coupled direct to a Crompton-Brunton 65-kw. alternating-current dynamo. The turbines are fitted with a sensitive form of hydraulic governor for regulating the speed. Each alternator carries its own continuous-current exciting dynamo on a prolongation of the armature spindle. The effective head of water is 276ft., and 150 cubic feet of water per minute passes through the turbine when working

at full load. The alternators generate electricity at a pressure of 2,300 volts, and the energy is conducted to Darjeeling through two bare copper mains of No. 7 standard wire gauge, carried on oil insulators fixed to posts of the Indian Telegraph Department pattern, and suspended 20ft. from the ground. Where these mains cross public some roads they are made of standard copper cable insulated heavily with vulcanised indiarubber, and suspended from a steel wire by means of porcelain clips; the steel suspending wire is also insulated. The electrical energy is carried to three transforming stations in Darjeeling, where it is reduced to 240 volts, at which pressure it is distributed throughout the streets of Darjeeling for lighting purposes on the three-wire system. The third wire is earthed and is carried along the top of the poles, forming a most efficient lightning conductor for the whole system. The street-lighting of Darjeeling is done by 200 incandescent lamp of 16 c.p., and two arc lamps of 3,000 c.p.

Another Tramway System.—Last week, in the works of the Glasgow Corporation Tramway Car Department, St. James-street, a practical demonstration was given by means of a large working model of a new electric system for street car propulsion. It is called the Munson electric conduit system, and is an American invention. This seems to be a contact system with the street contacts in a conduit. Midway between the rails on each track is placed the conduit, having an open slot on the top. Within the conduit, placed at intervals—the distance between each being regulated by the length of the car—are small gunmetal rollers. These rollers are fixed on the end of the plunger, to the other end of which there is attached a tongue, which is in metallic connection with the roller. The plunger is well insulated with a hard insulating substance, and the whole is contained in a brass tube, which is free to move. Opposite the tongue there are two contacts which are connected by a copper connection with the main wire, which is equivalent to the trolley wire on an overhead system. This main wire is laid in solid insulating material, such as hard bitumen. Opposite the roller described, in the conduit, there is a second one, which is connected similarly to that already described, with the main return wire on the other side. The action that takes place when a car is running is that, whenever the plough underneath the car comes between the two rollers, it forces them inwards, the tongue on the end of the plunger in both cases going in between the two contacts which are connected with the main cables. The current then leaves the cable on the one side, goes through the contacts, through the tongue of the plunger, along the plunger, through the roller, and into the car by means of insulated copper strips. Whenever the car leaves these two rollers they are forced out, and then become dead. The plough of the car, before leaving one pair of rollers, makes contact with the pair in front. The great point claimed in favour of this system of electric propulsion is that the entire system is an insulated one on both sides, the return current is not taken back by the rails, hence no trouble with the electrolysis is expected. Also no bonding of the rails is required.

Columbia's Artificial Moon.—The *Scientific American* gives in the issue of April 9 fuller details of the arrangements for lighting the library of the Columbia University. The special feature is the large white sphere hung in the dome, which sphere being illuminated by eight projectors gives from its matt white surface a very diffused light. This sphere only gives a general lighting to the library, as reading lamps and small electroliers are used to light the bookcases and tables. This artificial moon is 7ft. in diameter, and is made of wood, painted with kalsomine. The projectors are of the Colt automatic feed typ[e] are fitted with a focussing feeding gear. The len[s] are so arranged that they illuminate a circle on the 6ft. 6in. diameter, so as to avoid all direct lighting dome itself. The current used in each projector is n[o] 18 amperes, but no test of the actual current taken been made. A series of tests were made with an il[lumina]tion photometer, which indicated that the illumin[ation] horizontal surface on the balcony was 0·034 foot and that on the reading tables was 0·012 foot-candle arc is 6in. away from the condensing lens, which is 71ft. from the sphere surface; the latter was 60ft. f[rom] balcony and 80ft. from the reading tables. This give about 300 as the candle-power of the sphe[re] about 20 per cent. of the rays are absorbed by the surface and 20 more lost by reason of the of reflection, at least 500 candles will be r[...] by the globe. The value is probably somewh[at] and indicates that there are other considerable The candle-power of the underside of the globe, re[...] from the tests made upon the floor, was found to indicating a large loss when the light strikes such a as that of the sphere at an acute angle. When the meter box was placed horizontally in the balco[ny] illumination was found to be 0·034 foot-candle. Al[...] this illumination is not equal to that of a full moon zenith, yet it is sufficient to read by, although no great length of time. Under the best conditi[ons] illumination of the reading desks may attain, sphere alone, to 0·02 foot-candle, or equal to that normal rays of a candle 8ft. 6in. away. The ques[tion of] cost is then taken up, but from the above data it gathered that this is prohibitive. The use of 18-ampere projectors to produce 300 c.p. shows this.

Indiarubber.—The first of Dr. D. Morris's lectures on "Sources of Commercial Indiarubber delivered at the Society of Arts on Monday last lecture was mostly concerned with the botanical the subject, but the author described a new mec[hanical] contrivance which has been successfully used f[or the] separation of the caoutchouc globules from the [...] which they are contained. A mixture of half wat[er and] half rubber juice as it comes from the tree is pour[ed into] a vessel which revolves rapidly. The caoutchou[c rises] to the top, and the several globules, which are particles of rubber, hang together in a mass, and ca[n] be skimmed off or run out. They are then dried bricks, and are ready for export within six hours. the method closely resembles the churning proc[ess of] getting butter from cream. This process is in use i[n] haciendas in Central America, and has increased the of their production by 25 per cent. Dr. Morris gave statistical tables showing the continuous increase in the consumption of indiarubber, and also the increase in from 2s. 11d. to 3s. 11d. per lb., within the last four The total imports into Great Britain were 200 t[ons at] the beginning of the Queen's reign and 20,000 tons year 1896. The value of the latter was about £5,00[0,000] More than half of this amount was exported again, in its raw state or in manufactured articles. He adv[ocated] the exploitation of rubber on more scientific an[d less] destructive principles, and also tree planting. A c[urious] feature is that there is an export duty on the seeds o[f] rubber of £5 per pound, and of 10s. on each seedling seeds were supposed to lose their power 14 days after were gathered from the tree, but he had been able to results with Ceylon seeds after four weeks. A num[ber of] charts and pictures illustrating the various plants and origin and limits were shown on the screen, while

ments used in the collection of rubber, an interesting ion of rubber in all its stages, and a number of manu-ed articles were on view. The following is the synopsis remaining lecture on the subject, which is to be red at the Society of Arts next Monday: Peruvian olivian rubbers—"Castilloa elastica"—Conditions of h and exploitation in Mexico, British Honduras, mala, Nicaragua, and United States of Colombia—ela and Guiana—Mangebeira—Manicoba or Ceara—grosso—African rubber plants—Distribution of Lan-s—West African—East African—Mozambique—ascar rubbers—Lagos silk rubber ("Kickxia"—ds of preparation—Present condition of industry—rce—New sources of supply—Assam—Penang—a—Java—Borneo—New Guinea—Fiji—Cultivation rubber plants—Prospects in Mexico, Brazil, West Ceylon, Malaya.

onocyclic Plant.—Our New York namesake s fully an interesting example of the introduction monocyclic system into a direct-current station, g the area of its operation to take a wide extension. nt in question is at Middletown, O., where the own Electric Light and Power Company has y found it necessary to increase the monocyclic y of the plant to meet the increased call upon the In addition to the arc and incandescent lighting towns of the size of Middletown, certain factories progressive managers have adopted electricity in steam, and the motor load on the station already eeds the lighting load. The generating plant of two General Electric 12-pole, 150-kw., 1,040-revolution monocyclic generators, three 50-light -Houston series arc dynamos, and one General 100-h.p. 500-volt direct-current generator, all driven ntershafting furnished with the necessary friction . The 500-volt machine is used exclusively to direct current to several small motor plants ut the city; the arc machines operate 112 city s. The motor load on the monocyclic machines to within a short limit of their capacity. The of the Miami Cycle and Manufacturing Company, over a mile away from the station, takes 200 h.p. motors are running at their rated capacity. The is received in the factory in six 40-h.p., one 20-h.p., 10-h.p. transformers, reducing the pressure to 115 he motor circuits run from the 40-h.p. transformers, ing circuits from the three of smaller capacity, and all nt is measured in a recording wattmeter, connected primary circuit. The motor equipment consists in 10 General Electric induction motors—three of in the machine shop, driving 88 machines; one of in the drill and pattern room, driving 29 machines; of 10 h.p., driving the machinery in the frame ent; three of 30 h.p. in the polishing room, two polishers and one for the 48in. exhaust fan; one of driving two plating dynamos in the plating room, ther of similar capacity operating a number of machines in the erecting shop, as well as a three-ton . The incandescent lights in the factory number which, during the rush season, almost all are A large tobacco factory is also supplied with om the station. The incandescent lights in the ady wired number 3,800; of these 750 are in the tory, 100 are in the tobacco factory, 650 are in a house, and 2,300 in other parts of the town. mps burn with absolutely no interference from m the motor load; in fact, the entire motor load thrown on or off without in the least affecting the of the lamps, the presence of the motor load being usually only determined by reference to the ammeter. The monocyclic machines operate with almost perfect regulation, requiring little or no attention to maintain the constant potential at all times.

The Welsbach Electric Lamp.—The *Journal of Gas Lighting* is naturally keen on the work being done by Dr. C. Auer von Welsbach, and hence we find in its columns a good account of his new filament for electric lamps. This account is abstracted from the *Journal für Gasbeleuchtung*, and we again condense it for our readers. It seems that osmium is the mainstay of the new filament. Osmium is distinguished by possessing at once the highest specific gravity and the highest melting point of all known metals. It is found associated with platinum and iridium in many platinum ores. The property of osmium of which Dr. Welsbach takes advantage is its infusibility at any but the highest attainable temperatures. The intensity of the light emitted by an incandescent body increases more rapidly than the fifth power of its absolute temperature; and therefore a high temperature is clearly economical in the production of artificial light. In a vacuum, or in a reducing atmosphere, a filament of osmium may be heated to the temperature of the volatilisation of platinum and iridium, and it shows no indication of volatilising or melting, but at that temperature it emits a white light of great intensity. In a vacuum especially, such a filament may be heated by an electric current far above the melting point of platinum, and it remains solid. Only when the intensity of the current is enormous in comparison with the capacity of the filament does the latter melt at one point. Dr. Welsbach has found that commercial preparations of osmium are unsuited for use without further purification, but that pure osmium, or osmium containing a mere trace of platinum, gives tolerably elastic filaments, suitable for use in electric incandescent lamps. Some observations made by the inventor seem to indicate that more readily fusible materials than osmium may also be of hitherto unsuspected service in electric lighting. It is well known that a platinum wire, through which a sufficiently powerful electric current is passed, melts when it attains a white heat. If, however, the wire be closely enveloped by a thin yet dense and cohesive coating of highly refractory material, such as thorium oxide, the intensity of the current can be greatly increased before the wire will melt. Energy is withdrawn from the wire to its coating, and is radiated from the latter as light and heat. As the intensity of the current is increased, the radiation gradually becomes evident as a blinding light; and though the platinum is finally melted, the intensity of the current, and therewith of the light, can be raised still more, until the pressure of the vapour of the platinum ruptures the coating of refractory material. If a more infusible metal than platinum be used for the core, the intensity of the light may be still more increased. An extraordinarily magnificent and beautiful illuminating effect is secured if the coating of thoria be only a few tenths of a millimetre in thickness. The other rare earths, and lime, magnesia, and other so-called refractory materials, melt or vaporise too readily to be of much service for coating metallic filaments. Thorium oxide is used solely on account of its extremely refractory character, and does not serve, as in the Welsbach mantle, as a skeleton on which particles of cerium oxide may be insulated and allowed to exercise their peculiar catalytic powers. These powers, on which the special economy of incandescent gas lighting appears to depend, are not employed in the Welsbach electric lamp filaments; and their utilisation in electric lighting continues out of the question. We wait with interest more details as to the commercial aspect of the invention.

ELECTRICAL TRAMWAYS IN PARIS.

BY R. T. COLLINS.

The following is a portion of a long article by Mr. Collins on "Mechanical Tramways in Paris" which appeared in a supplement to the *Contract Journal* of the 20th inst. In the article referred to all the other systems of mechanical traction are described.

After being neglected for some time by the tramway companies, electricity is once more coming to the fore, and seems likely to be used very extensively on the new lines that will be laid down during the next year or two. In Paris there are serious drawbacks to the employment of electricity. Overhead wires are not tolerated inside the fortifications, and the only methods of propelling the cars are by accumulators or underground conduits. Recently, a line has been inaugurated working with a combination of trolley and accumulator, similar to the system which has been applied upon a small scale to the tramways in Hanover and Dresden, and, as we will show further on, this method is capable, under certain conditions, of realising great advantages. With two exceptions, however, all the existing electric cars have the power stored in accumulators. The three lines, from the Madeleine to Saint-Denis (Fig. 1), from the Opéra to Saint-Denis (Fig. 2), and from Saint-Denis to Neuilly, have been in operation for about five years. The two first lines have each a length of a little more than 9 km., of which about one-half is within the walls of Paris, and the third line, from Saint-Denis to Neuilly, follows the outside of the fortifications for a distance of about 6 km. These lines are being worked under arrangement with the tramway company by the Compagnie de Traction et d'Electricité for a fixed sum of 40 centimes per car per kilometre. As the cost of running the old types of cars was 47 centimes, the traction company found it necessary to adopt every possible economy in order to make the concession pay. New cars have been built of lighter construction, but with the same carrying capacity of 50 passengers, and the weight of the accumulators and propelling mechanism has been reduced. The cars now used only weigh 12,700 kilos, as compared with 14,000 kilos in the older types. The accumulators originally employed were the Laurent-Cély, and were placed under the seats of the vehicle, but these accumulators were not of sufficient durability, and all sorts of systems have been tried since then. In the new cars recently put into service the battery is placed underneath the vehicle, so that it can be removed on a trolley by a couple of men instead of by five as formerly. The battery contains 108 cells, giving an E.M.F. of 200 volts, and the total capacity of a cell weighing about 17 kilos 500 is 13 amperes per kilogramme, with an average rate of discharge of four amperes. The energy stored up is sufficient to enable the vehicle to run 45 km., but the battery is recharged at the end of each return journey, when about half the energy has been expended. The time occupied in recharging is about two hours. The bipolar motors of the Manchester type employed in the older vehicles have been replaced by others designed by M. Johannet. They are geared to the axles by ordinary spur-wheel gearing and run at 500 or 600 revolutions a minute. With a discharge of 70 amperes and at 200 volts the motor can develop 19 h.p. In view of the steep gradients that exist on two of the lines mentioned, it was naturally suggested whether it would not be possible to utilise the down grades for partly recharging the accumulators, and the system proposed by M. Reynier of converting the motors into generating dynamos, and sending the current into the accumulators, while going down hill, is found to result in appreciable economy. This is only possible, however, in cases where the profile of the route is irregular and the gradients steep, and, as it is found that the energy restored on some of the Paris gradients is from 24 to 27 per cent., it is evident that it must result in a notable diminution of working cost. The existing cars have not been running long enough to allow of our arriving at an accurate estimate of the working cost, but it has certainly been reduced from 47 centimes to about 34 centimes per car per kilometre, so that the Compagnie de Trac at length succeeded in running the line at a profit.

Each tramway system presents its own special di in the way of applying electricity, and on the lines the Madeleine and Courbevoie the chief problem charge the accumulators without the necessity of r to the power station, which had to be situated distance from the termini of the lines. The Industrielle des Moteurs Electriques et à Vapeur to employ the mixed system of trolley and accu but the inhabitants of Neuilly objected strongly overhead wire, and the company was obliged to accumulators throughout the entire system. T three lines, having a total length of about 17 k

Fig. 1.—Accumulator Car, Madeleine to St. Denis.

from the Madeleine to Levallois, and the others Madeleine to Courbevoie by way of Pont Bin Pont Neuilly respectively. The gradients are no larly steep, but nevertheless there are two long on Boulevard Malesherbes and the Avenue de Villi which the traffic is very heavy and stoppages At the Puteaux station the steam is generated Babcock and Wilcox boilers, each of which vapori kilos of water an hour. The exhaust is thoroughl for heating the feed water. Three Willans and engines operate a similar number of Brown which produce a current of 200 amperes at 60 volts. Under normal conditions two engines are to ensure the service. The current is conveye three termini by feeder mains which are ind of each other, as, owing to the impossibility of

Fig. 2.—Accumulator Tramcar from Opera to St. Denis.

absolute regularity in the running of the cars, happens that two or three cars are waiting to be at one terminus. Moreover, it is advisable recharging of the accumulators at one terminu not be influenced by the recharging at anoth length of the feeders to the Pont Neuilly is 6 Pont Bineau 2,000m., and to Levallois 3,500m. terminus there are two posts for connecting th with the battery. As the cars are in charge of omnibus drivers who have no technical experien been found necessary to adapt an automatic sig gives warning when the battery is fully charg operation of recharging occupies from eight to minutes. The car itself is built independently underframe, and can be removed when necessary. accommodation for 52 passengers. The accu

yed are of the grid pattern, manufactured by the té de l'Accumulateur Tudor. The battery comprises Tudor cells, and each cell is composed of five plates— ositives of the Planté formation and three negatives of aure formation. The accumulators are what is called 'rapid charging" type, which is, of course, absolutely ary in an installation of this description. They are all d inside the vehicle under the seats, and the battery is 3,600 kilos. We are informed that after running lvemonth, and receiving from 1,000 to 2,500 charges scharges, the positive plates are about to be replaced he first time, and as the negative plates last about as long as the positives, it is expected that they will service for another similar period. Each of the two

Fig. 3.—Thomson-Houston Accumulator Car and Trolley combined.

rs has a normal output of 15 h.p., but they can develop few minutes as much as 25 h.p. The motors may be ed either in series or parallel, and when in series may versed. Two ventilators are operated to clear away ases that may accumulate under the seats, and thus nt their causing any annoyance to the passengers. The mum speed of the cars on the level is 25 km. an hour, on ordinary gradients it is 14 km. The Société des ars has undertaken to work these lines at something than 40 centimes per car per kilometre, and the actual ing cost comes to about 34 centimes, without, however, g into account the cost of installation, which must siably augment this figure.

Mixed Electric Cars.

he Compagnie Française Thomson-Houston has been

Fig. 4.—Claret-Vuilleumier Electric Car, with street contact system.

ing strenuous efforts to secure permission to work with overhead contact in Paris, and, failing this, as effected a compromise by running the cars with trolley outside the city and using the accumulators in. During the past few weeks two lines have been gurated on this system between the Place de la ublique and Pantin and Aubervilliers (Fig. 3), both ing a length of rather more than 6 km., of which km. are within the fortifications. The power station is blished at Aubervilliers, and the installation comprises te. Roser boilers, with 193 square metres of heating face, and three single-cylinder horizontal engines 250 h.p. constructed by Lecouteux and Garnier. h engine works by means of leather belting a six-pole nson-Houston dynamo of 150 kw. at 400 revolutions. s type of dynamo has been specially designed for the Aubervilliers station, and in normal running furnishes 300 amperes at 550 volts. There are two principal circuits— one of 500 to 530 volts for the trolley, and another of 550 to 570 volts for recharging the accumulators along the route. In the depôt a battery of accumulators may be replaced in three or four minutes by means of a hydraulic crane which has been specially designed for the purpose. The two lines mentioned are served by 30 cars with a carrying capacity of 56 passengers, and are, therefore, somewhat larger than the other vehicles on the Paris tramways. As it is not found possible to lay down turn-tables at the termini, the vehicles have had to be constructed with driving gear at each end of the car. In Paris the bridges are very low, and in view of the small space between the arch and the top of the car, the trolley pole has had to be sunk into the roof, but this is an advantage in that while running with accumulators the pole is entirely out of sight. The accumulators are supplied by the Société pour le Travail Electrique des Métaux. The battery is composed of 224 cells, each of seven plates, which are charged at 500 volts from the overhead wire along the route outside the city. It is placed underneath the car, not only with a view of securing a greater stability, but also of preventing any emanation of gases inside the car, while at the same time it facilitates the removal of the battery when the cars are merely required to run outside the city. The vehicle runs on bogie frames in a way that utilises 80 per cent. of the weight of the car upon the driving axles, notwithstanding that four axles are used. This has been rendered necessary by the traffic on some of the gradients, which results in frequent stoppages and requires considerable effort in starting the vehicles. The motors are of the Thomson-Houston type, of 25 h.p., and the axles are fitted with the company's electromagnetic brake. At each end of the car is a commutator of the B A type, to which the current may be sent either from the overhead wire or from the accumulators, or the current may be sent from the wire simultaneously to the commutators and the motors and to the accumulators in order to recharge them along the route. The vehicles have been in service for too short a time to permit of any accurate estimate of the working cost being given, but the company is entirely satisfied with the results of the new system, which it deems to be the best under the circumstances, and the cars, which at first had to run every 12 minutes, are now following each other at 10 minutes' interval.

Claret-Vuilleumier Electric Cars.

As an alternative to the accumulators, whether charged from a central power station, from overhead wires outside the fortifications, or from underground feeders to the termini of the tramways, the only electrical method of traction employed in Paris is the surface contact upon the Claret-Vuilleumier system, which was first tried three or four years ago in Lyons. The new line runs from the Place de la République to Roumainville (Fig. 4), a distance of 7 km., of which 4 km. are within the city. The object of this system is to secure the advantages of underground conduit without going to the heavy cost of construction, in which, moreover, the conducting cables are only kept insulated with great difficulty. The essential features of the Claret-Vuilleumier system are the fixing of metallic plates or " contacts " between the rails for conveying the electricity to the motors and the putting into circuit of two of these plates at the moment that the car is passing over them. An arrangement has of course to be made to cut the circuit directly the car has passed over the contacts, otherwise the danger of the system would be so great as to render it utterly impracticable. The electricity is generated at a power station at Lilas, situated at about two-thirds of the distance between the Place de la République and Roumainville. There are three engines of 170 h.p., driving three Huguet-Hillairet four-pole dynamos by means of leather belting. The dynamos furnish 280 amperes at 530 volts, or about 150 kw. This installation provides the current not only for propelling the cars, but also for the 113 arc lamps in the Avenue de la République and the Avenue Gambetta. As we have said, the circuit has to be completed at the moment the car passes over the contacts, and this is effected by means of distributors which

are placed under the pavement at distances of 95m. The current is conveyed by underground cable to the distributor, from which 20 wires branch off, each one connecting a pair of contacts, and the twentieth pair is also connected with the next distributor. These contacts were formerly made of cast iron, but owing to their rapid wear have had to be replaced with steel. Raised slightly above the surface of the road, they are insulated by a mixture of resin and bitumen, in which they are sunk. The contact is secured by a longitudinal iron bar 3m. 30 in length underneath the vehicle, and as the contact plates are set 2m. 50 apart the bar is always in contact with one of them. The two distributors for a double line are placed in a cast-iron receptacle 1m. 30 in length, 77cm. in width, and 89cm in height. Each distributor, which is circular in form, carries on its periphery 20 connections for the wires which convey the current to the contacts. The circuit between each pair of contacts is completed by a switch which comes into action automatically at the moment that the contact bar of the car is passing over the metallic plates. When the bar touches two plates the current is divided, one part going to the motor and the other returning to the negative pole of the dynamo, but the returning current passes through an electromagnet on the distributor, which sets in motion a ratchet and turns the switch round to the points corresponding with the next pair of contacts. Thus, as the car advances, the switch continues to turn until it reaches the twentieth point, when one of the contacts is in connection with the next distributor. Before the current from the generating dynamo enters the distributor it has to pass through a commutator, and the apparatus can only be got at by turning a lever, which cuts the current and thus prevents liability to accident. It is evident that a delicate appliance like the distributor may possibly become deranged, notably in the failure of the switch to keep pace with the car, and, in order to overcome any danger, each vehicle is fitted with a trailing or safety bar. This is insulated from the body of the car, which carries an electromagnet in circuit with the contact bar and the underframe of the vehicle. So long as it receives the current the electromagnet draws an armature and interrupts the contact with the trailing bar. So soon, however, as the electromagnet fails to receive the current from the contact bar, the armature creates a contact with the trailing bar, which falls and short-circuits the distributing cables and the rails, when the current is cut off in the distributor by the melting of a lead connection. The two motors are suspended from the underframe of the car between the axles, to which they are geared by spur wheels. They are entirely closed in to protect them from the dust and mud, but the gearing is exposed and is not lubricated. The maximum force of each motor is about 30 h.p., and the average speed of the car is 12 km. an hour, though the commercial speed, including all stoppages, is 9 km. 900. The cars weigh nine tons without the passengers, and they have 52 seats. It is difficult to arrive at approximate data of the cost of installation and working of such a system, but according to M. Vuilleumier the cost of laying down a single line would be about 2,154fr. per 100m., a figure, however, which must vary considerably with the number of cars running and the frequency of the distributors. It may, however, be taken for granted that the cost is rather nearer that of the trolley system than of the underground conduit. The system is not without its disadvantages on lines where it is required to run the cars frequently, for as one distributor serves 95m. of line, it is evident that if one car should enter upon a section before the other leaves it would come to a standstill. The only remedy for this, if the cars have to deal with a heavy traffic and follow each other close up, as is done on many of the Paris lines, would be to shorten the sections and increase the number of distributors, but this would, of course, entail a heavy expense and add to the cost of working. Again, it happens now and then that the bar does not come into contact with the plates owing, it may be, to an obstruction, and as the switch in the distributor does not come forward the trailing bar falls and the lead connection in the distributor is melted. Some minutes have to be spent in repairing the connection. A mechanical derangement may also render it necessary to replace the distributor, when a much longer time is lost. The system appears to be convenient in cases trolley cannot be employed and where the cars d to run very frequently, but it can hardly be advantage under conditions of heavy traffic, and i ment is therefore limited.

A Comparison.

The amount of traffic to be dealt with on tramways is so considerable that the cars have large capacity, and must follow each other a intervals. They should, moreover, as much develop their own power or have the energy them. The trolley is practically excluded, notwi its greater economy in working cost as compare accumulators, and though the cost of installation total expense rather higher than the accumul trolley has yet the advantage of being able to more expeditiously with the traffic. It should bered that the cost of working with accumu been greatly reduced during the past twelvemo is probable that still further economies will be the future. The cheapest system of traction is th of which the total cost, including the installati estimated at less than 45 centimes per car per The vehicle is very adaptable to the necessities of traffic in a big city, and the instantaneous ge steam enables the pressure to be raised in a fe when it is required to use any special effort. some question as to whether the generator rapidly deteriorate and thus involve a goo expense in repairs, but if the experience of pagnie des Tramways may be taken as conclusiv appear that the cost of repairs is not high. after two years of working the Compagnie de has ordered 60 new vehicles, so that it may b granted that the directors are satisfied with the of the mechanism. The next system in order cost is the Rowan steam car, which is slig expensive than the Serpollet, and then comes vehicles, of which the total expense is about centimes per car per kilometre. It is difficult t position the compressed-air cars should occup the working cost depends so much upon the installation. A large compressing plant serving is more economical than a small one for vehicles, and according to M. Mékarski a li pressed-air cars should not be more expensive t worked with the trolley. In Paris, the compres now running are more expensive than the other traction, and it remains to be seen whether th to Billancourt, which will have a very powerful c plant, will be worked as cheaply as the trolley.

THE BALANCING OF ENGINES.*

BY JAMES WHITCHER, A.I.E.E.

(Concluded from page 462.)

In a cursory fashion we have discoursed of tw of completely balancing a slotted cross-head e By a similar reciprocating counter momentum o with resultant in line with original momen duced by opposite cranks, likewise acting thro cross-heads in masses, which are either idle or u as pistons of coupled engines. (2) By two equ weights, one on shaft opposite crank, the other round it in contrary direction at equal angular v radii to coincide when an engine centres, and th cating momentum of each counterweight to be h parts to be balanced. Another method (3) is to weights, or another engine set, oscillated in an a angles to the first from the same crank. The masses to be equal and balanced by counter opposite the crank. The same applies to a syst engines or dead-weights, disposed at angles 0de and 120deg. around the single crankshaft, wh perfectly balanced by a counterweight opposite having double the reciprocating momentum of

* Paper read before the Manchester Association of E

tewise with other such combinations. It is a great at the space occupied is so prohibitory of this style ne, for it is superior to any from the turning moment lancing points of view, and it admits of the most application of the principle of rotary stress.

last method I shall enumerate, (4) is the oscillating ss (dead-weights or other pistons) oppositely to the by means of a beam vibrated by linkage to the ad.

paring these four methods as they influence the stresses, when the engine is a single-cylinder one, that Nos. 1, 2, and 3 relieve the main bearings of tia stress, No. 4 imposes upon them double the stress piston alone—*i.e.*, the maximum alternating inertia that would be due to a similar fixed unbalanced On the crank pin or pins of Nos. 1, 2, and 4 are ting stresses also equal to above-mentioned maximum. t of No. 3 is a regular rotary stress of same ude. Comparing them as they affect the important n of weight added to the mechanism, assuming for of comparison that the velocities and masses of the ng weights are in each case designed to be equal to f the reciprocating parts, we find that in Nos. 1, 2, the net additional weight is equal to that of the in No. 3 it is double this. Which is the price e to pay for the advantage of rotary stress on the in.

ill be found that these conditions obtain very gene- er the whole ground traversed by our subject. We ninate the inertia stresses on the main bearings, but neither eliminate nor reduce them on the crank-pin, hey remain as in an unbalanced engine, except that convert them from alternating into rotary stresses. ases the added weight can be made useful by adapt- the parts of added engines.

efore, we are now able strictly to class and define antages derivable from balancing under three heads ws: (1) the elimination of the racking stresses engine frame and attachments arising from the ng effort; (2) the elimination of inertia stress on the arings; (3) the possible conversion of alternating in stresses into rotary stresses. These, of course, eir subsidiary advantages.

ave a clear way now for discussing possible modes of g the connecting-rod engine—the practical engine *llence*. First let us acquire some notion of what the ng effect introduced by the variable angularity of the y amount to. It adds or subtracts inertia pressure portion of the primary or crank component, which maxima per revolution of the crank—being $\frac{-1}{\sqrt{r^2-1}}$ and 180deg. and $\frac{1}{r}$ at 90deg. and 270deg., r being rod to crank. If $r=4$ the maximum influence is rimary free force; if $r=3$ it is ·35 thereof. These nces are not negligible therefore. If we analyse ondary component motion into a series of simple ic motions, we find that the governing term for the tion is proportional to $\frac{1}{r}\cos 2\,p\,t$. So dominant is tor in the series that for most practical purposes we tified in ignoring the remainder.

e oscillate an equivalent dead-weight or piston in e engine axis, but on opposite side of shaft, from e crank, and by connecting rod of same length as l engine, the terms expressing the secondary com- s disappear from the combined equation of motion. is manifest also from a diagram of the mechanism indicates clearly that the C.G. of the two masses regularly with the crank, independently of the angle . Only primary components remain, so that the nt effect is identical with that of a slotted cross-head with reciprocating parts of double weight.

her, if the second piston or weight as above be ed by an opposite crank, connecting rods being of length, both primary and secondary components out, and perfect balance is obtained. But there are practical objections to this arrangement; chiefly gard to space and awkwardness of construction.

If the engines, and therefore the connecting rods, are on the same side of crankshaft, the secondary effects add whether cranks on the same or opposite radii. If coupled, side by side, engines work on cranks at 90deg., the secondary components nearly balance, the difference being at maximum $\left(\frac{1}{\sqrt{r^2-1}}-\frac{1}{r}\right)$ as follows from statements above; but there is considerable primary free force, being 1·41 of that of each engine singly, in such an arrangement. However, with three similar engines, coupled side by side, with cranks at 120deg., it happens that primary components balance perfectly, and the secondary components come very nearly indeed into the same condition. Messrs. Sankey and Robinson first published this fact in their paper read before the Society of Naval Architects, and they are responsible for the proposition that a six-crank engine is the simplest arrangement, capable of perfect balance in itself, without special balancing mechanism; the three additional engines being necessary to suppress the moments.

They are so far right in this contention that their arrangement approaches most closely indeed to perfect balance; but from the practical point of view Messrs. Schlick, Yarrow, and Tweedy have gone one better in that they with a four-crank engine secured a good approximation to balance, both as regards free force and moments. In their system, which is being successfully applied to marine engines, the cranks are arranged each about 90deg. apart, but so far removed from the exact angle as will secure the best balancing effect. In short, their arrangement is such as is indicated by complete mathematical study and analysis of the four-crank engine motions, having in view the nearest attainable degree of suppression of free force and moments, without the addition of extra weight and parts. I must refer you to their specifications as to the manner it is worked out.

It is this particular mode of attacking the balancing problem I would commend to your notice to-night. If I cannot persuade you to introduce special balancing mechanism, I hope that at least you will make it a cardinal point of your engine design that the parts shall be arranged to ensure the minimum possible want of balance. For instance, with two-crank engines you will find that nothing is to be gained by deviating from an exact angle of 180deg. between the cranks, when the free force will consist of the sum of the secondary components, and will alternate at double the periodicity of the engine, having maxima of $\frac{-2}{\sqrt{r^2-1}}$ at 0deg. and 180deg. and $\frac{2}{r}$ at 90deg. and 270deg. Therefore, the rod to crank ratio must be given its maximum practical value, and to subdue the moments the two lines of reciprocating parts must be brought as near together as possible. Even the convenience of having one common piston valve for the two cylinders placed between them should be sacrificed. However, do what you will, I fear you will find no very great scope for improvement in two-cylinder engines without radical change of design; but in the multi-cylinder class you have a field more fertile of self-balancing expedients; and in any case the investigation has indirect utility in the fresh light it throws on the working and stresses of the mechanism.

Let us now return to the balancing of the single-crank engine. In fact, in the baffling quest after means of suppressing moments, one is continually forced back upon this consideration. In the midst of the practical difficulties which stand in the way of their removal, the query persistently occurs to one whether it were not better to balance each engine of a set completely in itself, than to flounder in the impossible feat of making the parts on one crank balance those on another.

As regards possible methods of balancing a single-crank connecting-rod engine, we have mentioned that equivalent to the No. 1 of the slotted cross-head engine. No. 2 is out of the question in this case, unless we can adopt a most ingenious suggestion of Mr. J. H. McAlpine, and make the effective radius of the counterweights vary by means of eccentrics or cams in a way to compensate for the connecting-rod effect. I am afraid, though, its location is outside the confines of practice. No. 3 would need a similar com

pensatory arrangement of the counterweight. No. 4 is quite feasible in the connecting-rod engine if the linkage is arranged so that the angularity errors of the links correct themselves, as is possible.

Another method has been invented by Mr. McAlpine, intended for use in steamships, which consists of a weight oscillated by a cam on the shaft of suitable shape—a sort of mutilated eccentric working in a slot. You will agree with me that it would be quite inapplicable to high-speed engines.

I have myself invented two methods, which it is rather premature to mention just yet, but I will describe them but briefly. They have for their object the compensation of the secondary component, while introducing a transverse component, so that counterweighting opposite the crank will afford a perfect balance. Incidental is the rotary stressing of the crank-pin bearing.

The one consists of an extension of the connecting rod beyond the crank by amount equal to its length between cross-head and crank, and attaching at the end a weight equal to that of piston and cross-head. The secondary motions of this extra weight are of opposite sign to those of the piston, and they cancel therefore. The effect is actually as though the total mass to be balanced were gathered at the crank-pin. And it is easy to see why this is so, for the piston having uni-direction motion its mass acts as though gathered at the cross-head, in which case the crank-pin would be the C.G. of the total mass. The extension need not necessarily be so long as stated, but the weight must be increased to compensate for decrease of leverage. Since the weight has a transverse motion double that of the crank, a counterweight having momentum equal to the sum of those of piston and extra weight will balance the mechanism except for the moment caused by the transverse motions of weight and counterweight not being in line, and a certain subsidiary moment referred to below.

In locomotives the latter defect is easily rectified by distributing the counterweight over two coupled wheels in suitable proportions, or by utilising the coupling rod to complete the balance, so that the resultant transverse momenta are brought into line. Further, a parallel linkage might be used to bring the weight back into a transverse line with the shaft, which addition would spoil the pristine simplicity of the arrangement, though it also corrects a yet more serious defect: the tendency of the swinging weight to produce alternating stresses on the slide. Yet another defect is corrected thereby, being that from the gyration of the connecting-rod mass there arises a moment of forces which would become a serious item if heavy weights were rigidly attached to rod and became concerned therein. Connecting the weight to the rod by a central pivot on which it is free to revolve would also remove that effect.

The second method is the outcome of the first, and though it lacks some of the essential simplicity of that one it has not its defects. It consists of a weight equal to that of the reciprocating parts arranged to swing about a fixed centre, at the end of a link, equal in length to the connecting rod, over an arc similar to that described by the rod. The weight to swing across the shaft centre, and the pivot to be in the engine axis towards the cylinder. If this weight swings in time with the rod its motion in the direction of engine axis exactly balances the secondary component of the piston motion, and its transverse motion is balanceable by that of a revolving counterweight opposite the crank with momentum equivalent to that of piston parts. Perfect balance is therefore obtained.

In practice, at least two swinging links would be required with half the weight on each, as it would be difficult to get the C.G. of one weight into the necessary position, and to give it the motion. The use of two, however, gives good facility for arranging them where their presence would not be inconvenient; and each may be oscillated by a link to the connecting rod in such a way that no error is introduced. The weight may be greater than that of parts to be balanced; and the link, and consequently the arc of travel shorter; and *vice versâ*: the essential points being that the momenta shall be equivalent and the oscillations similar.

You will observe that this method is in some ways analogous to the number (3) described with reference to
the slotted cross-head engine. It is, in fact, the sam
to suit the motion, by curving the guides on w
transverse sliding weight is oscillated, to a c
having the length of connecting rod as radius. I
be convenient in some cases to use such curved slid
in the crank chamber, or bed-plate, in place of su
links. The counterweighting is best accomplished b
of crank discs, and it would be preferable to bu
crankshafts. The net extra weight added by t
method is three times that of the reciprocating p
the second it is twice only.

To most of you, I expect, it seems a strange
thing to talk of adding in this way to the mecha
an apparently superfluous purpose. Yet you ha
ago become familiarised to the use of massive f
for a somewhat analogous purpose; and later on y
learnt to accept the large and undreamt-of inc
the proportion of bearing surfaces which high sp
rendered imperative. Perhaps in time, but I w
prophesy, you will also come to regard balancing me
as an ordinary and proper featnre of an engine.

You whose faith and interests are absorbed in
space, trip gear, slow speeds, and rope drives wi
have much inclination or enthusiasm to balance; b
is one important branch of the engineering indu
which it is unnatural to find apathy on this questio
apathy, or at least half-heartedness, there is. Loc
engineers of all others ought to be foremost in a
the problem, yet all their energies in this direct
spent upon empirical rules as to the amount of
weighting desirable and the way to share it betw
wheels. I do not think there can be any questio
ever but that balancing locomotives would prolon
working life as well as that of the rails and rollin
A smoother existence at least would result for th
and fireman, and the travelling public in general. I
from the severe vibratory effects caused by the vert
forces of counter-weighted wheels, rail joints would
chance of remaining tight and true, and the "railw
would have to be rechristened a lullaby.

There is really no great obstacle in the way of a
balancing of locomotives, even though standard pat
held as entirely sacred as they are deemed by the
build them. For instance, there is scarcely a valid obje
the application of bobweights, as suggested by Mr.
oscillated by opposite cranks and reverse connectin
And either of my methods described above may b
without any radical change of design. With grea
tude in the general plan of a locomotive, almost any
methods I have enumerated could be applied with
Alteration of the disposition of crank and cylinder
the way for many solutions.

A simple one is possible when the cranks are oppo
operating a bobweight in line with each cylinder fr
opposite cross-head, provision being made for keeping
off the slides, and compensating the secondary com
by the mode of linkage. The same is applicable to sta
and marine engines, but it must not be forgotten th
balancing mechanism is operated from the cross-he
inertia stresses are not relieved from main bearings.

Lastly, I would briefly draw your attention to t
that hydraulic balancing is possible, a piston being em
to vibrate columns or masses of fluids, such as oil, w
mercury in the required manner. Secondary piston
be adapted to modify the movement of the colu
balance the secondary components if the pump could
operated by a reverse connecting rod. Likewise hy
linkages or connections could be employed to opera
balancing weights.

The final section of this paper I will devote to con
tion of the want of balance caused by uneven rota
the shaft, which is much as to say by variable t
moment. When a shaft is doing constant work a
turning moment applied to it varies, energy is being
nately supplied to and taken from the flywheel.
causes a tendency to a periodical reversal of tor
between the crank and flywheel, and this puts vib
stresses on the engine frame acting to swing it abo
shaft centre. That execrable piece of mechanism,
our present point of view, and from that view alo

cle gas-engine, is a striking instance of this effect. than quarter of the cycle we have a very powerful applied to the flywheel by the crank; during the ng three-quarters there is a reverse torque of corregly smaller dimensions.

size of flywheel does not affect these stresses; as, h with heavier flywheel the variation of speed, and

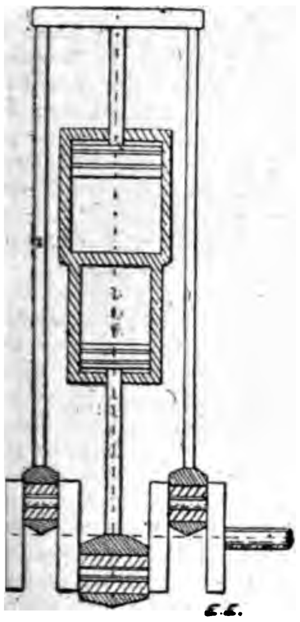


Fig. 1.

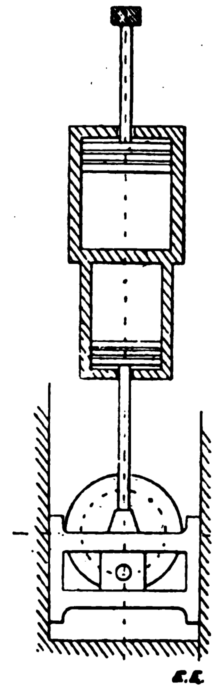
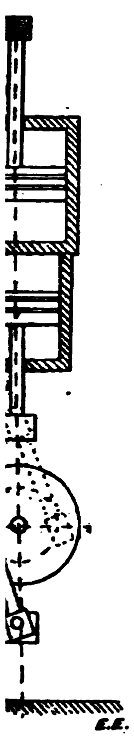


Fig. 2.

re the acceleration, is smaller, the mass is propory larger. There is evidently only one solution to ficulty, which is to steady the turning moment. is is done, it is almost useless to think of applying the refinements of balancing to the modern gas or ne.



. 3.

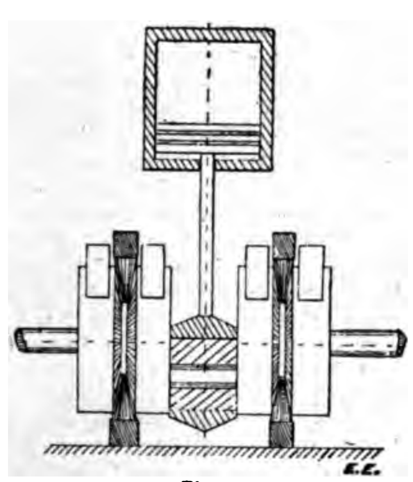


Fig. 4.

I must bring these remarks to a close. I had t one time to have done better, to have assembled s with more care, and to have put them more ely before you by means of wall diagrams and also to give in an appendix the mathematical of some of the points touched on. But the demands of other affairs spoilt my good resolutions. I trust, however, that the paper will be provocative of a good discussion, and if it arouse you to that I shall not have written in vain.

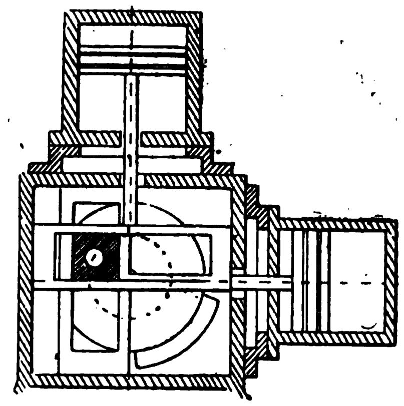


Fig. 5.

The diagrams herewith are not put forth as illustrations of possible types of balanced engines; they are simply

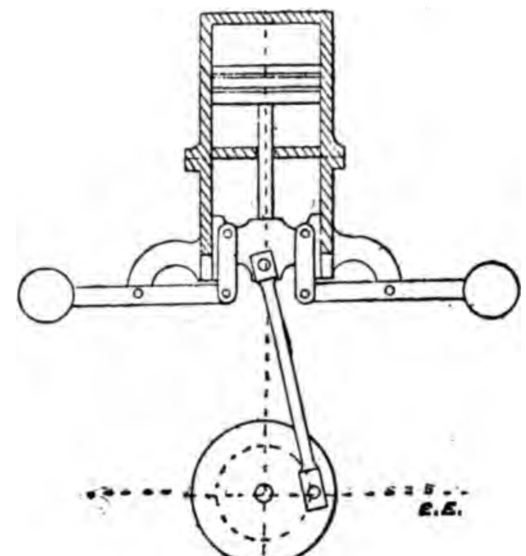


Fig. 6.

crude and exaggerated presentments of the principles of the methods described. Figs. 1 and 2 show a slotted

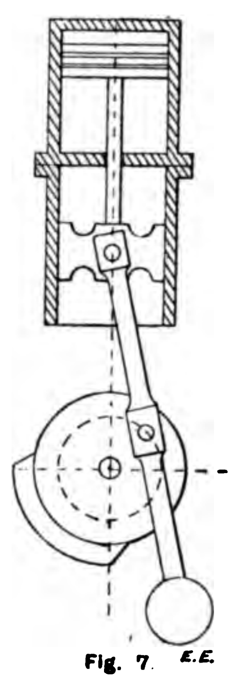


Fig. 7

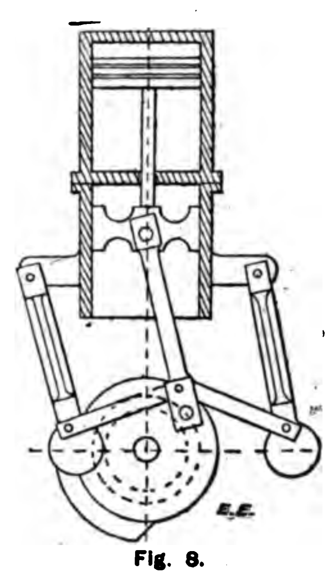


Fig. 8.

cross-head engine with two pistons in line, operated by opposite cranks. Fig. 3 shows a connecting-rod engine of same construction, with reverse connecting

rod in order to balance secondary components. Fig. 4 shows slotted cross-head engine with oppositely revolving counterweight discs, the loose ones being driven from the others by bevel gearing and fixed pinions. Fig. 5 is a slotted cross-head engine with cylinders at right angles, and balanced by counterweight discs. Fig. 6 is a connecting-rod engine, balanced by weights on beams linked to cross-head. Fig. 7 is the author's method of balancing the secondary components of piston motion by extending the connecting rod to take a suitable weight at end, and balancing the whole counterweight disc. Unless the transverse motions of counterweight and connecting-rod weight are brought into line the balance is not perfect, as there would be a moment of forces due to these motions. Fig. 8 is the author's method of complete balance of single engine by means of swinging weights and counterweight discs.

MAGNET AND ARMATURE WINDINGS.

A contributor of the *Western Electrician*, from which paper we take the following, notes a difficulty which always presents itself when winding magnet coils. This difficulty is shown at A (Fig. 1). The wire is wound on

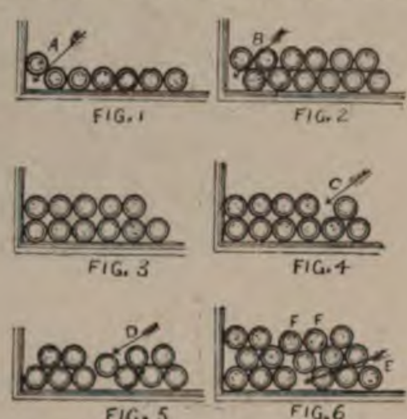


FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5 FIG. 6

E.E. FIG. 7 FIG. 8

the plan of a screw thread, necessarily, and the space for the last round is narrowed down too much for the coil to fit. There are many men who make a business of winding magnet coils who overcome this trouble by forcing the last turn down, crowding the other coils, and oftentimes injuring the yielding insulation to such a degree that its efficiency is affected. This is carried to such an extent at times that the insulation is badly cut between the wedge-like edges. On the other hand, if the last coil is not pressed down into place and the second layer is wound, as in Fig. 2, a space will exist at B. These places form the base of that evil known as spreading. As is known, the least spread of the wires in the bottom layer produces serious undulations in the successive layers, for the depression in the layers increase towards the surface. If the coils are wound as in Fig. 3, one layer topping the other, winding right-hand for first layer and left-hand for second, it will be found that the last layer is gaining on the first, with the result that one is obliged to allow the wire to drop over between the wires ahead, thus leaving a space at C (Fig 4).

The consequence of continuing to wind after the misplacement of one or more coils is illustrated in Figs. 5 and 6. If a second-layer wire takes the position shown at D (Fig. 5), and winding is continued over this, we get something after the plan in Fig. 6, in which E shows the space left in the first layer, and F F the two wires of the third *layer sunk below* the proper level, owing to the dropping of the wire of the second layer into the space ways are employed to overcome these troubles result of long practice with winding magnet coi qualifies one to calculate closely on the required ness of the layers to keep each even. Th method calls for figure work. The size of wi used is calculated, the insulation allowed for, number of turns per layer ascertained. Then t number of turns is put into each layer. The fi is carefully placed, and is used for a guide succeeding layers. Take a coil 6in. long, for and wind it with No. 20 wire, the gauge of increased about ·004in. by the insulation. A littl tion would show that the bare wire would fill t with, say, 200 turns. The insulated wire would fi about 146 turns. With the coarser wires, No. instance, 60 turns of bare wire might be suffici the space, and about 44 turns of insulated.

Fig. 7 shows the method of winding a "sho armature. The core insulation is marked H and t cloth G. The latter is wound as the work is pr and prevents the outside wires from getting out of during the building of the bobbin. Three systems ing are employed. These are selected accordin work required. The first system is made with of the bobbin, and possesses the most torque. Th is made with nine turns, and has high speed. The made with 12 turns, and is the medium range. The

FIG 9 FIG 10

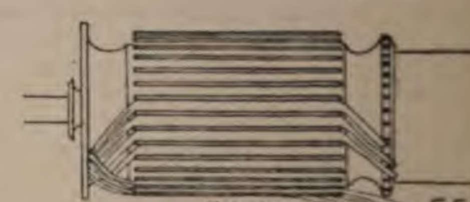


FIG 11 E.E.

slots are insulated with fullerboard and mica. The of securing the wire is shown in Fig. 8, in which I a section of a curved piece of wood, which is between the lips of the projection.

In Fig. 9 is shown a good way to wind a drum ar This end view indicates how the connectors may be from slot to slot, divided into two layers, one-hal laid next the core, thus forming the lower layer, other half forming the top layer, as represented by in Fig. 10. The advantage of this method of wi that the wires do not cross each other, and a thin insulation can be inserted to form a separation. To a coil from a drum wound after this fashion, first the upper part from the slot, then the lower pa below, then remove the conductor above it. Then every other upper conductor in the span between slots and then the coil can be removed, and if d replaced with a new one.

Fig. 11 shows the method of a packed "straig winding, which is constructed with the coil protrudi coils form a cylindrical ring at the end of the ar where they are protected by tape wound on the r metal support is provided for the ring, and this ri shaped as to form a part of the disc end which h laminæ and armature in place.

Personal.—Mr. George White was yesterday elected of the Bristol Stock Exchange. Mr. White's connect electric traction is well known to our readers.

TELEGRAPHING ACROSS SPACE.*

BY SILVANUS P. THOMPSON.

II.—Induction Methods.

(*Continued from page 468.*)

ıst not close this section without reverting to a most
point of advance made about 1888 or 1889 by Dr.
dge. When experimenting upon the oscillatory dis-
e conceived the happy idea of turning two circuits
nance, or, as he termed it, "syntony" with one
n such a way that when an oscillating electric spark
in one of the circuits, the inductive effect on the
mediately set up in it electric oscillations which mani-
mselves by an overflow spark. I call this experiment
because it affords a hint of another possibility—
that of signalling inductively from one area to
ınd using around those areas, not merely circuits of
t syntonic circuits, which, therefore, are necessarily
re sensitive in their response one to the other. Some
high-frequency experiments also have an obvious
ı this point.

III.—Electric Wave Methods.

lerk Maxwell had predicted the existence of electro-
waves, and had shown that their speed of propagation
l with that of light, it required, in reality, very little
strate by experiment the existence of such waves.
rery little was not actually achieved until the year
n the lamented Prof. Heinrich Hertz showed simple
f producing, detecting, and measuring these waves.
een known for many years, from the predictions of
d Von Helmholtz, and confirmed by the experiments
rssen, that in many cases an electric discharge is
illatory character. In the years 1887-8, Lodge,
, and others were investigating the nature of
illations, and the manner in which they are
y conducting wires, when Hertz conceived the
ıvestigating the disturbances which such oscillatory
set up in the surrounding space. He showed that,
nple apparatus, which he called an "oscillator," con-
two metal plates or conductors, connected by a con-
errupted at one intermediate point by a "spark-gap,"
:or on the appearance of each spark emitted a train
: waves into the surrounding space. He further
ıt if a mere circuit or ring of wire of suitable size,
uity of which is interrupted at one point by a minute
ced in the path of these travelling waves in a suitable
he waves as they reach it set up electric surgings in
and if sufficiently energetic cause it to show a small
he gap. This simple detecting device he termed a
r." Armed with these apparently primitive pieces
ıus, he then devoted himself to the task of exploring
gation of the waves. He found that, like waves of
y could be reflected by metallic surfaces, could be
by prisms, concentrated by lenses, and even could be
He measured their wave-length and velocity of pro-
He found that they could pass readily through walls
stone, or brick, which are opaque to ordinary light-
Metals and other conductors of electricity, on the
absorbed them, and were consequently opaque.
e researches of Hertz we meet, for the first time,†
recognition of a true travelling wave. With this
discovery there was opened out an entirely new field
ilities. Hitherto there had been inductive actions
hich might reach out from wire to wire, only to fall
n when their excitant cause died away. But now the
rave, once started on its path, did not collapse back
wire when the spark ceased; on the contrary, it went
g on. And just as the javelin, which can travel on
impulse has ceased, can act at greater range than the
hose thrust is limited by the length of arm and blade,
rue electric wave, by the very fact that it is a true
g wave, can carry signals to greater distances than the
luctive influence that simply extends outwards from a
rom a coil.
ork which Hertz had begun, was, after his death,
n by a whole army of investigators. Of these, and of
ievements, the best account that has yet appeared is
dge's little book on "The Work of Hertz and his
rs." To that book enquirers must be recommended
ils. Suffice it here to say much has been done in
g both the oscillator and the detector. Notable amongst these matters have been the forms of oscillator designed by Lodge and by Righi; the latter having the spark gap immersed in oil or vaseline between two metal balls. Many forms of detector have been proposed. Very early Lodge produced one under the name of "coherer," consisting of a metallic point very lightly pressed against a metal plate, and connected in circuit with a galvanometer and a local cell. The light contact constitutes an imperfect joint, which is practically non-conductive until caused to cohere and conduct by the impact of an electric wave; or, perhaps more accurately, by the stimulus of the minute surging electric current which results from the impact of an electric wave. Subsequently, taking a hint from M. Branly, Lodge substituted as a detector a new kind of coherer, consisting of a small glass tube partly filled with loose metallic filings—iron or nickel by preference—joined in the circuit. Such a coherer acts as a species of relay, by means of which an electric wave, incapable in itself of affecting a galvanometer or other instrument, is enabled to do so indirectly by setting into operation a local current. After the coherer has thus operated, it usually remains in the conductive state until subjected to some mechanical jar or shock. Lodge proposed to apply for this purpose a mechanical tapper worked either by clockwork or by a trembling electric mechanism. On several occasions, and notably at Oxford in 1894, he showed how such coherers could be used in transmitting telegraphic signals to a distance. He showed that they would work through solid walls. Lodge's greatest distance at that time had not exceeded some 100 or 150 yards. Communication was thus made between the University Museum and the adjacent building of the Clarendon Laboratory. For more than 18 months the Rev. F. Jervis Smith, of Oxford, using a carbon powder coherer, has maintained communication between his house and the Millard Engineering Laboratory, over a mile away.

Even before this Mr. Nikola Tesla, in a lecture delivered at St. Louis in 1893, had made a further suggestion of great importance. He proposed to transmit electric energy by oscillations to any distance, without communicating wires, by erecting at each end of the stretch a vertical conductor joined at its lower part to the earth, and at its upper to a conducting body of large surface. This constitutes a vertical base line from which to disseminate the oscillating disturbances.

About two years ago a young Italian, Mr. Marconi, came to this country, and succeeded in inducing the British Telegraph Department to give him facilities for experimenting upon wave-method of transmission. First upon Salisbury Plain, and then across the Bristol Channel, he succeeded in transmitting Morse signals to greater distances than anyone had previously attained. He sent signals from Lavernock Point to Bream Down—about nine miles as the crow flies over the open channel. To accomplish this he used as base lines two vertical conductors earthed at their lower ends, and carrying at the top extended surfaces. He used a Righi transmitter. As receiver he employed the special form of Lodge-Branly coherer presently to be described. This was connected in the manner Lodge had recommended in a local circuit, and was tapped by a mechanical tapper operated by a vibrating electric mechanism. The local circuit operated a Post Office relay connected to a Morse instrument signalling the dots and dashes. The coherer was itself included in the vertical base line. So far all is old. The special coherer used in these experiments by Marconi has very fine metallic powder, chiefly of nickel and silver, in a small glass tube exhausted of air. He also applied shunting resistances to the relay contacts, and interposed a fine iron wire closely coiled, as an impedance in the local circuit on each side of the coherer.

In 1897, some further experiments were carried out by Prof. Slaby, of Charlottenburg, on an even larger scale. He abandoned everyone of the novelties introduced by Marconi, and fell back upon the methods previously known. He used a simple Lodge-Branly coherer, employed elevated conductors as base lines, discarded the useless little iron wire impedance coils in the local circuit, and substituted for the Post Office polarised relay one made out of a Weston galvanometer. His success shows that all that is essential can be thus attained. He chose as the scene of his operations the Havel, and set up elevated conductors upon the castle of the Pfaueninsel, and on the campanile of the church at Sacrow. Thus equipped, he transmitted signals, at first about three-quarters of a mile, then three miles across the water. He found trees and masts to interfere with the signals to some degree. He then proceeded, with the aid of the military authorities, to experiment over an open stretch of country—from Rangsdorf to Schöneberg. The elevated conductors were wires raised by means of hydrogen balloons to heights of nearly 1,000ft. Signals were obtained at a distance of 21 km., or over 13 miles. Neither in Marconi's nor in Slaby's successful operations were syntonic devices employed. The following table summarises the results of Marconi's and Slaby's work.

Commenting on these results, Slaby notes how over open sea a much greater distance appears to be attained from a base line of given length. Assuming Marconi's best proportion, he calcu-

r read before the Society of Arts, March 30, 1898.

y years before, Prof. Joseph Henry had transmitted
lectric sparks from one circuit to another in different
a building. Doubtless, these were oscillatory; but it is
e, at this time, to determine whether the arrangements
h as to produce true travelling waves, or whether the
as (like Lodge's later experiment of the two syntonic
merely one of electromagnetic induction.

lates the vertical length of base line needed for communicating across the English channel at Dover to be 265ft., while from London to Paris, over land and sea, would require 4,700ft. He even estimates base lines of 6,600ft. as sufficient, were it not for the curvature of the globe, to serve for communication across the Atlantic.

	Distance. Miles.	Base line. Feet.	Ratio.
Marconi—			
Flat Holm (sea)	3¼	150	100
Bream Down (sea)	9	200(?)	250(?)
Spezia (land and sea)	4¼	100	200
Spezia (open sea)	11	100	500
Slaby—			
Sacrow (water and trees)	¾	80	70
Pfaueninsel (water and buildings)	3	200	50
Rangsdorf (land)	13½	950	70

The most recent improvements made towards perfecting this method of transmission are those of Dr. Oliver Lodge, whose labours, continnued during the past few months, are still in progress. He has first reorganised the transmitter apparatus so as to make it a more persistent radiator. It emits longer trains of waves. This has been accomplished by introducing in the path of the oscillations, between the spark-gap and the wings, a few turns of stout wire to act as an impedance coil. By this means the oscillations can be accurately tuned. The receiving apparatus is also tuned; in fact, each apparatus is made to operate both as emitter and as receiver, in turn, as required. Lodge has also modified the arrangements of the coherer circuits, to render them more certain of operation, no local current being allowed to pass through the coherer until after it had been affected by the waves. He has, in fact, thoroughly redesigned the sending and receiving instruments upon a rational basis, so that they shall be both less sensitive to stray impulses, and more sensitive to properly attuned waves. The results obtained with these have not yet been made public; but, employing a siphon recorder as the receiving instrument, remarkable precision of signalling has been attained. Further developments in this direction will doubtless be awaited with much interest. Meantime, in other countries—the United States, Russia, and France—other experimenters are at work. Any account given at the present time will, therefore, be necessarily incomplete.

In passing finally from a review of that which has already been attained to that which may reasonably be contemplated as within reach of attainment in the near future, I have no wish to assume the *rôle* of the prophet. Still less would I desire to emulate the example of the imaginative *litterateur* who, whether his name be Jules Verne or H. G. Wells, stimulates the public curiosity by amazing speculations, and in doing so renders the dis-service that the public so stimulated is made less capable than before of distinguishing between that which is and that which is not within the bounds of reasonable possibility.

It has been shown that there are three general methods of transmitting electric signals across space. All of them require base lines or base areas. The first—conduction—requires moist earth or water as a medium, and is for distances under three miles the most effective of the three. The second—induction—is not dependent upon earth or water, but will equally well cross air or dry rock. The third—electric wave propagation—requires no medium beyond that of the ether of space, and is, indeed, interfered with by interposed things such as masts or trees. Given proper base lines or base areas, given adequate methods of throwing electric energy into the transmitting system, and sufficiently sensitive instruments to pick up and translate the signals, it is possible, in my opinion, so to develop each of the three methods, that by any one of them it will be possible to establish electric communication between England and America across the intervening space. It is certainly possible, either by conduction or by induction; whether by waves I am somewhat less certain. Conduction might very seriously interfere with other electric agencies, since the waste currents in the neighbourhood of the primary base line would be very great. It is certainly possible either by conduction or induction to establish direct communication across space with either the Cape, or India, or Australia (under the same assumptions as before), and at a far less cost than that of a connecting submarine cable. I doubt very greatly whether the wave method can be made applicable at all to these so-distant parts of the globe. But whether by conduction, by induction, or by waves, I am firmly convinced that the immediate road to commercial success lies in two things. Firstly, we must frankly recognise that there is no such thing as telegraphing without wires—that the base line, or the base area surrounded by wires, is a fundamental necessity. Secondly, we must look to establishing real syntony between the sending and the receiving parts of the apparatus to render it, as far as possible, sensitive and independent, without which conditions such systems will become too costly and too unmanageable for commercial ends.

[The paper was illustrated by numerous slides illustrating the methods and instruments used by Hertz, Lodge, Righi, Marconi, and Slaby in their investigations, and the newest syntonic apparatus of Lodge. Experiments were also show[n]
the transmission of electric waves and their re[...]
detection. A small Lodge apparatus, construct[...]
Miller, was also exhibited in operation.]

DISCUSSION.

The **Chairman** said no doubt all present had com[...]
expectations, anticipating much pleasure in hearing [...]
developments of one of the most interesting and valu[...]
tions of modern science to useful purposes—electric[...]
But whatever their expectations they must have bee[n]
realised by the exceedingly lucid exposition by Prof. Th[...]
most intricate and difficult subject; so lucid, in fact, [...]
that probably few realised how intricate it was. He fe[...]
Thompson that perhaps in the immediate future the a[...]
wireless telegraphy to practical purposes was not q[...]
as some might have anticipated and hoped; but at th[...]
there were purposes to which they might reasonably h[...]
be applied, such, for example, as communication betw[...]
and lightships, and possibly between ship and ship. [...]
factory to learn that means were being sought for, a[...]
to some extent found, of differentiating one telegraphi[...]
through space from another by tuning. That was to [...]
ticularly interesting point, and the explanations whi[...]
given of the methods adopted by Prof. Oliver Lodge f[...]
the transmission of a particular message, and the rec[...]
message by the particular person intended to rec[...]
specially valuable. Obviously it would be very [...]
if messages sent through space were indifferentl[y]
by everyone who chose to play the part of an e[...]
That condition of things would somewhat resemble th[...]
in one of Hans Christian Andersen's stories, where [...]
coming from a pipkin revealed to everyone who ch[...]
them what each particular person was having for [...]
was not very desirable that that kind of curiosit[y]
gratified in connection with telegraphy, and it seemed [...]
the uses of telegraphy through space would be very [...]
if this sort of thing could not be prevented. Prof. [...]
of experiment, however, seemed to tend in that direc[...]
show the means of confining a message to the person [...]
receive it. He was sure Prof. Thompson would be pleas[...]
any questions on any point that had not been made cl[...]
were any such, any questions which could arise [...]
already answered in anticipation. If no one had any [...]
to put he would conclude by proposing a hearty vote [...]
Prof. Thompson for his paper.

The vote of thanks was carried unanimously.

ELECTRIC LIGHTING AND TRACTIO[N ...] BRADFORD.

The following is the text of a report of [...]
deputation from the Bradford Corporation whic[h]
visited the Continent to inspect electric tractio[n]
with reference to the supply of electricity f[...]
lighting and electric traction purposes from the [...]
This deputation consisted of the Mayor, Counc[...]
Dixon, Councillor T. Shaw, and Mr. A. H. Gib[...]
electrical engineer of Bradford. The report, afte[r]
to the route chosen, goes on to describe the vario[...]
tions visited, arranged in the following order:

Brussels.—The deputation were met by M. B[...]
Eenberg, of the Union Electricitäts-Gesellsc[haft ...]
inspected the electricity generating station of t[he]
Tramway Company. The deputation were also m[...]
engineer to the company, Mr. d'Hoop. This con[...]
an exceedingly well-equipped station, the plant [...]
of 250-kw. and 400-kw. direct-coupled slow-spe[ed ...]
and dynamos, and water-tube boilers. The [...]
was of the usual pattern, and contained the u[...]
ments, including Weston voltmeters, automatic sw[...]
recorders. The general manager placed at the dis[...]
deputation several maps and plans of the system[...]
showed models and actual working parts of the ca[...]
trical contacts. The system includes 12 miles o[...]
trolley wires and seven miles of underground con[...]
trolley consists of side poles, centre poles, and cross [...]
as can be seen at Leeds, Bristol, South Staffordshire[...]
conduit is composed of a cast-iron channel, in wh[...]
ported both the positive and negative conductors, [...]
attached to each side of the channel respectively, an[d]
composed of solid rails. Their position is such th[...]
ference by unauthorised persons is possible from th[...]
The company speak highly of the conduit system, [...]
having had to be done for 17 months, but give the p[...]
the trolley system for reasons of economy in initial [...]
and cheaper costs in maintenance. The cars are so [...]
to be readily convertible from the one system to [...]
The King of the Belgians will not permit pillars[...]

it thoroughfares. The working costs come out at mes per car kilometre, which is equal to about 2d. mile. The distributing system is divided into three which are fed electrically by eight feeding mains. On wing day the deputation inspected the trams running streets, and saw both systems at work. The speed appeared to be about 10 miles an hour on a gradient 20. There are over 40 motorcars, each one of which rail car. Each car and trailer carrying 64 passengers satisfactorily proved to be worked at the same cost run as the four-horse car carrying 34 passengers, ey superseded, and the receipts have been practically The service is very frequent: every 3½ minutes the busy parts of the day. Each car runs about s per day. The minimum fares are 1½d. first-d 1d. second-class, a four-mile run being 3d. respectively. The cost of equipping the overhead tated by Mr. Jansen, the manager, to be £1,400 per the line proper, overhead equipment; £1,150 per mile rical apparatus in station; £2,860 per mile for engines, tal, £5,410. The cost of the conduit service comes out 0 per mile, including everything but buildings. This re is accounted for by the fact that both conductors are onduit.

urg.—The deputation visited the electric generating hich are a considerable distance from the town. The constructed on the Thomson-Houston system, with s and centre posts, the latter being ornamental, and cases surmounted by arc lamps for street-lighting. ettes are also used in certain places. The cars only ake up passengers at fixed stopping places, but as there ral 3½ minutes' service, the public are in no way incon-d thereby. Hamburg has the largest electric tramway n Europe; 380 motorcars run daily, and in one street ular more that 2,000 cars pass along between 7 a.m. and ght. We are informed that the introduction of electric has improved the earning capacity and diminished the expenses of the system, and that on the lines where elec-s superseded horses the number of passengers carried has l 32 per cent. and the receipts increased 35 per cent. only one short line at present remaining on which ction is used, and that only for supplementary purposes, ne horse car is running, and electric cars run over the . The generating station is splendidly equipped and The machines consist of direct-coupled dynamos and the engines being triple expansion and of the inverted ype, each capable of developing 1,200 h.p., with a fixed at each end of the crankshaft, and there is in e one man to each engine. The switchboard is of the e, but also consists of an arrangement by which certain achines can be used for lighting at will in case of The engines and dynamos, although direct coupled, speed, and take up considerably more space than do our Siemens sets. Their arrangements also for supplying d light from the station are not so complete as our heir lighting pressure is 250 volts, whereas ours is at , which is the same voltage as that required for electric The result is that we are able to immediately switch machine from the lighting to the power circuit, but at they are obliged to use an intermediate machine for ing the voltage from 250 volts to 500 volts or 600 volts, for transmitting to the distance required.

.—The tramway system consists of overhead, under-and accumulator traction, the underground being used which runs out to one of the suburbs, and the accumu-ing used in connection with the overhead system where cross the Unter den Linden and other places where the crosses the centre of the town, and in such main streets illars or posts are prohibited. The motors, switching, lating apparatus are of the Union Electric Company's ture, and the cells are from the Gulcher Accumulator There are 28 seats in the interior of the car, which is l roomy, well ventilated, and lit by five incandescent These are the best and most substantial cars the deputa-. The cells and heating apparatus are under the seats. ection with the former is an automatic switch, which on as the cells have been sufficiently charged from the ire. The battery is capable of moving a car of 12½ tons nd of propelling a car from 9½ to 12½ miles with one It weighs with its accessories two tons. There is, a great objection to accumulators, as the weight has ried on all the gradients, and on the whole of the route ch the car runs, and the efficiency of the accumulators w, being only about 65 per cent. of the energy which . Nearly all the cars in Berlin, as also in the other ited, contain no seating accommodation whatever on the cars being constructed solely for inside con-, but trailers are put on almost anywhere for smokers s. The system of generation is practically the same t Hamburg, the machines being direct coupled and the rom 500 to 600.

a.—At Dresden, both the stations of the electric light ing and electric traction companies respectively were inspected, each station being very well designed and very handsomely equipped. The system of electric lighting in Dresden is that of the alternating system, and the engines and dynamos are of 800 h.p. and 1,000 h.p. respectively, direct driven. The generating station for traction purposes consists of direct-coupled dynamos to horizontal engines, and the usual form of switchboard from which the feeders go out to the various parts of the network. The dynamos in this station are all shunt wound instead of being compound wound, as in most cases, and consequently the manipulation of the switchboard requires greater attention than in most electric traction stations. The officials in charge were extremely courteous, and gave the deputation every information. The electric traction system in Dresden is that of the overhead, and the trolley poles, brackets, and cars are similar to those in use at Hamburg and Berlin, with the exception of the method of conducting the current from the trolley wire. In the place of the movable side arm which adjusts itself to any irregularity in the direction of the overhead wire, a wide bow-shaped conductor, having the appearance of a bent cane, is adopted, which appears to be about 3ft. across the top. The method of making contact, the appearance and adaptability of this collector, does not appear to be so satisfactory as the side-arm collectors.

Leipzig.—Upon arrival, the deputation proceeded to the works of Messrs. Koerting and Mathiesen, arc lamp makers, which are about three miles out of the town. They were shown everything relating to the process of manufacture of arc lamps by this firm, and the different types of arc lamps that have been made were shown in actual operation under various circumstances. The object of the visit was to see what arrangements, if any, were likely to be made with regard to the better lighting of the streets in the Frizinghall and Heaton districts by means of small arc lamps placed inside the present gas lamps, instead of the present incandescent lamps. At present it is not possible to say what may be done, but Messrs. Koerting and Mathiesen are undertaking one or two special experiments with this object in conjunction with instructions from our electrical engineer, which will occupy another couple of months. The great drawback at present to the use of small arc lamps for this purpose is the fact that they have to be recarboned every eight or ten hours, and consequently the carbons would not last the length of an ordinary winter's night.

SUMMARY.

After taking into consideration all that the deputation have seen, they were satisfied that the arrangements which have already been made at the electricity works, Valley-road, for running the Bolton-road and Great Horton tramways, are as complete as anything which the deputation have seen on the Continent. The generating stations, however, are very much larger and finer than anything to be seen in this country; and there can be no question but that, instead of making undue haste in the matter of electric traction or lighting, we are in each of these instances considerably behind the development which has already taken place in each of the towns which we visited. As will be seen from the report, it appears to be the practice to utilise either the accumulator system or the conduit system for crossing the more important thoroughfares in the centre of the town with electric trams, thus doing away not only with the unsightliness but possible danger of the overhead wires; and although the initial cost of the conduit system is considerably higher than that of the overhead, yet in such places as we have seen each company was unanimous in saying that it is far preferable in the centre of the cities.

INSTITUTION OF ELECTRICAL ENGINEERS, April 21

At last night's meeting of the Institution the following were the candidates balloted for:

Member.—Alfred Blackman, Aberdeen Corporation Electricity Works, N.B.

Associates.—Samuel Harry Hill Barratt, A.M.I.C.E., 19, Old Queen-street, Westminster, S.W.; Henry J. S. Brownrigg, 287, Finchley-road, N.W.; Thomas Harding Churton, 36, Great Wilson-street, Leeds; William John Crampton, Great Yarmouth; Llewelyn Lloyd Foster, Coventry Corporation Electricity Works, Coventry; Hugh Reginald Hearson, Shanghai, China; Robert William Jackson, 108, South-street, Eastbourne; Frederick William Lacey, M.I.C.E., Municipal Buildings, Bournemouth; William Lund, 43, Parkhurst-road, Holloway; William McGeoch, jun., Warwick Works, 46, Coventry-road, Birmingham; Arthur Ernest Malpas, 4, St. Mary's-street, Manchester; Thomas Hugh Parker, the Manor House, Tettenhall, Wolverhampton; James W. Polley, 54, Hazlewood-road, Walthamstow; Cyril Probyn Napier Raikes, Stamford Lodge, Watford, Herts; Bertram Gurney Stewart, 19-21, Heddon-street, W.; Arthur Kepple Taylor, 64, Samuel-street, Woolwich, S.E.

Students.—Edward Domett Morgan, Faraday House, Charing Cross-road, W.C.; Samuel Romilly Roget, B.A., 5, Randolph-crescent, Maida Hill, W.; Joseph Jocelyn Francis Shoolbred, 47, Victoria-street, S.W.

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TO CORRESPONDENTS.

 Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

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HACKNEY.

It is just as well that human affairs do not go well. The affairs of "bumbledom" have offered a butt to the shafts of sarcasm; the whole the work of bumbledom has sui idiosyncrasy of the English race, and whe affairs go topsy-turvy, we can all afford to That matters concerning the Hackney Vest the electric lighting have gone awry is co knowledge, and, as might have been expected, has been the fluctuations of the Vestry's min the ratepayers have stepped in with a move cries check to the hitherto vacillating po the Vestry. When the history of electric l at Hackney comes to be written it will fo interesting study in matters municipal. Ou temporary, *London*, in its issues of April 7 a contains some very drastic and caustic arti the subject, hinting that strenuous attempt been made to bribe and corrupt the vest This question of a corrupt Vestry is o the ratepayers themselves, not for us. broad principles which should guide rate vestries, and councils in such matter easily stated, although the details must considerably in each case. Lord Kelvin, opening of the Blackpool station in 1893, out what class of operations should be munici and in this class is the distribution of the me lighting. It is a matter which appeals to the local community, and is a benefit to that community. If, however, the local authori not recognise its responsibility, there is no ob to the work being done by a company. Thus w that the best way is for the authority to do th but failing this its powers may devolve upo vidual enterprise. To a certain extent Hackn recognised its responsibility, and its Vestry a provisional order. For years, however, divis existed about the carrying into effect of that Engineers have reported, and their servic pensed with; but time flows on, and the sta not yet. Seeing that procrastination prevai there any wonder that private adventurers be look upon Hackney as a suitable place at to obtain a lighting concession? The fu began. Not one, but several adventurers the field, and since that entrance the has stultified itself by its invertebrate actio procrastination as yet reigns supreme. The s affairs comes to this: (1) a large popula deprived of electric lighting because of the inc of its representatives; (2) private adventur willing to provide the lighting if the au will transfer its powers; (3) strong repr tions are made that some members, at an of the authority are corrupt, and that the adventurers are favoured because of a pa to that corruptness. There can be n opinions as to the better plan. Under the tions which prevail, municipalisation is far an preferable. There is another point in the H matter that tends to show the action of th payers to be justified. One of the most im of municipal matters is that the authority k

work connected with sanitation in its own hands, yet the proposal at Hackney is to delegate some of this work to a company. Somehow, while we feel the company promoters have gone a long way too far with their methods, we are not disposed to condemn them so much as the vestrymen. A more disgraceful way of treating a purely business matter has probably never been found than the way at Hackney. Year in and year out, with constant choppings and changes, the thing goes on. A decided negative would be rational, if a little pig-headed, but there is nothing to be said on behalf of men who either will not or cannot make up their minds. According to the latest advices, the forthcoming election is to be fought on the electric light question, and the final solution is left for the new vestry to settle. The ratepayers may be taken to have had their interest fully aroused, and we trust will so cast their votes that a final stop is put to procrastination.

FORTHCOMING EVENTS.

FRIDAY, APRIL 22.

Royal Institution.—Albemarle-street, at 9 p.m., "The Recent Eclipse," by W. H. M. Christie, C.B., M.A., F.R.S., Astronomer Royal.

Physical Society.—At Burlington House, at 5 p.m., "On a Method of Viewing Newton's Rings," by the Rev. T. C. Porter.

Institution of Civil Engineers.—At 8 p.m., Students' meeting. "New Cut Swingbridge, Swansea," by Mr. M. W. Henty, Stud.Inst.C.E.

MONDAY, APRIL 25.

Society of Arts.—At 8 p.m., Cantor lecture on "Sources of Commercial Indiarubber," by Dr. D. Morris, C.M.G. (last of two lectures).

London Chamber of Commerce.—At 2.30 p.m., extraordinary general meeting—alteration of regulations.

TUESDAY, APRIL 26.

Institution of Civil Engineers.—At 8 p.m., annual general meeting of corporate members only, to receive the report of the council, and to elect the council and auditors for the ensuing year.

North-East Coast Institution.—At Literary and Philosophical Society Rooms, Newcastle on-Tyne, at 7.30 p.m., the discussion on Mr. James Andrews's Paper on "Cylinder Ratios"; and "The Effect of Different Arrangements of Crank Angles upon the Economy of Quadruple Expansion Engines," by Mr. A. L. Mellanby, B.Sc.

WEDNESDAY, APRIL 27.

Institution of Mechanical Engineers.—At Civil Engineers, at 7.30 p.m., Presidential Address, by Samuel W. Johnson, Esq., and first report to the Gas-Engine Research Committee, by Prof. Frederic W. Burstall; supplementary paper and adjourned discussion.

Institution of Electrical Engineers.—At 7.30 p.m., Students' meeting, "The Commercial Development of the Electric Lighting of Small Towns," by C. Milton and H. Bell.

Society of Arts.—At 8 p.m., "Photography and Colour Printing," by Captain W. de W. Abney, C.B.

Liverpool Engineering Society.—At Royal Institution, Liverpool, at 8 p.m., annual general meeting, to elect officers for ensuing season. Paper to be read: "Diagrams as Illustrating Ships and Engine Performances," by Mr. Andrew Hamilton, M.Inst.N.A.

THURSDAY, APRIL 28.

Institution of Electrical Engineers.—At Institution of Civil Engineers, at 8 p.m., ordinary meeting.

Institution of Mechanical Engineers.—Anniversary dinner at Freemasons' Tavern.

FRIDAY, APRIL 29.

Institution of Mechanical Engineers.—At Institution of Civil Engineers, at 7.30 p.m., "Steam Laundry Machinery," by Mr. Sidney Tebbutt.

Royal Institution, Albemarle-street.—At 9 p.m., "Magneto-Optic Rotation and its Explanation by a Gyrostatic Medium," with experimental illustrations, by Prof. Andrew Gray, M.A., LL.D., F.R.S.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

THE SHANNON ELECTRIC POWER SYNDICATE.

SIR,—So many erroneous impressions prevail with regard to the project of my directors that possibly a useful purpose may be served by a brief and authentic description. Originally the desire was to utilise the various lakes of the Shannon River as storage reservoirs, which would ensure a sufficiency of water for the power required during the summer. In short, it was desired to use these natural reservoirs to equalise the variable flow of the stream to a certain extent, ensuring a fixed summer quantity, greater than the normal, between Lough Derg and Limerick. In this scheme of storage Lough Allen was included. A certain volume of water would have been retained there to supplement the flow into Lough Derg when the quantity required from that lake exceeded the supply entering it at the upper end. This procedure, we were given to understand, spelled ruin to the fishing industry. Rather than force it, I advised my directors to revert to the use of steam during periods of drought, and to leave the summer flow untouched. We have been asked, "What is the summer flow?"—a question which seems rather a reversal of the usual course, since it is the point at which we desire to arrive in conjunction with those who are interested in its determination. Without entering on controversy, it is difficult to understand the objections raised. The case stands thus: At present, the river is regulated by the Board of Works; we are told that that regulation does not meet the desires of fishery proprietors. Next, we propose to change that state of affairs into a flow of greater uniformity; we are again told that *that* does not meet the case. *Now*, proposing to leave the control of the waters absolutely alone, to use water when it is there, and steam when it is not there, precisely the same objections are raised as to the two wholly different conditions—the existing and the proposed—named above. And yet no single specific case of injury to anyone's interests has been yet alleged.

Further, the intention is to develop a certain amount of power; that, with its necessary abstraction of a small share of the river, is considered to be generally objectionable. Side by side with that statement, however, we are told that were we to take four or five times the amount of water, and develop four or five times the power at once, we should deserve support; and, although the original proposal was to develop 5,000 h.p. only all the year round, and although the present intention is to develop 5,000 h.p. all the year round, and, in addition, another 5,000 h.p. during wet periods, it has been publicly stated that the capacity of the works has been decreased. These things must speak for themselves. I shall content myself with pointing out that even 10,000 h.p. is a very considerable factor in the industrial life of a community, and that the argument that no one should erect a water-mill unless it take the whole power of the river concerned is a novel one. The broad position is this: The intake and outlet of the power canal—call it a millrace, for simplicity—are separated by about a mile of river containing fisheries. Down that river flows a volume of water, varying from $1\frac{1}{4}$ million of cubic feet per minute to one considerably smaller. Everyone knows that the height of the flood water at Castle Connell frequently prevents good sport—one has only to read the papers to see it. Of that flood it is proposed to divert a comparatively trifling amount and return it to the stream lower down. Where is the injury to the intervening waters? And it must be borne in mind that the waters above the intake and below the outlet remain in precisely the same state, whether the used water reaches them *viâ* the Doonass rapids or *viâ* the power canal. One wonders to what extent the inland fisheries and industrial condition of Ireland would be benefited were every weir and every millrace to be removed.

When the water is there, part of it will flow night and day *viâ* the canal; when it isn't there, the generators will be steam driven. Apparently a difficulty is found in comprehending that the arrangements of the works are such

that the water will flow continuously, even though it may not be operating the plant. But there is no mystery about such a state of affairs, which can be observed daily in hundreds of other places. That is precisely all.—Yours, etc., H. T. FULLER, Engineer to the Company.

BAD WIRING.

SIR,—I had hoped the day of jerry wiring was over; unfortunately, it is not. The enclosed is a sample of wire which I yesterday took out of an installation. This wire, you will see, is fair outside bell wire. I might mention that a large portion of this wire had been run under the floors, without any casing, in holes bored in the joists. When will fire insurance companies learn that it is advisable from their point of view to safeguard their interests? In justice to South Shields I must mention that the work was not done by a South Shields firm.—Yours, etc.,

South Shields, April 19, 1898. JOS. A. JECKELL.

[The sample is question was of a tinned wire cotton covered, then came a single layer of pure rubber, then more cotton, and finally a braiding slightly impregnated. The wire is certainly most unfit for electric lighting purposes in any position whatever.—ED. *E. E.*]

COMMERCIAL FORMS OF ELECTRICAL RESISTANCES USED FOR LIGHTING AND POWER PURPOSES.*

BY LL. B. ATKINSON.

In the early days of electrical engineering, when telegraphy was the leading branch of the science or industry, "resistance" as a property of the electric circuit had very important functions; and from the property of circuits that the resistance is proportional to the length of the conductor, in the case of faults occurring on telegraphic lines it became a means of increasing the distance from the end of such fault. And for such purposes, therefore, standards of resistance were used which were carefully calibrated, and the primary value of such resistances rested in their accuracy. Such for telegraphic purposes is still the case, but the growth of the use of electricity as a means of transmitting and distributing light and power has given rise to the use of resistances for quite other purposes, and having other requirements than that of representing an absolute or accurate value, and it is to these resistances that the present paper is devoted. The current in an electric circuit is defined by Ohm's law—that is,

$$\text{Current} = \frac{\text{E.M.F.}}{\text{Resistance}},$$

so that as for most purposes the E.M.F. is fixed, the resistance of the circuit is the variable by which the current is to be controlled. And thus for almost every conceivable use of electricity for lighting or power purposes, resistances are used as controllers or regulators of the current. The functions of a resistance being primarily to regulate or determine the amount of the current, which it does by its resistance, its second function is to dissipate the heat produced by the electric power expended on the resistance. This becomes a matter of cooling surface, and leads to a wide range of possible designs. Speaking generally, then, in considering electrical resistances, the points to be considered are the (1) material of which the electrical resisting circuit is composed, (2) the nature of the support for such circuits, and (3) the material for insulating the circuit from the support, and in addition the nature of the switching mechanism for varying the amount of resistance in circuit.

(1) MATERIAL OF WHICH THE ELECTRICAL RESISTANCE CIRCUIT IS COMPOSED.

Since all conductors offer resistance to the passage of the electric current, any conductor may be used as a resistance. The following table shows the resistance of 1cm. in length of various metals and alloys, carbon, and liquids, the cross-sectional area of the specimen being one square centimetre and the temperature 0deg. C.

This table is only to be used as a guide, since, except with pure silver and copper, as all the other materials are of somewhat undefined composition, and the resistance of alloys and carbon varies greatly with their chemical and physical condition. It will be observed that several of the materials used are special alloys, for the most part of nickel and manganese, which, in addition to having a very high resistance, have a very small

TABLE I.—Table of Specific Resistances.

	Resistance per cubic centimetre.	Percentage variation per degree centigrad
Silver	1·504 microhms	·377
Copper	1·598 "	·388
Iron	9·716 "	·453
"German silver"	20·93 "	·03
Platinoid	51·0 "	—
"Manganin"	52·0 "	practically
"Eureka"	60·0 "	do.
"Rheostene"	100·0 "	do.
Carbon	4,200-40,000 "	−·2
"Relugite"	3·2 to 3,200 ohms	−·2
Solution of soda, 10 per cent. solution	11·5 ohms	—
Solution of zinc sulphate, density 1·405	28·3 "	—
H_2SO_4, density 1·10	1·37 "	−1·7

temperature coefficient, which is important, as resistances a often worked to a temperature of 200deg. C., causing a ve considerable variation of resistance. An interesting exampl of this is in the use of iron wire when it is approaching red heat, in which case it will be found that the resistanc rises so rapidly that a very large increase of E.M.F. will only cause a very small increase in the current, because as the E.M.F. is raised, causing a small increase of current, thi raises the temperature so that the resistance rises almost a fast as the E.M.F. The writer some years ago used thi property for arc lamp resistances, when even if the lamp was cut out the permanent rise in current was quite small. The metals, solids, and liquids shown in the table are those which are most frequently used for making resistances, and with regard to these the usual form of the metals and alloys is in the shape of wire or strip, the former generally wound into coils. Carbon may be used either in rods, in which case the ends should be electro-coppered, and the connections clamped and soldered to the copper, or the carbon may be used in the form of flat plates piled on one another. The material "relugite," shown in the list, is a new material now being put on the market by the Electric Insulation Syndicate, of Cardiff, and having an incombustible base, such as asbestos, in which i deposited conducting carbon, and the specific resistance of which can be made as required within the limits given, and this material also may be used either in strips, the current passing from end to end, or in plates of layers, through which the current passes. Liquids are used generally where high resistances are required, and are on the whole an unsatisfactory form of resistance, as the solutions creep and cause loss of insulatio on the circuits to which they are attached, whilst the liquid also leak or evaporate, so that they have to be made good, and the composition and resistance is constantly varying.

Carrying Capacity of Resistance Materials.—It is importa to determine what is the carrying capacity of the wires, strips, or plates of which a resistance is composed, this being defin in relation to some particular allowable rise of temperatur The rise of temperature to be allowed is probably the point o which the greatest difference of opinion seems to exist amon manufacturers. It is somewhat curious that the fire insuranc offices, who define to a nicety the insulation of the circuit an other quantities, are exceedingly vague on what is probably o of the chief fire risks that are run, most of the offices satisfyin themselves by merely stating that the resistance should be co structed of and mounted upon incombustible material, and th no combustible material should be within a foot of the resis ance. Since most organic matters and fabrics char at a tempera ture of 200deg. C., the writer thinks that that limit, at a events, should never be passed, and probably the rule defini that the maximum temperature of the hottest part at the maxi mum working load should not exceed 150deg. C. would be a sa rule. The principal methods of dissipating heat from resistanc are by radiation, air currents, and in certain cases by circulati liquids, such as oil or water. The amount of heat radiated the temperatures discussed is not large, and the use of liqui for cooling is not common, so that, practically speaking, cooli by air or currents is the usual method. It is obvious, therefo that the designs should be such as to allow a free circulation air through those parts where the heat is being produced.

Wire Resistances.—For this reason, where wires are used, is advantageous that the diameter of the wire should be sm so as to give a maximum surface for a given cross-sectio area, and to carry the requisite current a sufficient number wires should be placed in parallel. Again, where wires wound into coils, these coils should be open, and there sho be a space between successive turns of the coils of two or th diameters to allow an effectual passage of air. In the case long coils placed vertically, the upper parts of the coil beco far the hottest, as the air heated by the lower coils is the c cooling medium. It is almost impossible to give any gene rule as to the carrying capacity of wires in coils. Diagram shows the relation between the diameter of the wire

* Paper read before the Northern Society of Electrical Engineers, April 18, 1898.

carrying capacity of wires stretched out straight in air, and for certain temperatures. If the wires are coils drawn out so that the space between the wires about two diameters, the current the wires will carry for same temperature will be about one-third of that given by diagram. One of the most effective forms in which wire

FIG. 1.

be used is in the form of wire gauze, and the best class of e is that in which the longitudinal wires carry the current, wires all being in parallel connection, whilst the cross ds carry away the heat, and in this case the load to be ed by a given wire is double that given in the table. A difficulty occurring with wire resistances, particularly e alloys, such as German silver, are used, is that the wires ne brittle or rotten, and break, causing short-circuits and r of fire. In the case of resistances enclosed in boxes at only the outside surface will dissipate the heat, the ing capacity of the wires is much less than that given he table, and the ultimate carrying capacity of the ance will depend on the surface of the casing exposed e air, and for a temperature of 150deg. C. the total nal surface should be about 10in. per watt to be dissipated. surface for this purpose may be increased, if of metal, sting ribs or fins upon the casing so as to increase the ce. Some resistances are only required for a short time at vals, such, for instance, as resistances for starting motors, ere the element most to be considered is not the surface hich depends the power of steadily dissipating heat, but otal specific heat of the parts on which depends the rise of erature with the given load in the time for which it is to ed, and in this case materials having a high specific resist- with large bulk may be used to advantage, or if fine wires sed they may be embedded in materials such as enamel, or or asbestos, which will absorb by conduction the heat from ire itself.

rbon Resistances.—A common form of carbon resistance sts in the use of ordinary lighting pencils with the ends red and connected up by clamps. These resistances for g purposes can be run at a very high temperature, but dissipate heat badly, they are very liable to come broken, re not often used for resistances which may have to be ported. Carbon resistances made up of plates placed in ne are often used, and they have the advantage that the ance may be varied by screwing them up more or less tight clamping screw. In this case a very large part of the ance is due to the resistance at the surface of contact

FIG. 2.

FIG. 3.

FIG. 4.

en the layers, and due also to the fact that the current s in the plane of each layer from the points of contact at urface of one set of plates to those of the next set; in most instances, not coming opposite to one another on ates. In other words, except when the plates are screwed ite tight, the current is travelling by a zig-zag course gh the pile of plates, and it is principally this which s the resistance to be varied. The material previously mentioned—viz., "relugite"—is used in the same way, and with the same results, but it has a great advantage over the carbon resistances in that the material being flexible and elastic, a much wider range of the screw is obtained, so that the resistance can be varied more gradually, whilst the tendency with solid carbon resistances for the plates to actually break

FIG. 5.

FIG. 6.

FIG. 7.

contact, and so set up an arc, is got over. The chief difficulty with carbon resistances is that they present a very small cooling surface. This difficulty has been obviated in the case of "relugite" resistances by interposing metal plates between the plates of material, which metal plates are larger than the plates of the material, and thus serve to conduct the heat from between the plates, and to present a large surface for the air to pass through to cool them.

Liquid Resistances.—The commonest form of liquid resistance is a wooden tub filled with water, in which is sulphuric acid, common salt, washing soda, or other metallic salt, to render it more or less conductive, and in which are immersed plates leading in the current. Such resistances cannot, of course, rise above the temperature of boiling water, and they absorb a large

FIG. 8.

FIG. 9.

amount of heat due to the large latent heat of steam. Such an arrangement is, of course, a very rough one, and only used for temporary purposes. For permanent installations, iron or earthenware jars or pots are used, containing solutions, and having electrodes of various forms which can be moved in relation to one another.

(2) MATERIALS FOR SUPPORTING RESISTING WIRES OR MATERIALS.

In the early days of the use of electric power resistance wires or coils were usually strung in wooden frames (see Fig. 1), and

FIG. 10.

the writer believes he was the first to introduce into the market standard patterns of resistances, in which the supports were wholly composed of incombustible material—that is to say, iron frames carrying slate or porcelain insulating parts to which were attached the resisting wires—and Figs. 2 and 3 show

FIG. 11.

FIG. 12.

designs which were registered by the writer in 1887, and large numbers of which were made by the writer's then firm. These designs, slightly modified, have been largely adopted, and Figs. 4, 5, 6, and 7 shows various forms made by different makers which are now in the market, all embodying the same important point of fireproof insulating supports for the wires. These resistances may be, and usually are, provided with a

switch having a number of contacts which enables, more or less, the resisting wire to be included in the circuit. A class of support previously mentioned is the use of enamel on a base of iron. In this case the iron is first enamelled, to give it an insulating coating; the wires, which are very fine, are then placed on the enamel, and covered with thick coating of

Fig. 13.

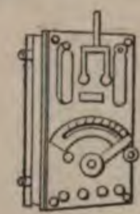


Fig. 14.

enamel, which is then fused, so that the wires are firmly embedded in it. The resistances known as the Carpenter resistances, and the resistances in most heating and cooking apparatus, are arranged in this manner. In this case the enamel carries the heat from the wire to the iron supports,

Fig. 15.

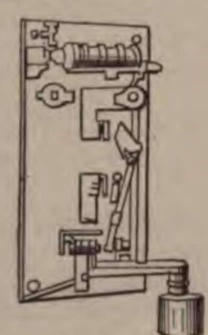


Fig. 16.

which then distributes it, and forms the cooling surface. In the case of the "relugite" resistance material, this is carried in iron frames, generally on pillars or bolts passing through it; the insulation being enamel, and in certain cases mica or asbestos sheets are used where flat surfaces are to be insulated.

Fig. 17.

Fig. 18.

It may be well now to describe and illustrate forms of resistance embodying the arrangements already set forth. Fig. 1 shows the old-fashioned wooden resistance box, with wire coils. Figs. 2 and 3 show the original fireproof resistance designed by the author in 1886, while Figs. 4, 5, 6, and 7 show how closely

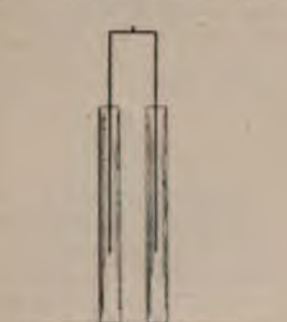


Fig. 19.

Fig. 20.

these have been followed by other forms now on the market. Figs. 29, 30, and 31 show other forms of resistances using coiled wires. In all these the wires are carried in an iron frame, either on slate strips or on porcelain insulators, and a multiple switch, with connections to the wires, ... more or less of the resistance to be put in circuit.

Figs. 21, 22, and 23 show forms of carbon resista[...] Figs. 21 and 22 (which shows the parts taken asunde[...] resistances formed of a pile of Varley's flexible carbon, [...] are adjusted by screwing down the milled nut at the top. T[...] resistances are useful for experimental work, but they wil[...] carry or dissipate any large amount of power. Fig. 23 s[...] the carbon resistance in an iron frame screwed up from one[...]

Fig. 21. Fig. 22. Fig. 23.

such a form, however, being only useful for low resistances[...] large currents, the specific resistance of carbon being to[...] except in this case. Figs. 24, 25, 26, and 27 show various f[...] of resistance designs by the writer, in which the new mat[...] "relugite," is used. In Figs. 24 and 25 the top and bo[...] plates are of iron, enamelled on the inside; there is a ce[...] bolt also insulated by enamel, and a pile of plates altern[...] of the material and of metal lies between these plates, and[...] pressure is adjusted in Fig. 24 by a handwheel and in Fi[...] by a nut. In Fig. 26 a similar arrangement is made, t[...] being an independent pressure plate inside the end frame p[...]

Fig. 24.

Fig. 25.

Fig. 27 shows a combined switch and "relugite" resis[...] for the purpose of allowing an ordinary lamp not [...] to be turned on and off, but to be regulated as requ[...] Figs. 17, 18, 19, and 20 show various forms of liquid resista[...] Fig. 17 is a form used for laboratory purposes, and with a [...] solution of zinc sulphate may carry as much as 2,000 [...] between the electrodes. Fig. 18 shows a form used for [...] starting. The segments forming one electrode is shown [...] immersed, the outer casing, which is of iron, forming the s[...]

Fig. 26.

Fig. 27.

electrode. When completely immersed, a contact on th[...] ment support short-circuits the resistance entirely. Fi[...] shows a form of liquid resistance which the writer has use[...] current entering at the bottom of one tube and leaving [...] bottom of the next tube, a wire fork or bridge being rai[...] lowered in the tubes. A curious phenomenon occurs with[...] an arrangement, the complete explanation of which the [...] is unable to give—viz., that using lead plates at the b[...] of the tubes and a copper or iron bridging piece, the [...]

Fig. 28. Fig. 29. Fig. 30. Fig. 31

ance and heating effect is not equally divided betwe[...] tubes, but is largely concentrated in one of them. F[...] shows a form of liquid resistance used for lowering [...] for theatrical purposes, and consists in an earthenwa[...] or jar, at the bottom of which is a lead cone; another lea[...] being raised or lowered in the jar. These are shown by [...]

nes. Figs. 13, 14, and 15 show forms of resistance generally used for motor starting only, as the cooling surfaces are small, in which the wires are embedded in asbestos, enamel, or cement; these will be referred to again.

(*To be continued.*)

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared, and should be written on one side of the paper only. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time.

Questions.

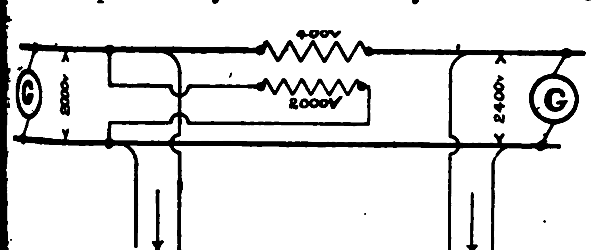
56. Give your reason for and against the taking of premium pupils in electric light stations.

57. What are the advantages and disadvantages of a superheater?—F. M. M.

Answers.

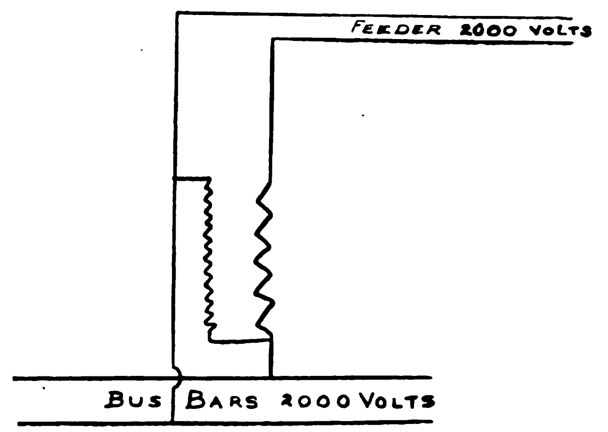
Question No. 51.—Two supply stations in adjoining districts use respectively 2,000 and 2,400 volts on their high-tension mains. Sketch the best and most economical arrangement of booster connection to allow power to be transferred from one district to the other.—P. T.

Best Answer to No. 51 (*awarded* 10*s.*).—In the accompanying diagram is illustrated the arrangement of a booster for making it possible to convey electricity from either of the two districts to the other. In order to supply current to the 2,400-volt district, the 2,000-volt system must be boosted up by 400 volts, and similarly for supplying to the 2,000-volt district from the 2,400 this current must be reduced in pressure by 400 volts. Only one booster or



transformer is necessary to either raise or lower the pressure, and it need only be large enough to transform the current multiplied by the difference in pressure between the two systems. The two earthed or negative mains are joined together by a permanent metallic connection. The secondary of the transformer is connected between the positive sides of the 2,000 and 2,400 volt mains, and the primary is joined across either the former or the latter mains, as shown in the diagram. The ratio of the turns of the transformer depends upon the pressure of the mains to which the primary is connected. If to the 2,400-volt side, the ratio will be 6 to 1; and if to the 2,000-volt side, 5 to 1. For supplying from the 2,000-volt district to the other, with the connections as shown in the diagram, the 2,000 volts in the primary will induce 400 volts in the secondary of the transformer and add this pressure to the original, thus delivering current into the mains at 2,400 volts. In supplying from the 2,400-volt side, no connections require to be altered in any way. The transformer in this case offers an opposing E.M.F. of 400 volts, and the result is 2,000 volts on the 2,000-volt side. Care should be taken in connecting up the transformer to see that the windings are in the right direction, otherwise there would be a rise of pressure given instead of a fall, and *vice versâ*. It is, of course, essential that the periodicities of the two systems should be the same. The terms positive (+) and negative (−) are only used for the purpose of illustration. A motor-generator may be used on continuous-current systems in exactly the same way as indicated above.—T. A. LOCKE.

Answer to No. 51 (*awarded* 5*s.*).—By the wording of the question, I take it that the 2,000-volt supply is required to be "boosted" up to the 2,400-volt pressure of the other station. The best and simplest arrangement for doing this, one that gives absolutely no trouble in practice and requires no attention, is to connect in the feeder or feeders which convey the current from the low pressure to the high, what is known as an augmentator or "booster" transformer. It should be fixed at the generating end of the feeder, in order to secure the economy of the augmented pressure in transmission. The following diagram shows the windings of the transformer, and how they are connected.



The secondary winding is connected in series with the feeder, and the primary as a shunt across the two mains. The transformer should be designed equal to the carrying capacity of the feeder. If the feeder is intended to carry 100 amperes, and the increase of pressure required is 400 volts, then the capacity of the transformer must be 40 kw., but the copper in the secondary must be of sufficient cross-section to carry the whole current in the feeder (100 amperes) instead of 20 amperes, as would be the case in an ordinary 40-kw. transformer of the same voltages. In fact, any transformer of the proper primary and secondary voltages (2,000—400) can be used as a "booster," provided the current in the feeder does not exceed the current-carrying capacity of the secondary winding of the transformer. Of course, the small adjustment required to bring the two supplies perfectly equal in voltage can be done on the fields of the alternators supplying the current. This arrangement will allow of the two systems being run in parallel if necessary, but it would, no doubt, be best to keep the two supplies separate for other reasons. If it were desired to send current from the 2,400-volt supply to the 2,000-volt system, the same "booster" could be made to reduce the pressure by arranging a change-over switch to reverse the primary connections of the "booster." Then you would have the transformer reducing the pressure 400 volts instead of increasing it to an equal extent. If the two supplies are on the direct-current system, continuous-current boosters would be required. The revolving armature of the booster would be connected in series with the feeder in the same way as the alternating booster shown, and designed to carry the maximum current the feeder is expected to transmit. The field would be connected shunt across the two conductors of the feeder, or, better still (owing to the high E.M.F. and great length of wire that would be needed on the magnets), excited from a battery of cells which are almost invariably in use in a direct-current station. A rheostat should be connected in the field of the booster to regulate for the varying E.M.F. of the battery and armature reaction, and which will also enable the pressure to be varied independently of the generators.—J. P. B.

Question No. 52.—On a three-wire direct system, how is it possible to tell the actual amount of "earth" on +, 0, and − mains at the generating station without shutting down any portion of the system.

Best Answer to No. 52 (*awarded* 10*s.*).—Let x, y, and z be the *full resistances* of the +, 0, and − main respectively (Fig. 1), and let V_1, V_2, and V_3 be the potentials of the three

mains. Let V be the potential difference between the positive outer and the middle main, and suppose also that V is the potential difference between the negative outer and the centre main. We shall first prove the most convenient method of measuring the insulation resistance, F, of this network, and we shall then show how to get two

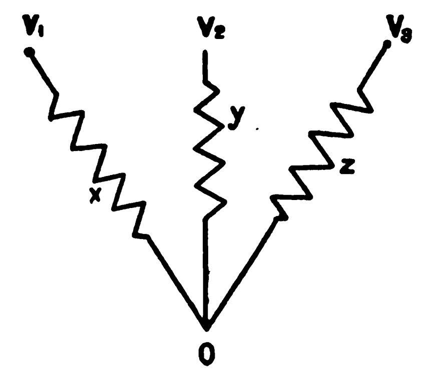


FIG. 1.

other equations, which will enable us to find x, y, and z separately. From Fig. 1 we get by Kirchhoff's law that

$$\frac{V_1}{x} + \frac{V_2}{y} + \frac{V_3}{z} = 0.$$

Also, since $V_1 = V_2 + V$, and $V_3 = V_2 - V$, we easily deduce that V_2, the potential of the middle conductor, is given by the equation

$$V_2 = \frac{V\left(\frac{1}{z} - \frac{1}{x}\right)}{\frac{1}{x} + \frac{1}{y} + \frac{1}{z}} = \frac{V\left(\frac{1}{z} - \frac{1}{x}\right)}{\frac{1}{F}} \quad . \quad . \quad (1)$$

where F is the insulation resistance of the network. This equation enables us to prove the well-known method of finding F described below. Connect the middle conductor to earth through an ammeter in series with a resistance, R, and note the current, C_1, indicated. Shunt

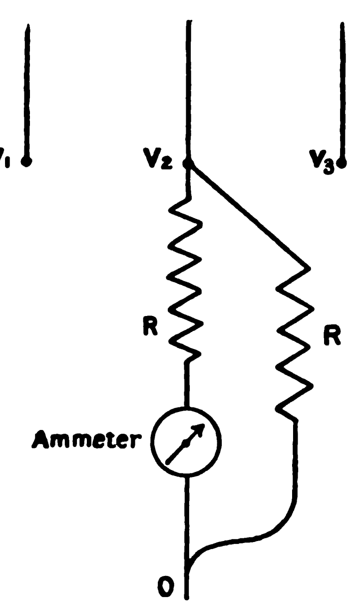


FIG. 2.

the ammeter and resistance by a resistance, R (Fig. 2), and note the current, C_2, indicated Then

$$F = R\,\frac{C_1 - C_2}{2\,C_2 - C_1}.*$$

To prove this, we notice that in the first case

$$V'_2 = R\,C_1 = \frac{V\left(\frac{1}{z} - \frac{1}{x}\right)}{\frac{1}{F} + \frac{1}{R}} \quad . \quad . \quad . \quad . \quad (2)$$

* Compare also "The Localisation of Faults on Electric Light Mains," by F. C. Raphael, pp. 51 and 174.

and in the second case

$$V''_2 = R\,C_2 = \frac{V\left(\frac{1}{z} - \frac{1}{x}\right)}{\frac{1}{F} + \frac{2}{R}} \quad . \quad . \quad .$$

Dividing (2) by (3)

$$\frac{C_1}{C_2} = \frac{\frac{1}{F} + \frac{2}{R}}{\frac{1}{F} + \frac{1}{R}} \quad \therefore \quad F = R\,\frac{C_1 - C_2}{2\,C_2 - C_1}.$$

In this method of finding F a voltmeter or a galv can be used instead of the ammeter, the formula r the same.

We have now got one equation connecting x, y namely,

$$\frac{1}{x} + \frac{1}{y} + \frac{1}{z} = \frac{1}{F} \quad . \quad . \quad . \quad .$$

To get two others without shutting down an of the system, we might proceed as follows: Dimi voltage between V_1 and V_2 (say, 2 per cent.) to V', new value of V_2 is given by the equation—

$$\frac{V'_2 + V'}{x} + \frac{V'_2}{y} + \frac{V'_2 - V}{z} = 0.$$

$$\therefore \frac{V'_2}{F} + \frac{V'}{x} - \frac{V}{z} = 0 \quad . \quad . \quad .$$

Similarly, by diminishing the voltage betweer V_3 to V', we find

$$\frac{V''_2}{F} + \frac{V}{x} - \frac{V'}{z} = 0 \quad . \quad . \quad . \quad .$$

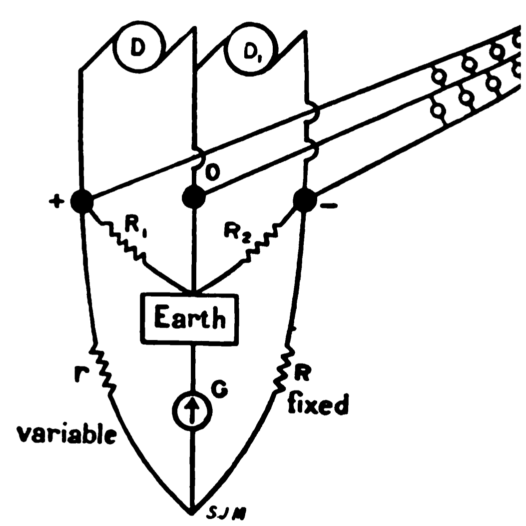
In equations (5) and (6), V'_2 and V''_2 must be f an electrostatic voltmeter.

From (5) and (6) by subtraction we easily find

$$x = F\,\frac{V'^2 - V^2}{V''_2\,V - V'_2\,V'}$$

Similarly, we can find z and then y follows We have thus shown how to find the fault resi each main individually without interrupting the s
J. C. R.

Answer to No. 52 (*awarded* 5s.).—The sy measuring leakage by the two-lamp method i avail in this case assuming the middle wire earth they will always glow with the same intensity v across the two outers. The same also applies w meters are substituted for lamps. The following can be used with the working current and does r the supply. Below is the working diagram.



The insulation resistances, R_1 and R_2, can be c amount of earth on the outer + and − mains v want to measure. R is a fixed and r a variable r both of which are known, and G is the galvanom whole being arranged in the form of a bridge diag the pressure of the supply taking the place of the

ıethod of working is to adjust r till there is no ion on the galvanometer. Then we know that

$$\frac{r}{R}=\frac{R_1}{R_2}.$$

ʳ shunt R_1 with a known resistance of x ohms and ıdjust r till there is no deflection on the galvano- r becomes r_1 now.

n

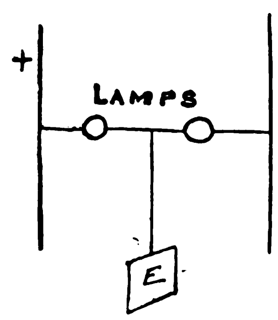
$$\frac{r_1}{R}=\frac{\frac{R_1 x}{R_1+x}}{R_2}$$

ɔutting the value of R_2 in terms of R_1 we get

$$R_1=\frac{x\,(r-r_1)}{r_1}.$$

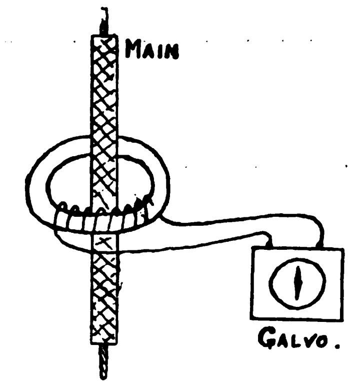
is the insulation of the + outer main to earth. resistance of the − outer main to earth is obtained he first balance, $\frac{r}{R}=\frac{R_1}{R_2}$, from which $R_2=\frac{R\,R_1}{r}$.—
I.

ver to No. 52 *(awarded* 5*s.*).—The lamp-signal method ɔcting "earths" on mains is usually employed, but ɔt indicate the actual amount of "earth" on any lar main. In fact, the only thing it indicates is the ıce in the amount of "earth" on the two mains, or e potential difference to earth of the two mains is ıe when the lamps are equally bright. The lamps nected as follows:



ngenious method has been invented by Mr. A. B. , of Liverpool, by which it is possible to indicate rent leakage to earth on any of the three mains in -wire feeder. It consists of a small soft-iron ring, which many turns of thin copper wire are wound. eding main has one of these rings slipped over it, he free ends of their coils connected to sensitive ımeters. The steady flow of a direct current in the has no effect on the coil. When testing for "earths" ılated pole is intermittently put to earth, and the the galvanometer, due to the induction in the coil by the leakage current, is noted. The following will give an idea of the construction of the tus.

, if the scale of the galvanometer be calibrated in s, it is possible to indicate the actual amount of on any particular main. One drawback to the use method, to enable the fault to be located, is that tributing network has to be split up so that a portion may be supplied separately by each feeder. It is also possible to find out roughly the amount of "earth" on a system by the feeder ammeters. If the opposite pole to



that on which the ammeters are connected is earthed, you can both tell roughly the amount and the district in which the fault is, by noticing the deflections on each of the ammeters.—J. P. B.

ELECTRIC LIGHTING AT SUNDERLAND.

The following report by the borough electrical engineer (Mr. J. F. C. Snell) on the needed extensions of the Sunderland electric lighting station has been passed by the Council. The report, dated Feb. 25, reads as follows:

The growth of demand for electricity is such that further extensions are necessary, as will be seen from the accompanying Table A. To the present date the number of lamps connected has increased to 20,411, as against 19,177 in December last, or an increase of 1,234 in two months, to which must be added some 800 more applied for. The number of consumers has also increased from 170 to 191. In preparing the designs and estimates for the same, I propose that the Local Government Board be memorialised to sanction a loan which will meet our requirements during the next three years. This will enable extensions to be made, step by step with the demand, without waiting each time for the sanction to borrow the necessary capital. The accompanying Table B gives the estimated power, units sold, working expenses, sinking fund, and revenue to the end of the year 1901.

The works costs can be worked out with a fair amount of accuracy; the sinking fund is based upon the mean capital outlay for year; and the interest is taken at present rate. Complete plans are provided, showing the extensions of buildings, plant, pipework, etc. I recommend the adoption of either Lancashire or Galloway type boilers, after careful consideration of all other types. The site chosen is a convenient one; it necessitates a few alterations to the existing trenches, and the removal to another place of the present tank. Ground space is becoming valuable at the station, and this scheme, I submit, makes the most of our area, and delays the pulling down of Dunning House, and a considerable amount of extension to the engine-room wall. The whole of the details of pipework, etc., is shown on the plans. I also recommend the construction of a large underground tank, so that a sufficient reserve of water may be available in case of accident to the company's mains; and the fitting to our existing cast-iron tank of the necessary apparatus for softening the feed water, similar to the plant I have recommended the Borough Asylum Committee to adopt, and which is working so well at Messrs. Richardson's mill. The existing softener is much too small for our present requirements, and could be sold. A set of workshop tools is also provided for in the estimate, so that the majority of our repairs can be

TABLE A.

r ending	No. of consumers.	8-c.p. lamps fixed.	Increase.	Maximum load, E.H.P.	Increase.	Capacity of station, E.H.P.	Capacity (E.H.P.) deducting stand-by.
1896	113	11,289	—	294	—	345	210
1897	170	19,177	7,888	499	205	480	345
1898 (E) ...	—	23,750	4,573	630	131	715	480

TABLE B.

t.	Electric H.P. required.	Total units estimated to be sold.	Estimated total capital outlay to end of year.	Working and sleeping costs.	Sinking fund and interest.	Total costs.	Revenue.	Net profit for year.
			£	£	£	£	£	£
9	630	418,550	46,300	3 580	2,370	5,950	6,055	105
00	800	529,470	56,000	3,860	3,180	7,040	7,800	760
1	1,000	660,960	69,000	4,360	3,700	8,060	9,430	1,370

carried out in the station. I have looked forward many years in designing these extensions, so that the station may ultimately be completed on a basis of uniformity and economy. The estimate for all requirements to the end of 1901 is as follows:

Buildings, flues, trenches, roof, underground tank, engine foundations	£2,050
Three new boilers, feed pump, water softener, and all pipework	3,950
Two new steam dynamos, Nos. 9 and 10, with all piping, cables, etc.; two balancing transformers, extensions to switchboards, etc.	6,550
Lathe, drilling machine, and other tools and instruments...	178
Total	£12,728

For our immediate requirements the buildings, tank, two boilers, feed pump, and one new steam dynamo (No. 9) will only be required, at an estimated cost of £7,800. I must urge upon the committee the importance of getting the water softener, buildings, and boilers especially in time for next winter's load, as the demand is increasing so rapidly.

SECTION II.—MAINS.

The proposed lighting of the workhouse has raised the question as to the best method of reaching that district. The station now supplies energy by two distinct systems—viz, direct-current, low-tension, and alternating-current high-tension (for the residential district). At the time when the station was first built, I may say that Prof. Kennedy had barely an alternative to this arrangement; but since then the Board of Trade has raised the limit of low tension to twice its former figure and this doubling of pressure gives the following advantages: (1) the existing mains will carry four times the energy they now do, with the same limits of length and fall of pressure; (2) the radius of supply may be doubled while conducting the same energy as at present, and still have only the same loss; (3) by doubling the radius of supply, of course the area of supply is quadrupled.

The advantages of direct-current supply, as compared with alternating-current high tension, are: (1) simplicity and reliability; (2) availability for motors and for storage; (3) more efficient and simple methods of public arc lighting; (4) safer handling. And to this, in our particular case, may be added a fifth and most important advantage—viz.:

The uniform supply to all parts of the town, implying greater efficiency and reliability and less working costs. An incidental advantage will be that the same pressures for both lighting and tramways will be obtained. The alternating plant is gradually being loaded up, and I expect will be loaded up by the year 1900. Instead then of adding to this plant, I propose to serve that district by direct current, and to lay a feeder (in the existing conduits which convey the high tension cable) to, say, the corner of Belvedere and Stockton roads, looping up the now isolated pieces of distributing mains; a much more reliable, safer, and more economical system will thus be provided; a 24 hours' supply given with economy to all consumers, residents, and others alike; and the whole supply will be derived from one system instead of two. It must be distinctly understood that I do not propose to do this yet; but I shall require your sanction to this scheme to enable me to pave the way gradually for the change. I am confident, after the most careful and lengthy consideration of the matter, that this will be the best system for Sunderland, both immediately and when considering the future. The alternating plant could still be made use of for pioneering another district—*e.g.*, Roker—until such time as that outside system had grown to such an extent as to warrant its transference to the general system. It may be necessary when effecting this change (unless some arrangement is arrived at between the Corporation and the consumers) to change the lamps in most of the consumers' premises, and to effect some minor alterations therein. The cost will not be large, compared with the very great advantages otherwise obtained. I wish to point out that the present mains will carry from three to four times the amount of energy without increase of section by this method, and therefore a very great saving will thus be effected. The city of Edinburgh is effecting a complete change to this system under Prof. Kennedy's advice, and the cities of Aberdeen, Belfast, and Bradford also.

Estimate.

Extensions of feeders in present district required at once...	£675
Mains to the workhouse	2,200
New feeder to residential district	1,665
Three years' ordinary extensions of mains and services, meters, etc.	7,000
Allowance for new lamps and alterations to consumers' wiring in certain cases	1,000
Total	£12,540

SUMMARY III.

I therefore recommend to your consideration—(1) that the Local Government Board be asked to sanction a further loan of £26,000 for electric lighting purposes, to carry out the foregoing scheme; (2) that, subject to the sanction of the Board, the Council be asked to grant leave to borrow £10,000 for immediate requirements; (3) that I be empowered to draw up specifications and call tenders for two Lancashire or Galloway boilers, and all piping and accessories, one new Weir's pump, one new steam dynamo, complete with piping, etc., and two motor-transformers; (4) that I be authorised to take steps so that the change to the 440-volt system may be effected in the spring of 1899, subject to the approval of the Board of Trade.

ELECTRIC LIGHTING AT STIRLING.

The following report by Mr. R. F. Yorke on the power available at Touch for the electric lighting of S[illegible] was submitted to the Police Commissioners by the Li[illegible] Committee on the 11th inst.:

To the Town Clerk of Stirling.—Dear Sir,—In accordan[illegible] instructions received from you, I herewith have pleasure [illegible] mitting my report on the water power at the Touch reser[illegible] connection with the electric lighting of Stirling. I ha[illegible] careful levels taken with the following results: (1) from th[illegible] of the water in the filters to the level of the water in the s[illegible] tank there is 29ft. head; (2) from the water-level in the s[illegible] pond to No. 2 reservoir there is 223ft. head; (3) from the [illegible] level in the settling pond to No. 3 reservoir there is 265ft. and (4) from the water-level of No. 3 to the water-level of [illegible] there is 128ft. In every case the level has been taken [illegible] surface of the water when the reservoirs are full. From [illegible] reservoir there is a short length of 8in. pipe; this is conne[illegible] a 15in. pipe, and this again at a lower level is connected to [illegible] pipe, which terminates with a valve controlling the su[illegible] water into the settling tank. Again, from No. 3 reservoir [illegible] settling tank a pipe of uniform diameter of 12in. is laid the [illegible] way. The whole of the water consumed in Stirling passes t[illegible] these pipes, with the exception of a very small supply fr[illegible] burn, which supply is gathered below the reservoirs.

From meter readings that have been taken over a consi[illegible] period, I find that the average water supply of Stirling [illegible] taken at one and a half million gallons per day. Allo[illegible] quarter of a million gallons to be supplied from the burn a[illegible] sources outside the reservoirs, leaves one and a quarter [illegible] gallons to pass through the pipes from No. 2 and No. 3 re[illegible] to the settling tank. With the permission of your Wate[illegible] missioners I propose to continue the 12in. pipes that now [illegible] nate at the settling tank to a point where a convenient site [illegible] turbine-house exists close to the filters. By this means w[illegible] obtain an additional head of 29ft., and the water after [illegible] through the turbines would flow into a distributing tank, a[illegible] into the filter beds as at present. Taking the one and a [illegible] millions per day to be equivalent to 138 cubic feet per [illegible] Messrs. Gilbert Gilkes and Co., hydraulic engineers, of K[illegible] and manufacturers of the late Prof. James Thomson's vortex t[illegible] are prepared to guarantee to deliver on the turbine shaf[illegible] allowing for all losses, 54 b.h.p. from the pipe leading from [illegible] and 47 b.h.p. from the pipe leading from No. 2 reservoir. I[illegible] to obtain the best results, therefore, it would be advis[illegible] draw on No. 3 as much as possible; but I recommend that ea[illegible] should be fitted with a turbine which will be coupled direc[illegible] dynamo, thus forming a duplicate plant. The valves which [illegible] the supply to the turbines can be regulated in the same ma[illegible] those which now regulate the supply in the settling tank, [illegible] the flow of water into the filters will not be in the least [illegible] from what it is at present. The valves also will be so a[illegible] that the two turbines can be worked from either pipe. [illegible] maximum 54 b.h.p. guaranteed by the turbine manufactur[illegible] dynamo makers, Messrs. Laurence, Scott, and Co., of N[illegible] undertake to deliver 90 per cent. into the cables in the [illegible] electric energy.

The cable which I recommend is that manufactured [illegible] British Insulated Wire Company, of Prescot. This firm un[illegible] to supply and lay the cable, exclusive of trench work, [illegible] guarantee its satisfactory working for three years; and th[illegible] undertake to transmit the electric power to Stirling, a dist[illegible] 3½ miles, with a loss not exceeding 13 per cent., taking th[illegible] current when charging the accumulator, and 15½ per cent. [illegible] increased current when lighting direct.

With regard to the accumulator-house, I propose to ut[illegible] building formerly used as the butter market. I have su[illegible] the dimensions of this to a firm of accumulator manufac[illegible] viz., the Chloride Electrical Storage Syndicate, Manches[illegible] they find that the space will be ample. Their offer incl[illegible] supply and erection of a battery of 250 cells, which will be [illegible] of dealing with a maximum load of 308 amperes for three h[illegible] 4,514 lamps alight at one time for three hours. During th[illegible] of maximum load the dynamo current—viz., 69 amperes—[illegible] capable of lighting 1,022 lamps. The combined plant, there[illegible] be capable of dealing with 5,536 lamps alight at one time. T[illegible] put is shown by experience to be capable of dealing with [illegible] 9,000 lamps connected, and this is a fair estimate of the [illegible] of lamps that would be taken up in the extended area. Th[illegible] of the accumulator or storage battery guarantee to del[illegible] the distributing mains 75 per cent. of the electric energy [illegible] at Stirling, and also to maintain the battery to within 70 [illegible] of its capacity for the sum of £164 per annum. This g[illegible] must be considered as very satisfactory, as it amounts [illegible] 6½ per cent. on the cost of the battery. (See Schedule I.)

The total output which the combined plant is capable [illegible] works out as follows: Of the 54 b.h.p. given by the turb[illegible] taking the guaranteed efficiency of the dynamo at 90 p[illegible] 36 256 watts will be obtained. Allowing 13 per cent. lo[illegible] cable, 31 543 watts will be delivered continuously to the [illegible] lator at Stirling—that is to say, 757,032 watt-hours per [illegible] Board of Trade unit is equal to 1,000 watt-hours. W[illegible] therefore, 757 units supplied to the battery per day. Of [illegible] makers of the battery guarantee to deliver into the dis[illegible] mains 75 per cent., which gives an available supply of 5[illegible] of Trade units per day. In practice, however, we sha[illegible]

ın this, for at least during seven hours a day in winter
ent from the dynamo will go straight to the lamps without
through the accumulator, and therefore the 25 per cent.
harging will be saved. There will be a slightly increased
ıe cable due to the increased current when lighting direct,
net gain will not be less than 50 units. This makes the
put of the combined plant available for the electric light-
irling 618 units per day, and this output may be con-
ample for the supply of current for 8,000 lamps in the
l area.

l Outlay.—The total cost of the guaranteed tenders
to £3,940, to which must be added an allowance for the
n of the 12in. mains to the turbine-house, switchboard and
g instruments, turbine-house and foundation, and fitting
cumulator-house with stands, and putting same in repair.
e items I have allowed £650, which, with engineer's fees,
ıgs the cost to £7,000. (See Schedule 1.)

ng Expenses.—The cost of working, which includes wages,
nd maintenance, is amply provided for by an allowance of
r annum. (See Schedule 2.) If we reckon that 100,000
year are sold, the average consumption would then be
s per day, which is less than half the capacity of the com-
ant. The cost of generating the electric current works
arly 1½d. for each unit supplied (this, of course, does not
account interest and sinking fund, which is dealt with
e head of total costs). Although I understand that my
confined to the consideration of the sufficiency of the
wer and the method of utilising it in order to obtain the
lts, it may be convenient at this point to consider shortly
cation to the complete scheme.

Costs.—The cost of distribution will be practically the
atever be the method adopted for generating the electric
and it may be taken at £6,500 for the extended area.
kes the capital outlay for the extended scheme £13,500,
wing £675 per annum for the interest and sinking fund,
5 per per cent. on the capital outlay, makes the total
ost on the undertaking £1,325. (See Schedules 2 and 3.)

e.—Taking 100,000 units as the number to be sold per
and charging at the rate of 4½d. per unit (which is con-
o be equivalent to gas at 2s. 3d. per 1,000 cubic feet), the
produced would be £1,875 per annum, thus leaving a clear
£550. This profit, however, will not be realised until the
ber of lamps have been taken up.

ks.—I have now shown that by utilising the water power
ists in connection with your Touch reservoirs you can,
moderate expenditure of some £13,000 to £14,000, deal
ly with the lighting of the extended area—viz, 8,000
nnected—and that by charging for the private lighting
te of 4½d. per unit there would be a considerable surplus
s the total number of lamps have been taken up. It may
l that the quantity of water now taken by Stirling is
, and that in the future means may be adopted to restrict
nt waste in the town. In that case the present supply of
a half million gallons may be curtailed. A little con-
n will show that even if economies are carried out they
affect in the least the power that is available from
ervoirs. If the present waste in Stirling is stopped, it
ily follows that the overflow from your reservoirs will be
l. The waste, therefore, will only be transferred from
to the reservoirs, and it may as well be utilised in the
as pass to waste down the burn. From data recorded
nsiderable period, it is proved beyond question that the
upply from your catchment area and rainfall is capable
the quantity of water required for the turbines, and in
ection I quote from the report sent to me by Messrs.
Gilkes and Co. as follows: "From the recording meter
s we find that the daily flow from the reservoirs to Stirling
1,500,000 gallons. A very trifling proportion of this goes
settling pond without passing through the reservoirs. At
250,000 gallons flow daily from the reservoirs to Stirling
received from you figures showing the amount of water
eservoir monthly for four years. These figures have been
ut diagrammatically—we enclose the diagrams—and you
hat it is safe to assume a constant supply of 1,250,000
The quantity is large for a town like Stirling, and less
used some day, but as we are clearly informed that
the water is needed for the town or not, it may be
down to the filter beds, it does not matter how much
uses. What it has used in the past proves that the
1,250,000 gallons." This clearly shows that whether the
r Stirling is diminished or not, the power available will
fected.

ions.—I have only dealt so far with the power that can be
from the reservoirs Nos. 2 and 3, utilising the two 12in.
t are already laid from them to the filters. By utilising,
the supply from No. 4, the largest and highest reservoir,
) per cent. additional power can be obtained. The cable
opose should be put down in the first instance will be of
size to carry the increased current, and there is sufficient
the accumulator-house for doubling the storage capacity.
h 8,000 lamps connected is a large proportion for the
of the inhabitants, it will be possible by utilising the
al power to supply current for other 4,000 lamps—i e., a
12,000 lamps connected. I am obliged to your Town
for giving me this opportunity of demonstrating the very
onomical results to be obtained by utilising the Touch
There are few towns where the electric light has been
d at less cost than £3 per lamp connected. In many
lead, the rate is much higher. By this scheme the rate
an £2 per lamp connected; and your outlay will therefore
be much less than in other towns not so favourably situated. The principal advantage, however, in the use of the water power is due to the great saving in the generating expenses. Not only is the item of fuel wiped out altogether, but the other items of expense connected with the working of an electric supply station, such as salaries wages of workmen, stores, depreciation, etc., are reduced all along the line. This result is due to the great simplicity in working of a combined water-power and electric storage plant.

It may be convenient, in conclusion, to summarise the various points referred to in this report: (1) The Police Commissioners, by utilising the water power now wasted, may obtain a constant guaranteed output of 54 b.h.p. from the turbines, which, after allowing for losses in the dynamo, cable, and electric storage, is capable of producing a supply of 618 Board of Trade units per day. This is sufficient for supplying the extended area with 8,000 lamps of 8 c.p. connected, or, say, one lamp for every two inhabitants in the burgh. (2) The above supply will be capable of dealing with the electric lighting of Stirling for a considerable time; but if in the future it should become insufficient, additional power can easily be obtained from No. 4 reservoir capable of dealing with 4,000 more lamps connected at a small additional outlay. (3) After making a liberal allowance for working expenses, interest, and sinking fund, and taking 100,000 units per annum as the number sold, the cost of supply works out at 3½d. per unit, equivalent to gas at 1s. 8d per 1,000 cubic feet.

When the total number of lamps have been connected, the selling price being taken at 4½d. per unit, there will be a considerable surplus to the Commissioners, even at that low rate; and as the Corporation paid between £600 and £700 last year for gas for public lighting alone, they would therefore, by the substitution of electricity for gas, have it in their power to make this scheme a financial success, so that there will be no ultimate loss to the ratepayers, even if the demand for private lighting for the first year or so were small. I may add that if the necessary consents and wayleaves be obtained, the whole work could be completed in time for the coming winter. I herewith forward for inspection a plan of the proposed arrangement of turbines and dynamos; four diagrams showing monthly condition of the reservoirs for the last four years; a drawing of a curve, showing the possible output from the storage station during the heavy winter lighting; and also a drawing showing the available space in the butter market arranged for the accumulators. I also send a section of the double steel-armoured insulated cable proposed to be laid down between the turbine-house and the accumulator-house in Stirling. I may point out that, in addition to the guaranteed results of the various manufacturers, all of whom are of high standing, it will be necessary for the Police Commissioners, before proceeding with the scheme, to first obtain the consent and approval (*v de* Clause 6, Section 1, and Clause 64 of the Stirling Electric Lighting Order, 1895) of the Board of Trade, who will send their electrical adviser to Stirling to make an inspection, and if he is satisfied, to pass the proposed works. (Signed) R. FREDERICK YORKE.

SCHEDULE No. 1.

Estimate for Capital Outlay.

Two 54-h.p. turbines, with frames, suction pipes, delivery, and erection	£540
Two dynamos	380
Switchboard	30
Buildings	200
Fittings, etc.	20
Underground cable—3½ miles concentric $^{37}/_{13}$, with laying and jointing	2,495
Accumulators—230 cells = capacity 308 amperes for three hours, or 154 amperes for six hours = 4,466 lamps for three hours	2,525
Stands and converting buildings	100
Allow for continuation of two 12in. pipes, with laying and jointing	200
Allow for trench for cables	100
Engineer's fees and contingencies	410
	£7,000
Allow for distribution—mains, meters, etc.	6,500
	£13,500

SCHEDULE No. 2.

Working Expenses.

Engineer	£180
Assistant	100
Labourer	52
Waterman	52
Present waterman, increase in wages	26
Oil, stores, etc.	26
	436
Add maintenance of accumulator, £164; and maintenance of other plant, £50	214
	£650

SCHEDULE No. 3.

Repayment of Capital, with Interest.

For repayment of generating and distributing plant, with interest, allow 5 per cent. of total cost of £13,500 .... £675

The committee resolved to recommend to the Commissioners that it be remitted to them to see whether the necessary consents and wayleaves can be obtained, and to report.

The **Deputy Clerk** read the following note, which had that day been received from Mr. Yorke with respect to extensions.

"In the event of the cheap supply encouraging the use of electricity for lighting and motive power, etc., the question arises of what will then be the value of the water power in the event of a large increase in the demand. The answer is that its value will be very materially increased, as it will then be used to its fullest extent for the greater part of the year, whereas under the 8,000 lamp scheme, it will only be used to its fullest extent for a few months in the winter. It will be noticed that, although the combined water power and storage plant is capable of giving an output of 618 units per day, the average daily consumption will be less than half this amount if only 100,000 units are sold, which is about the average of other towns. Taking the increased demand for the electric lighting and motive power to be equivalent to the supply of 16,000 lamps connected, or an annual output of 200,000 units, it would be advisable to put down an auxiliary plant consisting of three gas or oil engines of 50 h.p. each. These would only be required to work, say, for the four winter months, and two of these would be working and one would be spare. This auxiliary plant in connection with the accumulator will be capable of doubling the output (*i.e.*, 200,000 units per annum). It would be worked at the highest efficiency, because it would only be used for lighting direct during the hours of heavy load. The water power would deal with the light loads and the charging of the battery. For the summer months about one-half the output of the water power will be sufficient, the cost of generating being 1½d. per unit. For the four months in spring and autumn the full power of the water will be required, the cost of generating being ¾d. per unit. For the winter months the full power of the water will be required at ¾d. plus a similar amount from the gas power at 2d. per unit. In other words, the cost of generating the electric current for the whole 12 months works out an average of 1¼d. per unit, exclusive of interest and sinking fund. The cost per unit, therefore, for generating the electric current under the extended scheme of 16,000 lamps will be less than that for the 8,000 lamps in spite of the higher cost of the auxiliary gas power during the winter. It will be easily seen that the reason for this is that the water power is working at its fullest extent for a much longer time during the year, which more than counterbalances the increased cost of generation by means of the auxiliary gas power during the winter. The cost of wages, salaries, etc., will not be increased, and the additional outlay for the increased plant will only be some £1,500, exclusive of distributing mains. The interest and sinking fund will, therefore, be increased by £75 per annum. The revenue, however, will be doubled, and it will be possible to supply the electric current at a much cheaper rate, say 3d. per unit, which is a lower rate than that charged in any town in the kingdom, being equivalent to gas at 1s. 6d. per 1,000 cubic feet. And should the demand warrant it, even this low rate will probably be improved upon, or a special rate may be granted for the use of power for motive purposes. It is evident, therefore, that the bigger the demand the more effective and efficient will be the employment of the water power, and the cheaper rate at which the electricity can be supplied."

After discussion the matter was adjourned for a time.

Mr. Yellowlees, in seconding the adoption of the committee's recommendation, called the attention of the Commissioners to an unfortunate expression in a letter from Prof. Kennedy, in which he said the action of the Police Commission in this matter had not been courteous to him. He was very sorry that Prof. Kennedy should have thought of accusing the Commissioners of discourtesy. He certainly had never heard him spoken of except in terms of the highest respect, to which he was well entitled, but at the same time it was not to be allowed that because they did not look upon his last report as a conclusive one, their action was in any way discourteous. Their only desire was to see that the best scheme was got for the community.

Mr. Thompson, speaking later, disputed Mr. Yellowlees's statement that the Commissioners had done nothing detrimental to Prof. Kennedy. The Commissioners had put him aside, and called for another report, and that was to Prof. Kennedy a sufficient warrant for saying it was not a usual or courteous action. He thought the Commissioners deserved the rebuke that was contained in the letter. In regard to the other matters, Mr. Yellowlees had taken it for granted that there was nothing to be said on behalf of the Water Commissioners, but he trusted they would take steps to satisfy themselves that nothing would be done to interfere with the water supply which it was their duty to conserve. He thought some person who was a water engineer should be called in to speak as to the capacity of the reservoirs, and whether it would be safe to send down this water at all seasons.

THE HACKNEY ELECTRIC LIGHTING ORDER.

A large and rather noisy meeting was held on Monday evening at the Town Hall, Mare-street, Hackney, called by the ratepayers to protest against the parting of the electric lighting order to a private company. Mr. Geo. Chambers, J.P., chairman of the Vestry, presided over the meeting.

Mr. Dent moved the first resolution: "That this town's meeting is of opinion that it is detrimental to the interests of the ratepayers to part with the lighting order, and therefore recommends the Vestry to retain the order, and hereby emphatically protests against any attempt to create a monopoly." The Electric Lighting Committee recommended that the order should be given to a private company as the Vestry were unable to carry it out themselves, and then at the expiration of 12 years the Vestry to repurchase the scheme as a going concern, but nothing was s[…] as to the terms of purchase. In so doing, he (Mr. Dent) consi[…] the parish would be parting with a valuable asset, and then a[…] end of the 12 years would have to pay an enormous sum—po[…] £350,000—to get it back again. He considered the Vestry sh[…] do the same as St. Pancras, Shoreditch, and other parishes[…] make what profit it could for the benefit of the ratepayers.

Mr. H. R. Taylor seconded the motion in a very strong[…] erratic speech, making very serious charges of bribery[…] corruption against some of the vestrymen, which statem[…] were uncorroborated and met with approval only by that pa[…] the hall crowded with members of the Folk's Hall Social D[…]cratic Federation.

Mr. Henry Hulland, on behalf of the joint committee, tri[…] place arguments and figures before the meeting showing[…] grounds upon which the committee had come to their deci[…] but the meeting did not appear to want facts, and would not[…] him a fair hearing.

The resolution was put and declared by the chairman t[…] carried by 500 to 3. A deputation was then elected of 30 ge[…] men to wait upon the Hackney Vestry to convey the terms o[…] resolution, and also that a copy of the resolution be forwarde[…] the Board of Trade, and asking for an extension of the ligh[…] order.

At the Vestry meeting held on Wednesday evening, the Ve[…] reassembled in committee to consider the joint report of the [...]mittee, and after considerable discussion Mr. J. W. Wi[…] succeeded in carrying a resolution for the matter to be disc[…] in open vestry. The moment this was declared a crowd of [...] payers and others thronged the gallery, and some lively and[…] very creditable scenes were witnessed on the floor of the h[…] Vote after vote was taken, and division after division, amid[…] utmost confusion and disorder, upon a number of resolut[…] the object of which was to adjourn the further considerati[…] the subject, two months, six weeks, three weeks, six month[…] mentioned and divided upon. Very strong language was [...] and after fighting the question on purely party lines from sev[…] eleven o'clock, a resolution was carried by 49 to 21 adjourning[…] further consideration of the subject till the first meeting o[…] Vestry in June, it being understood that the elections next m[…] of vestrymen would be fought upon the question.

During the discussion **Mr. Chubb** said it had been stated[…] gentlemen representing various electric lighting firms had[…] in the building at the time the matter was being discusse[…] committee, and were kept informed by some members as to [...] was going on, the gentlemen in the meantime regaling [...] members with Scotch whisky and cigars; and with the co[…] of the Vestry, the hallkeeper was called in and denied[…] statement.

WALSALL ELECTRIC LIGHTING ACCOUNT[S]

The accounts of the year's working of the Walsall[…] poration's electric lighting station have just been rec[…] The loans sanctioned under the provisional order am[…] to £23,400, of which £21,500 has been borrowed[…] per cent. We give herewith the revenue account,[…] revenue account, balance-sheet, and statement of elect[…] generated, sold, etc., for the year ended Dec. 31, 1897[…]

REVENUE ACCOUNT.

Dr.				£
Generation of Electricity.				
Coal, including delivery	£278	14	6	
Oil, waste, water, and engine-room stores	87	4	1	
Wages at generating station	220	17	5	
				586
Repairs and Maintenance.				
Buildings	42	19	8	
Engines and boilers	76	7	10	
Dynamos, exciters, and transformers	89	4	9	
Instruments and tools	1	15	10	
Accumulators	7	9	9	
				217
Distribution of Electricity.				
Wages at distributing station	50	6	2	
Repairs and maintenance of mains	14	1	5	
Repairs and maintenance of meters	2	13	5	
				67
Public lamps—attending and repairs				81
Rents, Rates, and Taxes.				
Rents	125	11	11	
Rates and taxes	53	6	0	
				178
Management Expenses.				
Salary of engineer	199	0	0	
Salary of clerk	70	18	6	
Printing, stationery, etc.	23	18	3	
General establishment charges	62	2	3	
				35[…]
Special charges—insurance				1[…]
Total expenditure				1,50[…]
Balance carried to net revenue account				54[…]
				£2,04[…]

	£	s.	d.
of current	1,685	0	10
discount	39	4	2
	1,645	16	8
ghting	360	0	0
f meters	41	18	6
	£2,047	15	2

Net Revenue Account.	£	s.	d.
brought forward	445	3	10
on stock	554	19	3
applied in redemption of stock	524	8	3
	£1,524	11	4
	£	s.	d.
at credit of revenue account	547	9	11
, being deficit	977	1	5
	£1,524	11	4

General Balance-Sheet.	£	s.	d.
due to borough treasurer on current account	169	12	7
creditors on open accounts to Dec. 31, 1897..	722	3	2
returnable	45	10	0
demption fund	270	1	6
for discount on current	15	17	6
account—balance at credit thereof	540	13	3
	£1,763	18	0
	£	s.	d.
hand as follows: coal, £10; oil, waste, etc., s. 1d.; carbons for public lamps, £9. 10s.	40	15	1
debtors for current supplied, rent of meters mps, etc.	741	1	6
in hands of engineer	5	0	0
	786	16	7
nue account, balance at debit thereof	977	1	5
	£1,763	18	0

Statement of Electricity Generated, Sold, etc.		
y generated—B.T. units		145,606
y sold: Public lamps	21,820	96,376
y sold: Private consumers—by meter	74,556	
y used on works		9,136
antity accounted for		105,512
y not accounted for		40,094
r of public lamps		14
aximum supply demanded, kilowatts		155

LEGAL INTELLIGENCE.

REVOCATION OF MAGNOLIA PATENT.

appeal against Mr. Justice Romer's judgment and order revocation of the letters patent No. 8,655 of 1890 for the cture of Magnolia metal has been abandoned. The Court al has therefore dismissed the case with costs, and the void has now been struck off the register.

ase has been carried on for about seven years, and the id by the Magnolia Company amount to something like

ACTION AGAINST ELECTRICAL ENGINEERS.

Westminster County Court on Wednesday his Honour Lumley Smith, Q.C., had before him the case of Hallett v. and Leonard, in which the plaintiff, a builder, sued the nts, a firm of electrical engineers, to recover payment of unt in respect of work done to a house at 41, Bedford-

plaintiff's case was that his firm was employed to do a con- le amount of decorative work to the house in question, and endants were also employed to do the electrical wiring and tion. When the defendants had completed their electrical ey left the walls in a very imperfect condition, and the ras that the work which was the subject of this action had ne.

he defence, **Mr. Leonard**, a partner in the defendant firm, led, and swore most positively that the whole of the work was rendered necessary after they had completed their al wiring was carried out by their own men, and not by intiff's.

al other witnesses were called in support of this conten- it after hearing their evidence his **Honour** said there was conflict of evidence, but on the whole he thought the f's were right, and therefore judgment would be for the claimed, with costs.

CK v. THE NATIONAL TELEPHONE COMPANY, LIMITED.

was an action heard before Mr. G. Pitt-Lewis, Q.C., deputy and a jury, on the 14th inst.

lerdon was counsel for the plaintiff, and Mr. Morton Smith defendants.

The **Plaintiff** (Alfred Flack, 8, A Block, Dufferin-street, Bunhill-row) sought, under the Employers' Liability Act, to recover the sum of £150 as damages for injuries caused to his right eye through the alleged negligence of the defendants' servants. The plaintiff said that on Aug. 18 he was sent by the defendants, in whose employment he had been for nine years, to cut down certain wires at Wardour-street and put up new ones. The work was of a dangerous character, and it was necessary for him to climb a pole and hang on there by twisting his leg in order that he might get at the wires and cut them down. He had complained to the foreman of the dangerous character of the work, but the assistance which he asked for was not given him. His eye was very much hurt, and he had to remain in the hospital for three weeks. He now found that the other eye was in sympathy with the eye which had been affected. The accident happened by a piece of wire flying up into his eye immediately after being cut.

The defendants' case was that the plaintiff made a mistake in cutting off the wire too far from the insulator. If he had cut it off close up to the pole no injury would have befallen him. No order was given him as to how many wires he was to cut at once, and it was entirely his own fault that he had been injured.

The jury took this view, and found for the defendants. Their counsel said they would not ask for costs.—*City Press.*

COMPANIES' MEETINGS AND REPORTS.

ORIENTAL TELEPHONE AND ELECTRIC COMPANY, LIMITED.

The directors, in their report for the past year, state that the revenue account shows a balance to credit of £10,909. 18s. transferred to profit and loss, and including £629. 14s. 3d. brought forward from 1896, and after deduction of £2,858. 8s., representing the interim dividend of 4d. per share paid on Oct. 30 last, there remains £8,681. 4s 3d. to be dealt with. The directors recommend the appropriation of this sum as follows: £5,716. 16s. in payment of a final dividend of 8d. per share, free of income tax, making 5 per cent. for the year, £1,000 to extinguish the balance at debit of Colombo exchange suspense account, £1,000 to reserve fund, and to carry forward £964. 8s. 3d. The revenues of the Indian companies continue satisfactory. The Bombay Company has paid a dividend of 6 per cent. as against 5 per cent. for 1896, and has reserved from profits of the year a further sum of Rs.30 000, which has been deemed desirable in consequence of the continuance of the plague in that city and the unsatisfactory outlook in connection therewith. The Telephone Company of Egypt has declared, as hitherto, a dividend of 6 per cent. on its preferred shares. and the business still continues to develop. The China and Japan Telephone Company has paid its debenture interest, and makes fair progress both at Shanghai and Hong-Kong. The electric lighting branch of the Company's business carried on at several of its stations has paid its way for the past year, and the current year opened with a fair amount of business in hand. In accordance the articles of association, Mr. Lloyd and Mr. Frost retire at this meeting. Mr. Lloyd offers himself for re-election. Mr. Frost does not do so. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., also retire, and offer themselves for re-election.

RAND CENTRAL ELECTRIC WORKS.

Sir C. Rivers Wilson, G.C.M.G., C.B. (the chairman of the Company) presided at the adjourned annual meeting of this Company on the 14th inst. at Winchester House.

The **Chairman**, in moving the adoption of the report, said there was a deficiency in the accounts for last year, which, however, had been anticipated, as they had only been working partially during the latter part of the year, the earlier months having chiefly been devoted to experimental work. It was natural to expect that a great work such as theirs could only proceed slowly and by degrees, and with great foresight it had been provided that during the early period of the operations the shareholders should receive a substantial return on their outlay. For the past year this would be a dividend of 6 per cent., for the current year it would be 8 per cent., and next year 10 per cent., so that they were in a very satisfactory position. Commencing to connect with the various mines in May last, their receipts for that month had been only £700. This had gone on increasing month by month till it reached £2,300 in December, and for January of this year it had risen to over £3,000.

The report was adopted.

CROYDON TRAMWAYS COMPANY.

The adjourned general meeting of this Company was held on the 20th inst. at the Guildhall Tavern, Gresham-street, E.C., and was of a very protracted character. Major-General Kaye presided.

Mr. Longley Smith announced the result of the poll demanded at the last meeting to the effect that the appointment of the committee, the election of Mr. Longley Smith as a director in the place of Mr. Wain, and the appointment of Mr. C. J. Baker as a director in the place of Mr. L. Tomkins, were carried.

The meeting having confirmed the above, the extraordinary general meeting followed. It was declared, as the result of the poll taken on the 14th ult. in regard to the sale of the Company's undertaking to the British Electric Traction Company, that the motion was lost.

Mr. Carruthers-Wain (the late chairman of the Company) said that the meeting that day was illegal, and that on the next day he would apply for an injunction restraining the new Board from acting as they were doing.

An extraordinary meeting was then held, at which the following resolutions were adopted: the number of directors was fixed at five; the appointment of Major-General Kaye and Mr. T. K. Freeman as directors of the Company was approved of; the remuneration of the new secretary was fixed at £200 per annum; the late secretary to receive £250 (a vote of thanks was unanimously moved to him for his past services); the payment of the expenses incurred by the investigation committee and of Major-General Kaye in respect of any costs he may have to bear in the action Kaye *v.* the Croydon Tramways Company and the late directors was also approved of.

A **Shareholder** asked whether the directors had had any interviews with the Croydon Corporation.

Mr. Smith said that they had not yet reached that point. They had considered the question of the adoption of electric traction. They were on the eve of approaching the Corporation, and he believed that they would be able to make arrangements of a favourable nature.

INDO-EUROPEAN TELEGRAPH COMPANY.

The ordinary general meeting of the Indo-European Telegraph Company, Limited, was held on the 20th inst. at Winchester House, Mr. J. Herbert Tritton presiding.

The **Chairman**, in moving the adoption of the report, which was adopted, expressed regret at the death of Captain Earle, a valuable member of the Board. He said Mr. T. W. Andrews had been elected to the Board in Captain Earle's place. The revenue had increased by £7,000. It was probable there would be an increase in expenditure during the coming year, as they were going to put down another wire between Warsaw and Odessa, permission having been granted by the Russian Government. They were also making some alterations in Persia. They had adopted the automatic Wheatstone apparatus with satisfactory results.

GREAT NORTHERN TELEGRAPH COMPANY.

The report of this Company states that the net receipts during 1897, including the balance brought forward from 1896, amount to £332,474, exclusive of interest on the investment of the reserve and renewal fund, which has been credited direct to this fund. Deducting £39,361 for interest and amortisation of debentures and £75,000 for interim dividends (already paid), there remains a balance of £218,113, which the Board proposes to distribute as follows: extra dividend, making the total dividend for the year 10 per cent., £75,000; reserve and renewal fund, £77,777; pension fund of the staff, £2,777; directors' remuneration, £1,500; balance to be carried forward, £61,057.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Winchester.—The City Council invite offers to light the street lamps for a term of three or five years from November 1. Tenders are to be sent in by May 1.

London, N.E.—The Bethnal Green Guardians invite tenders for electric lighting plant. Tenders by May 17.

Eccles.—The Corporation invite tenders from persons willing to undertake the free wiring of premises in the borough. Tenders by April 22.

Bootle.—The Corporation invite tenders for the supply and erection of arc and incandescent lamps, lamp posts, and accessories. Tenders by April 25.

Sunderland.—The Corporation invite tenders for the supply of (1) high-speed 225-kw. steam dynamo; (2) Lancashire or Galloway boilers. Further particulars appear in our advertising columns. Tenders by April 29.

Madras.—The Secretary of State for India in Council announces that the time allowed for the receipt of tenders by the Chief Engineer for Irrigation, Madras, for the utilisation of water power of the Periyar Lake has been extended from Oct. 31, 1897, to July 1, 1898.

Esher.—Tenders are invited for the running and maintenance for five years of an electrical installation, comprising gas-engines, accumulators, dynamos, etc., and connected machinery at Millburn, Esher. Further particulars by application to Messrs. O'Gorman and Cozens Hardy, 21, Embankment-gardens, S.W.

Hyde.—The Technical Instruction and Free Library Committee of the Corporation invite tenders for the supplying and fixing of the wires, fittings, gas-engine, dynamo, etc., necessary to the installation of the electric light in the New Technical School and Free Library. Full particulars appear in our advertising columns. Tenders by May 5.

Colwyn Bay.—The Urban District Council invite tenders, in connection with the lighting of their new promenade by electricity, for steam engine and boiler (or gas-engine), dynamo, switchboard, cables, etc. Full particulars appear in our advertising columns. Tenders by May 9.

Aberdeen.—The Town Council are prepared to receive tenders for the supplying and laying of about 10 miles of ·67 single-core feeder cable, about five miles of ·2 three-core network cable, and about 3¾ miles of arc lamp series cable. The cable is to be armoured and laid in wooden casing. Full particulars appear in our advertising columns.

Waterloo (Lancs.).—Tenders are invited by the Urban District Council for wiring and all fittings necessary for an electric light installation to the Town Hall, Waterloo. Plans of the building may be seen, and further particulars obtained, on application to Mr. F. Spencer Yates, A.M.I.C.E., surveyor to the Council, Town Hall, Waterloo. Tenders by 26th inst.

Aberdeen.—The Harbour Commissioners are prepared to receive tenders for the supply and erection of 62 arc lamps on cast-iron posts; also three leading lights, each consisting of four arc lamps mounted on 80ft. posts. All lamps have to be manufactured under either Brockie-Pell or Crompton Pochin patents. Full particulars appear in our advertising columns.

London, E.—Tenders are invited for supplying the necessary plant and installing the electric light at their new infirmary, Palestine-place, by the Bethnal Green Board of Guardians. Plans can be seen and specifications obtained from the architects, Messrs. Giles, Gough, and Trollope, 28, Craven street, Charing Cross, W.C., on payment of £5. 5s., to be returned on receipt of a bona fide tender. Tenders by May 7.

Amsterdam.—Tenders are invited by the Consul-General of the South African Republic at Amsterdam for the supply of (1) insulators with brackets, and (2) hard-drawn copper wire. Tenders not received before 24th inst. at Nicolaas Witsenkade 9, at Amsterdam, will not be regarded. Specifications (in three tenders) can be procured on demand by Mr. F. J. Belinfante, late A. D. Schinkel, Paveljoensgracht, The Hague, at 1s. each.

London, S.W.—The Secretary of State for War is prepared to receive offers in writing, accompanied by competitive designs and specifications, for the supply of portable electric search-light apparatus. General particulars as to requirements can be obtained on application, either by letter or personally, to A. Major, director of army contracts, War Office, Pall-mall, S.W. The offers and designs must be delivered at the War Office, Pall-mall, London, S.W., by April 27, addressed to the Director of Army Contracts, and marked on the outside "Designs for Search-Light Apparatus."

Brierley Hill.—The Dudley, Stourbridge, and District Electric Traction Company, Limited, invite tenders for erection and completion of power station, with chimney stack, carshed, walling, etc., on site near to Dudley-road, Hart's Hill, Brierley Hill. Drawings, specifications, and forms of contract may be seen on application to Mr. Thomas Robinson, architect and surveyor, Victoria-chambers, Stourbridge, from whom bills of quantities and form of tenders may be obtained not later than May 5 on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders by May 12.

Edinburgh.—The Mid-Lothian and Peebles Lunacy Board invite tenders for the installation of electric light in their asylum at Rosslynlee, near Edinburgh, including generating plant, wiring, fittings, lamps, etc. Plans, etc., may be seen at the office of Prof. Baily, Heriot-Watt College, Chambers-street, Edinburgh. Specifications, etc., can be obtained from Prof. Baily or from Mr. R. Addison Smith, clerk and treasurer, 19, Heriot-row, Edinburgh, on payment of £1. 1s., which will be returned after receipt of a genuine tender. Separate tenders may be accepted for (1) the generating plant, including accumulators, switchboard, etc., and (2) wiring, fittings, lamps, etc. Tenders by April 23.

Victoria (Australia).—Tenders are invited by the Council of the city of Hawthorn for the supply and erection, or for the supply only, of: (Section A) buildings only; (B) boilers, water-heater, pumps; (C) engines, dynamos, switchboard, mains, sub-mains, transformers, meters, arc lamps, insulators, testing instruments; (D) supply of poles and their erection; running of the plant for three years. Specifications and forms of tender can be obtained at the office of the Agent-General for Victoria, Lieut.-General Sir Andrew Clarke, G.C.C.M., Victoria Office, 15, Victoria-street, Westminster, London, S.W., on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Tender for Electric Lighting," and addressed to the Mayor of Hawthorn, Victoria, Australia, on June 24, at 5 p.m.

RESULTS OF TENDERS.

Huddersfield.—The Corporation have accepted the following tenders for supply of steel tramway rails (girder section), fishplates, soleplates, and bolts, etc.: Dick, Kerr, and Co., London, rails and fishplates; G. W. Crosland and Co., Huddersfield, soleplates; Bayliss, Jones, and Bayliss, Wolverhampton, tie rods; Phœnix Nut and Bolt Company, Birmingham, bolts.

Leyton (Essex).—The Urban District Council have accepted the following tenders for the extension of the electricity station:

T. Coxhead, Leyton, buildings	£2,594	15	6
Siemens Bros. and Co., Woolwich, dynamos	737	0	6
Wells Bros., Sandiacre, engines	1,707	16	0
Laurence, Scott, and Co., Norwich, switchboards	150	0	0

Portsmouth.—The following tenders have been received by the Corporation for the supply and erection of additional Lancashire boilers, feed pumps, mechanical stokers, coal conveyor and elevator, economiser, steam, feed, condensing water, and other pipes, chequer plating, and sundry ironwork:

Yates and Thom (accepted)	£7,900
Tinkers, Limited	9,215

Blackpool.—The Corporation have accepted the following tenders for the supply and erection of plant at the electricity

abcock and Wilcox, Limited, boiler and superheaters; chant, and Morley, condensers and storage tanks; Ferranti, Limited, rectifiers; British Insulated Wire Limited, cables; C. J. Cowan, boosters; Nalder and mited, transformers.

.—The Town Council have accepted the tender of the Cable Construction Company, Limited, for supplying g new feeders and relaying old ones for the sum of The Electric Lighting Committee have accepted the Lambert Bros., Walsall, for supplying and fixing the ipes required for connecting the condensing plant, for £130; and also the tender of W. Wistance for supply-ner for the condensing plant for the sum of £17. 10s.

outh.—The Corporation have received the following the extension of the electric lighting station:

ch (accepted)	£4,198
	4,350
nd Sons	4,471
ht and Son	4,540
	4,577
ell	4,600
kins	4,822

–The Council have accepted the tender of the Chloride Storage Syndicate, Limited, Manchester, for the supply complete of two storage batteries at the electricity rks, together with the necessary stands and other d work mentioned in the specification prepared by Mr. ar, for the sum of £1,079, and for the maintenance of the term of 10 years at £64 per annum, and also for the of the batteries forming part of the existing electric llation at the town hall and other public buildings for of £30. They have also accepted the tender of the ulated Wire Company, Limited, Prescot, for the execu- undermentioned electric lighting work, in accordance ecification prepared by Mr. T. L. Miller, at the follow- : cable connections to mains for arc lamps, with oxes, fuses and connections to each lamp-post, at yard; cable connections to mains for double incan- nps on arc lamp-posts, with junction boxes and other complete, at 1s. 6d. per yard.

outh.—The following tenders have been received by Pier, Winter Gardens, and Parks Committee for sup- l fixing cables, conductors, lamps, columns, fittings, e lighting of the pier and the lower pleasure grounds:

d Phillips	£2,255	18	0
trical Engineering Company	1,740	0	0
d Cooper	1 521	18	0
	1,602	0	0
arton, and Down, Limited	1 707	0	0
inson, and Co.	1,252	17	0
uth and District Electric Supply Company	1,415	0	0
ulated Wire Company, Limited	1,583	14	9
ant	1,458	6	0
and Co., Limited	5,204	0	0

eyor's report on the tenders, recommending that ash, Robinson, and Co., and the Bournemouth and lectric Supply Company's tenders should be considered nmittee, these being the most suitable for the purpose, fore the committee.

BUSINESS NOTES

n.—Two deputations waited upon the Town Council on ust. in opposition to the tramway scheme.

gh.—It is understood that the electric light is being l into the picture gallery at Holyrood Palace.

Vales Counties Asylum.—The Building Committee has rised to act with regard to the electric lighting of the

nd.—The Council have decided to send a deputation ntinent to glean information respecting electrical

.—The Town Council will apply for £11,500, instead as previously agreed upon, in order to provide for plant.

y. - It is stated that there is a possibility of extensions ams being constructed by an electric tramways company ing city.

rough.—The Town Council have authorised a sub com- tain professional assistance in order to introduce an ting scheme.

-The proposal to light the town clock by electricity mitted to the engineer of the Dock Commissioners for n and report.

The Corporation have received sanction from the Local Board to the borrowing of the sum of £33,594 for the electric lighting.

-Immediate steps are to be taken by the Electric pany to have all their lamps thoroughly overhauled l where necessary.

amps for Cardiff Police.—The head constable favours ntroducing electric lamps for the use of the police e oil lamps, and will report to the Watch Committee ct at their next meeting.

Bournemouth.—A meeting has been arranged for to-day, 22nd inst., between the Urban District Council and the representatives of the British Traction Company.

Carlisle.—The Local Government Board have sanctioned the loan of £30,000 for the purposes of the electric lighting, repayable in 25 years from date of borrowing.

E. H. Gudgeon and Co.—We note that this firm of electrical engineers and contractors have opened branch offices and show-rooms at the Arcade, Winchester.

Southampton.—The electrical engineer's report states that the number of units metered at the works during March was 19,186, being an increase of 42·5 per cent. over the number for March, 1897.

Mitchelstown.—With reference to the Guardians' application for a provisional order for the electric lighting of Mitchelstown, Major Cardew, R.E., inspector to the Board of Trade, will shortly hold an enquiry.

Gourock.—A deputation has been appointed to proceed to London, in company with deputations from Greenock and Port-Glasgow, to confer with the Board of Trade as to the introduction of the electric light.

Manchester.—The committee's recommendation to apply to the Local Government Board for £150,000 for the purposes of the electricity undertaking of the Corporation has been amended to £200,000, and carried.

Edinburgh.—The Town Council have increased the salary of the resident electrical engineer by £100 per annum. It has also been resolved to add 13 electric arc lamps between Donaldson's Hospital and Coltbridge.

Scarborough.—At the last meeting of the Council a letter was read from Mr. Walter Beer, asking whether the Town Council would favourably consider a scheme for an electric tramway in the borough, but no order was made.

Rand Central Electric Works, Limited.—Warrants for the dividend at the rate of 6 per cent. per annum for the period ended December 31 last have been posted to the shareholders registered in the books of the Company as on March 31.

Submarine Cable Trust.—The revenue for the year to April 15, including £159 brought forward, amounts to £23,156. The expenses of the Trust were £1,159, and the payments on account of the coupons to £21,976, leaving a balance of £20 to be carried forward.

Dudley and Stourbridge Tramways.—We are informed that an inclusive contract for the electrical equipment of the Dudley and Stourbridge tramways has been placed with the British Thomson-Houston Company, Limited, and work will be commenced immediately.

St. Helens.—The Corporation having applied to the Board of Trade for sanction to introduce electricity as the motive power on the Corporation tramways, and for sanction to borrow £25,000 for purposes connected therewith, Major Cardew, R.E., held an enquiry on the 19th inst.

Dundee.—A proposal is on foot to establish an electric car passenger service between Dundee, Broughty Ferry, and Barnhill. Plans are in course of preparation, and the proposed route has been inspected, on behalf of the promoters, by a well-known English firm of surveyors.

Taunton.—At the monthly meeting of the Town Council, Mr. Standfast proposed, in accordance with notice he had given, the rescission of the resolution agreeing to apply for a further loan of £10,000 for electric light works, but as the resolution was not seconded, it fell through.

Greenock.—A joint meeting of the Greenock, Port-Glasgow, and Gourock Corporation representatives was held on the 14th inst. to consider the request of the Board of Trade for a conference on the question of introducing the electric light. A deputation was appointed to proceed to London.

Bradford.—The lighting of Bolton-road and Morley-street tram routes with arc lamps, at a cost of £500 a year, and the reduction of the charge for electric current for lighting from 5d. to 4½d. per unit, with a sliding scale for the use of the current for motive power, have been agreed to by the Corporation.

Cardiff.—At the last meeting of the Lighting and Electrical Committee of the Cardiff Corporation, it was decided to strike out the name of a firm from the list of competitors for the supply of junction boxes for electric cables, on the ground that they did not comply with the trades union clause.

Apostoloff Automatic Telephone Parent Syndicate.—Mr. J. W. Cohen, of 13 and 14, Abchurch-lane, E.C., the liquidator of the Apostoloff Automatic Telephone Parent Syndicate, Limited, has declared a first dividend at the rate of 10s. in the £ upon admitted and proved debts of the company. He states that there will be more than sufficient to pay all creditors within a short time 20s. in the £.

Coatbridge.—At the monthly meeting of the Town Council the various minutes regarding the negotiations with the British Electric Traction Company previous to the enquiry by the Commissioners were submitted and passed. The Town Clerk stated that Lord Jersey, the chairman of the Commission, had arranged that a draft of the proposed order would be sent down before it was finally issued.

Newcastle.—At the last meeting of the Electrical Committee of the Corporation the question of the further extension of the electric lighting of the city was considered. After some conversation, it was decided to request the Corporation to give them pow' to approach the electric light companies in the city, in order ascertain the amount required for the sale of the plant and gen works to the Corporation.

Calcutta Tramways.—From the speech of the chairman of the Calcutta Tramways, Mr. E. C. Morgan, at the ordinary general meeting of shareholders, held on the 19th inst. at the offices of the company, it appears that the company are still negotiating with the Calcutta Corporation. As soon as a satisfactory arrangement can be made the lines are to be transformed into electrical ones, and their scope further extended.

Cleethorpes.—The whole of the tramway lines and other material for the construction of the extension of the Grimsby street tramways into Cleethorpes have arrived at Grimsby, and the work of laying the metals will be proceeded with at once. Isaac's-hill, which stands at the entrance to Cleethorpes, has been considerably lowered to furnish an easy gradient for the ascent of the cars, and there is every prospect of the line being in working order for the summer traffic.

Wallasey.—Mr. Walter A. Ducat, Local Government Board inspector, held an enquiry last week at the Public Offices, Egremont, in reference to an application of the Urban District Council for powers to borrow £20,785 for electric light extensions. It was stated that £840 profit had been realised from the electric supply since the system was installed in January last year, and applications for electric energy were coming in such numbers that the Council could not meet the demand without extending their works.

Trent Valley Light Railway Scheme.—Formal notice has now been given of the intention to make application in May before the Light Railway Commissioners for an order authorising the promoters to construct a light railway from Blyton Station, on the Great Central Railway to Frodingham Station, on the same company's Grimsby line. The proposed railway will pass through or into Blyton, Laughton, land common to parishes of Scotter and East Ferry, Scotter, Messingham, Bottesford, Holme, Ashby, Brumby, and Frodingham. The land required will be about four acres per mile, in all about 74 acres.

Walsall.—The electric cable is to be extended fron Park-street to and along Stafford-street as far as Day-street, at an estimated cost of £470 The Electric Lighting Committee's report states that the total number of consumers supplied on March 28 last was 105 The total units generated at the station during the month of March was 17,516. The total output from the main generators was 16 567 units The total units from the transformers was 13,502. The total units registered on the meters was 10,134. The machinery has been run for 210 hours during the past month. The wages paid during the month amount to £47. 10s.

Leith.—A special meeting of the Town Council, as local authority within the burgh of Leith, under the Tramways Act, 1870, the Edinburgh Tramways Act, 1871, and other Acts of the Edinburgh Street Tramways Company, has been held for the purpose of considering and deciding whether the Town Council, as local authority, should exercise the right conferred on them by these Acts to purchase that portion of the tramways works, and property, and undertaking of the company which is situate within the burgh of Leith. Bailie Waldie, as convener of the Tramways Committee, moved the necessary formal resolution for the purchase of the tramways, which was agreed to.

Appointments Vacant.—The Glasgow Corporation invite applications for the positions of (1) a resident engineer to take charge of engines, boilers, dynamos, accumulators, and all accessories comprised in electrical generating stations; and (2) a superintendent of mains to take charge of the laying of new mains, and the maintenance of new and old mains, both copper strip and cable, also connections to consumers' premises, inspection and testing of consumers' installations, fixing of meters, giving of notices, and all other work appertaining to the distribution of electrical energy. An engineer of Government vessels is required by the Government of Lagos, West Africa. Particulars of these and various other vacancies appear in our advertising columns.

Lynn.—The Electric Lighting Committee have reported to the Town Council at its last meeting as follows: "The committee considered the report of Prof. Henry Robinson, C.E., on the lighting of the town by electricity, and also a further letter of 8th inst. from him. Recommended to the hall that the report be adopted, subjected to the committee approving of the site for the central-station works on inspecting same. Agreed that Prof. Robinson be invited to state the terms upon which he would be prepared to design and carry out the works upon the basis of his report. Resolved that it be recommended that application be made to the Local Government Board for their sanction to the borrowing of a sum not exceeding £30,000 for the purposes of electric lighting. The committee afterwards viewed various sites for the central-station plant, and were of opinion that the one mentioned in Prof. Robinson's report is the most suitable one" The Mayor proposed the adoption of the recommendations. The report was adopted, the sum to be borrowed having been fixed at £22,000.

Passenger Lifts.—The City and South London Railway Company has placed the order for the whole of the electric lifts required on their new Islington extension in the hands of the United Ordnance and Engineering Company, Limited, of London and Erith, with whom Easton, Anderson, and Goolden, Limited, are now incorporated. Each lift will be fitted with their patent gear, and will be capable of carrying about 70 passengers, and the average stroke will be 72ft. The current required for working will be supplied from the generating station of the railway company. This firm has recently adapted one of the hydraulic lifts on the Stockwell section of this line, so that it is now worked by electricity. The United Ordnance and Engineering Company, amongst other work of this class, has in progress five electric lifts for the New Brighton Tower, three of them serving to the 80ft. level, and two to the top of the structure, which is over 500ft. high, the speed of the latter lifts being 300ft. per minute, and each carrying 30 passengers. They are also supplying a large electric platform lift to raise two tons for the Royal Agricultural Hall.

Weston-super-Mare.—With regard to an offer which the Municipal Electric Supply Company recently made to the Urban District Council, the latter have replied that should they determine to dispose of their electric lighting order the terms contained in the letter of the company should receive the consideration which they deserved. The general terms of the offer, which is considered a very favourable one, are stated thus: "We propose taking a lease of your provisional order upon the terms that at the end of 10 years (and at any time thereafter) by giving two years' notice in writing the Council shall be entitled to purchase the entire undertaking and goodwill at a valuation to be fixed by independent valuers. Upon transferring the order to the company they will pay to your Council all costs and expenses incurred by them in connection with obtaining the said order, and all fees paid or due to your consulting engineer, Mr. W. C. C. Hawtayne."

Inquest.—Mr. S. F. Langham held an inquest on Saturday at Guy's Hospital on James Henry White, 58, Bay-road, Tunbridge Wells, a telegraph wireman in the employ of the South-Eastern Railway Company. William Lyford, platelayer, deposed that White on the 11th inst. was at work on the top of a telegraph pole between Grove Park and Hither Green. He was engaged in fixing a line of wires. Suddenly the pole swayed and fell to the ground across the rails, White falling with it. Henry George Wood, telegraph inspector, said he inspected the spot after the accident. The pole, which was 26ft. in length, had fallen out. It had been standing in 18in. of earth. The rest of the earth had been removed durimg some work going on along the line. White evidently knew the pole was "shaky." He had spoken of its swaying, and prior to going to work on it had "strutted" it and then "stayed" it with a steel wire. The stays had been taken away before he was sent on the job. The jury returned a verdict of accidental death, and added a rider to the effect that the accident had been brought about through the improper removal of the stays.

The Hans Renold Chain.—We have received an advanced proof of a new sectional catalogue describing and listing the Hans Renold chain for transmitting power. The type of gearing introduced by this inventor is remarkable for its silent running compared with ordinary spur-wheel gearing. It also follows that silent running means greater efficiency, as all jars and rubbing waste power. These chains are, as is now well known, built up of a number of steel links with projecting teeth. These teeth are so formed that they engage and grip the spaces in the gear wheels, and again disengage when the chain leaves the wheel. The laminations threaded on the same pins also take up an individual bearing, which gives an even distribution of stresses. The diagrams and information in the catalogue are most interesting. For the new form of gear recently introduced Mr. Renold claims that the load is evenly distributed over all the teeth in contact with the chain; that the wearing surfaces are also so much increased that the stretching is reduced to a minimum; that the peculiar form of link and tooth will not allow the irreducible minimum of stretch to disturb the correct pitch of the gearing; and that an increase of strength can be obtained without an increase of pitch, and therefore great power can easily be transmitted with ratios of 1 to 6, 7, or 8, and even 10.

New Electricity Supply Syndicate, Limited.—A syndicate with the above name was registered on April 2 by F. King, 28, Park-road, Wandsworth Common, with a capital of £40,000 in £1 shares. The object of the syndicate is to enter into an agreement with A. J. Salisbury-Jones, G. L. Bidwell, and F. W. Salisbury-Jones, and to promote, construct, equip, maintain, manufacture, improve, work, and manage electrical works and appliances for electric lighting. The signatories, each holding 100 shares, are Lord Lurgan, F. B. Jameson, Joseph Hone, John Chambré, Townley B. C. Hardman, Hon. G. E. Hill-Trevor, A. A. Baumann, Viscount Chelsea, M.P., T. F. Kynnersley, Captain W. W. Abney, H. A. W. Hervey, C.B., Shelford Bidwell, F.R.S., Lord Berkeley Paget, D. A. Bevan, Captain H. H. Wombwell, Lord Eustace Cecil, Joseph Oppenheim, J. Douglas Fletcher, Henry B. Hart, and Lord Farquhar. The first directors are Lord Lurgan and A. B. Baumann. Qualification, 50 shares. Remuneration, £2,000 per annum, divisible. We understand that a primary battery is to be the mainstay of the syndicate's business. This battery is said to be able to compete with all country-house and isolated electric lighting plants, but we have no proof before us that such will be the case. We are pleased, however, that a syndicate, and not the general public, are supplying the money.

Hull.—The minutes of the Works Committee, which were submitted to last week's meeting of the City Council, contained a resolution appointing a sub-committee to meet the National Telephone Company with a view of making arrangements for the placing of their wires in underground culverts (as requested by them), the Corporation to be at liberty to take such culverts at any time if they obtain a license from the Postmaster-General authorising them to work and use telephones. The minutes also embodied a draft agreement drawn up on these lines. Sir James Woodhouse, M.P., drew attention to the debate upon the subject which took place in Parliament since the above recommendation had been framed, and strongly advocated the withdrawal of the minute on account of the monopoly it would give the company over the streets of the city. This was agreed to. Referring to Huddersfield, he said the Corporation had their own telephone system. Of course they could not have the supply of telephonic communication to other people; but they had 43 circuits and

ent places, and had put down their own plant, which had 2; and after providing for all expenses and 6 per cent. and sinking fund, the actual cost of each telephone was d. per annum. They had worked it experimentally to at could be done with regard to a municipal telephone

.—It is generally conceded, says the *Leeds Mercury*, that nways Committee have effected a considerable improve- late. The introduction of electricity on the Kirkstall- ay section, with a five minutes' service along the more portions of the route, has been a great gain, both as the convenience of the public and the revenue. Some the number of persons carried to and fro by the Leeds tion tramcars on the five days of the Easter holidays— o Tuesday inclusive—may be gathered from the fact that receipts are £719. 6s. 1d. in excess of what they were for esponding period of 1897. The augmented traffic was l regulated, and no breakdown of any kind was reported. viest traffic was on Easter Tuesday. Taking all the routes the receipts for the five days were £2,043. 16s. 7d., as £1,324 in 1897. On the days mentioned there were 25 motors, with 15 "trailers" attached, making a total of running the whole length from Kirkstall to the Canal . It is interesting to note that on the entire distance of les, from Kirkstall to the Park, the earnings of the new service were—on Good Friday, £229. 3s.; Saturday, . 5d; Sunday, £92. 11s. 5d.; Monday, £234. 17s.; , £281. 4s. 11d.; making the very satisfactory total of 6s. 9d.

ander Decorations.—The United Abestos Company, of Billiter-street, E.C, manufacture, under the above ulded ceilings, friezes, and staircase dados of a highly tal and artistic character. A variety of these panels, e made of Italian asbestos, were on view last year at bition of fire resisting decorations at St. James's Hall, y. It was then mentioned that a ceiling made for the on Hotel and Restaurant, Dublin, consisting of 200 panels of this asbestos, was in one of the workshops of artins and Sons, Stephen's-green, when that establish- partially destroyed by fire. It was found the day after at while everything around had been completely destroyed mes, and that even solid metal pillars had been melted emendous heat, the asbestos ceiling remained absolutely l. Curiously enough, this same ceiling had to undergo a e test, and we have seen a letter from Mr. James J. Farrall, I., architect, Dublin, referring to the recent fire at the n Hotel, in which he states that the ceiling must have ected to a tremendous heat, notwithstanding which it is y uninjured by the fire. Mr. Farrall further says: everything into consideration, I am decidedly of opinion fire would have spread to the upper portions of the before the services of the fire brigade could be availed of been for the fireproof qualities of the ceiling covering ffet, and I shall have no hesitation in recommending the of similar decorations wherever practicable." We may conclude that these panels are not only highly ornamental ly useful.

ond.—A special meeting of the Richmond Town Council last week to consider the London United Tramways Bill re Parliament. The Mayor (Councillor Chancellor) was ir, and there was a full attendance of members. Alder- inson, as chairman of the sub-committee, remarked that had the disadvantage of having two Bills before them to In the original Bill the promoters contemplated a double Richmond to Kew. That had now been abandoned, but posed to make a double line over Kew Bridge so as to heir Kew line with that on the other side of the river. ey had abandoned the double line in Richmond they pro- rive their cars by electricity by means of overhead wires, ablish a generating station where their depôt now existed. ittee thought that it was not desirable that this should d, and were also of opinion that the overhead wires opposed, but if they did it all they should adopt the tor system. The new Kew Bridge as at present designed too narrow to allow a double line, and the expansion of e and its approaches would mean an extra expense of r £15,000, and if the generating station were in Kew- would perhaps be another ugly chimney shaft to dis- place. He moved the recommendation of the committee, to the effect that the Council oppose the Bill by petition. e ensuing debate Councillor Bastable thought they should e the line going over Kew Bridge, for there were other Richmond to consider. They had a monopoly in the nd by connecting the tramways with the other side of it would open up a new route, which would mean a not a few. He, however, strongly deprecated the over- . Councillor Smith said the company should wait until e was built. The motion was then put, and carried

—On April 15 a special meeting of the Corporation was e City Hall for the purpose of taking into consideration rom Messrs. Casey and Clay on behalf of the Dublin amways Company, notifying the intention of the com- ply for an Order in Council to enable them to construct f tramway within the city of Dublin as set out in the sited in the town clerk's office, and seeking to obtain t of the Corporation to the construction of such lines of The letter was inserted on the minutes. The report of gineer on the memorial of the Dublin United Tram- ways Company, promoters of the Dublin United Tramways (Extension of Lines and Alteration of Existing Lines) Order, 1898, was then considered. The report stated that the lines sought for now by the tramway company were practically the same as those submitted at the Easter sittings of last year, but in connection with which the Council did not come to any final decision. There were 16 different proposals from the tramway company to extend, connect, and double several of their lines, as already mentioned. One of the extensions of the line would come through the gates of the Phœnix Park at Parkgate-street into the main avenue of the park, passing the Zoological Gardens and Constabulary Barracks and terminating by junctions to the end of the existing tramway on the North Circular- road. There was also an extension proposed from Dolphin's Barn-lane to Rialto Bridge. It was resolved (1) that the tramway company shall not double the existing line of tramways in Capel-street between Grattan Bridge and Ryder's- row, nor shall they double any portion of the tramway in Bolton- street and Dorset-street Upper between King's Inns-street, at Bolton-street, and the present passing place in Dorset-street near Granby-row; (2) that the portion of the tramway line between Dunphy's-corner and the corner of Dunphy's-lane remain a single line, and that there be also a single line up to Cross Guns Bridge unless the bridge be widened to the satisfaction of the borough surveyor and at the expense of the tramway company, in which event the line shall be doubled; (3) that tramway No. 5 be a single one, with the necessary crossing places as may be agreed upon, in Britain-street, in Capel-street, and in Rutland-street at Summer- hill, and that the remaining portion be doubled; (4) to extend the Dolphin's Barn line to Rialto Bridge, forming a junction at Charlemont-street and Harcourt-road, and interlacing the existing line at Redmond's-hill; (5) to approve of the lines proposed to be constructed at the junction of Grafton-street and Stephen's green, and the lines from Stephen's-green North to Merrion-row, and from Stephen's green North to Hume-street, and other connections in Stephen's-green; (6) that there should be a single line from Merrion-row at the Stephen's-green end to the point near Lower Pembroke-street, and that the remainder of the line be doubled; (7) to construct the line connecting Stephen's-green East and Earlsfort-terrace with Leeson street Lower, and passing through that thoroughfare to Eustace Bridge, over the Grand Canal; and also (8) the new line proposed to pass from the existing line in Great Brunswick-street over Victoria Bridge, Ringsend-road, and to terminate opposite the north-west end of Barrow-street. The remaining proposed line is intended to run along Ringsend- road, across the Dodder to Irishtown, and to terminate at the junction of the existing lines at the northern end of Tritonville-road. The general scheme of the company, subject to conditions laid down by the Corporation, was adopted. The Town Clerk submitted a letter asking for instructions regard- ing the recommendations set forth in the report of the committee of the whole house relative to the proposed new electrical station at the Pigeon House Fort. This letter was referred to a committee of the whole house to consider the entire question of the new station, the site at the Pigeon House Fort, or such other suitable situation for a station as they may determine. The committee are to submit the question of this station and scheme to the best electrical experts obtainable for their advice; to consider and suggest to the Council the best method of raising the necessary money for the building and equipment of such a station as will electrically light the entire city; to advertise for and obtain tenders for the carrying out of the work; that when the tenders have been obtained, to report on the whole question to the Council; that the preliminary expenses involved in carrying out this resolution be defrayed out of the borough fund.

PROVISIONAL PATENTS, 1898.

APRIL 12.

8489. Improvements relating to the electro-deposition of metal. Howard Wilkins Wright, 18, Southampton-buildings, Chancery-lane, London.

8495. Improvements in electric switches and fuses. James McFarlane and Holland House Electrical Manufacturing Company, Limited, 154, St. Vincent-street, Glasgow.

8496. Improvements in motorcars. Anthony George New, The Voltage, Woking.

8497. Improvements in vehicles. Anthony George New, The Voltage, Woking.

8539. Improvements in and relating to electric heaters. Edwin Forsythe Porter, 77, Chancery-lane, London. (Complete specification.)

8550. Improvements in automatic magnetic circuit breakers. William Maxwell Scott, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

APRIL 13.

8584. An automatic switch for electric cooking utensils. Frederick Jonathan Down and Justus Eck, 5, Priory-road, Bedford Park, London.

8602. Barriers for the outside entrance of tramway, electric tramway, and railway carriages. Curt Lindner, 5, Seestrasse, Dresden.

8603. Waterproof contact apparatus for electric railways with underground conductor. Gustav Ihle, 5, Seestrasse, Dresden. (Complete specification.)

8638. Improvements in electric furnaces for the manufacture of carbide of calcium or other electro-chemical or electro-metallurgical products of the like kind. Paul Determes, 65, Chancery-lane, London.

April 14.

8710. Improvements in and relating to electrical incandescence lamps. John Robert Quain, 60, Queen Victoria-street, London.

8713. Improvements in and connected with generators for electrical igniters in gas or like engines. Benjamin McInnerney, 55, Chancery-lane, London. (Complete specification.)

8718. Improvements in telephonic apparatus. Moise Freudenberg, 45, Southampton-buildings, Chancery-lane, London.

8735. Improvements in telegraphic transmission over long submarine cables by Wheatstone's automatic apparatus. Secondo Roos and Piètro Biraghi, 4, South-street, Finsbury, London.

April 15.

8823. Improvements in or connected with drum armatures for electric generators and motors. Valere Alfred Fynn, 47, Lincoln's-inn-fields, London.

8829. An improved apparatus for counting telephonic conversations. Friederich Graf, 18, Buckingham-street, Strand, London.

8832. Improvements in electricity meters. Charles Edouard O'Keenan, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

April 16.

8848. Improvements in the method of and means for the electrical propulsion of railway, tramway, and other similar vehicles. William George Heys, 70, Market-street, Manchester. (Jean Jacques Heilmann, France.) (Complete specification.)

8856. An improved method of intercepting dust arising from the commutator of dynamos. James MacLaren, 156, Bedford-road, Bootle.

8864. Improvements in electric devices for theatrical purposes. Michel Sanson, 8, Rue des Princes, Brussels. (Complete specification.)

8881. A pocket telephone. William Connor, jun., 115 St. Vincent-street, Glasgow.

8901. Improvements in or relating to electrostatic machines. La Sté A. Cohendet and Co. and Paul Archat, 111, Hatton-garden, London. (Date applied for under patents, etc., Act, 1883, Sec. 103, March 5, being date of application in France.)

8913. A method of and means for transmitting electric currents through musical instruments to players or performers. Hendrick Bernardus Knoblauch, 55 and 56, Chancery-lane, London.

8920. Improvements in trolley poles and standards for electric traction. Siemens Bros. and Co., Limited, and Frank Ayton, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

8927. Improvements in electrical apparatus for gas lighting and other purposes. James Frederick Bennett and Walter Appleyard, The Don Confectionery Works, Bridge-street, Sheffield.

SPECIFICATIONS PUBLISHED.

1897.

7315. Electric circuit hour meter or automatic cut-out. Bastian and Staunton.

7868. Electrical clocks. Hope-Jones and Bowell.

8025. Electrical connection for tables and the like. Banks.

8906. Electric couplings. Davy and Thomas-Davies.

11148. Alternating-current motors. Belfield. (Lamme.)

11190. Electrolysis of fused zinc chloride. Lyte.

11355. Means for attaching shades to electric incandescent lampholders. Hall and Clarke.

13049. Enclosed arc lamps. Drake and Gorham.

17314. Motor vehicles for electric railways. Lake. (McGuire.)

17545. Electric circuit closing device. Hollstein.

20449. Current-conducting rails for electric railway systems. Walkins and Jewett.

21180. Dynamo-electric machinery. Lewis and Howitt.

24421. Systems for the transmission of electrical energy and apparatus for use therein. Lake. (Tesla.)

30686. Primary batteries. Hubbell, Hubbell, Boyer, and Mucklow.

30838. Apparatus for use in the manufacture of accumulator plates. Marschner.

1898.

1493. System comprising a method of and means for making connection between an underground conductor and vehicle motor, such as a tramcar or the like. Butler.

3341. Method of and means employed for connecting electric glow lamps to main conductors. Palm.

TRAFFIC RECEIPTS.

Liverpool Overhead Railway.—The traffic receipts for the week ended April 17 were £1,736, as compared with £1,478 in same week of 1897, being an increase of £258.

Birmingham Tramways.—The traffic receipts for the week ending April 16 were £4,137. 7s. 10d., as compared with £3,326. 5s. 10d. for same week in 1897 being an increase of £811. 2s. 0d.

Dover Tramways.—The traffic receipts for the week ending April 16 were £180. 7s. 0d. The total receipts for the year 1898 are £1,695. 4s. 2d. The mileage open at present is 3 miles.

Bristol Tramways.—The traffic returns for the week ending April 15 were £3,273. 4s. 4d., compared with £2,219. 7s. 2d. for same period of last year, being an increase of £1,053. 16s. 9d.

South Staffordshire Tramways.—The traffic returns for the week ending April 15 were £856. 16s. 2d., as compared with £606. 4s. 6d. in same week of 1897. The aggregate receipts for the year are £8,938. 6s. 3d., as against £8,647. 7s. 6d. in the same period of the previous year.

City and South London Railway.—The returns for the week ended April 17 were £945, compared with £845 for same week of 1897, being an increase of £100. The total receipts for the half-year amount to £16,771, compared with £16,684 for the same period last year, being an increase of £87.

Dublin S.D. Tramways.—The traffic receipts for the week ending April 1 were £358. 12s. 8d., as compared with £367. 11s. 1d. in the corresponding week in the previous year, being a decrease of £8. 18s. 5d. The number of passengers carried was 62,971 in 1898 and 60,701 in 1897. The aggregate returns up to date are £5,152. 1s. 8d., as compared with £5,514. 4s. 9d. last year, being a decrease of £362. 3s. 1d. The mileage open is the same as last year—viz., 8 miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	6	10½-10¾
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	15½-15¾
Brush Company, Ordinary	3	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2	2½-2¾
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	103-106
Callender's Cable Company, Debentures	100	110-113
—— Ordinary	5	9-10
Central London Railway, Ordinary	10	10⅛-10⅜
——	6	6⅛-6⅜
—— Pref. Half-Shares	1	1⅛-1¼
—— " "	5	4½-4¾
Charing Cross and Strand	5	13½-14½
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	10¾-11¼
—— 4½ per cent. Debentures	100	115-117
City of London, Ordinary	10	26-27
—— Prov. Cert. 90,001-100,000	5	17½-18½
—— 6 per cent. Cumulative Pref.	10	17½-18½
—— 5 per cent. Debenture Stock	100	133-136
City and South London Railway, Consolidated Ordinary	100	69-71
—— 4 per cent. Debenture Stock	100	138-142
—— 5 per cent. Pref. Shares	10	15-16
—— " " '96	10	13½-14½
County of London and Brush Provincial Co., Ordinary	10	14½-15
—— " " "	4	5-6
—— 6 per cent. Cum. Pref.	10	15½-16½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
—— 5 per cent. Debentures	—	90-93
Crystal Palace District, Ordinary 5 per cent. Stock	100	128-132
—— Preference 5 per cent. Stock	100	140-143
Edison and Swan United Ordinary	3	3½-3¾
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	105-108
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	3¼-3¾
Electric Construction, Limited	2	2¾-3¼
—— 7 per cent. Cumulative Pref.	2	3½-3¾
—— 4 per cent. Perp. 1st Mort. Deb.	100	105-108
Elmore's Copper Depositing	1	[illegible]
Elmore's Wire Company	2	[illegible]
W. T. Henley's Telegraph Works, Ordinary	10	23½-24½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-113
House-to-House Company, Ordinary	5	10-11
—— 7 per cent. Preference	5	11-12
India Rubber and Gutta Percha Works	10	21-22
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	16½-17½
—— 6 per cent. Pref.	5	8½-9
London Electric Supply, Ordinary	5	3¾-4¼
Metropolitan Electric Supply, Limited, Ordinary	10	19-20
—— 4½ per cent. First Mortgage Debenture Stock	100	117-121
National Telephone, Ordinary	5	5¾-6
—— 6 per cent. Cum. First Pref.	10	15-16
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	5½-6
—— 3½ per cent. Deb. Stock, Red.	100	106-108
Notting Hill Company	10	19½-20½
Oriental, Limited, £1 shares	1	1¾-2
—— £5 Shares	5	8-8½
—— £4½ shares	4½	7-7½
Oriental Telephone and Electric Company	1	1-2
Royal Electrical Company of Montreal	—	143-145
—— 4½ per cent. First Shares Mortgage Debentures	100	105-108
South London Electric Supply, Ordinary	2	2½-2¾
St. James's and Pall Mall, Limited, Ordinary	5	17½-18½
—— 7 per cent. Pref.	5	10-11
—— 4 per cent. Deb. Stock, Red.	100	107-110
Telegraph Construction and Maintenance	12	35-36
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	100	135-139
Westminster Electric Supply, Ordinary	5	16½-17½
Yorkshire House-to-House	5	5½-6

NOTES.

Scott Medal.—The Committee on Science and the the Franklin Institute has recommended the award ohn Scott Legacy Medal and Premium to Messrs. and Psaroudaki for their invention of holophane or securing a good diffusion of an artificial source

ew Publication.—We have received the first *Cold Storage and Ice Trades Review*, and would a warm welcome but that the expression seems riate. The great use of electricity as a lighting cold-storage rooms does not seem to be referred to esent number.

head Electric Traction.—We understand that Quin, the electrical engineer at Blackpool, has and patented a method of rendering a trolley d immediately a fracture occurs. The details of ce are not yet to hand, but it is said that the ends would be dead before they touch the ground ling.

rical Taxes.—In London, engineers are com- that the rates and taxes bear too heavily on ight stations. In Spain, the complaints from all ted patriots will be even stronger, as in that a war tax is to be imposed on the electric lighting ings. Gas and petroleum interests will come under equally.

Book.—We have received a book entitled "Quan- hemical Analysis by Electrolysis," by Dr. Alexander in co-operation with Dr. Walter Löb, both of The present book is an authorised translation revised and greatly enlarged fourth German y William Hale Herrick, A.M., and Bertram B. , Ph.D. The book is published by Chapman and

ric Lighting at Singapore.—*Indian Engi-* nnounces that a draft scheme has been submitted Municipality by Messrs. Moine and Co. for ramways and the electric lighting of Singapore. posal will be taken into consideration in due nd, if vested interests do not intervene, the at will make a necessary advance in its develop-

ution of Electrical Engineers.—With respect tra meeting of this Institution at the Society of Thursday, May 5, it is hoped that, subject to the n on Messrs. Parshall's, Cardew's, and Trotter's ing finished last night, a paper will be read by ard Andrews on "The Prevention of Interruptions icity Supply." The actual arrangements for May 5 unced at the close of the meeting last night.

Railways.—On Friday, April 22, according to s, the Board of Trade confirmed the first order for truction of a light railway under the new arrange- The line in question will run from Mound Station Highland Railway to Dornoch in Sutherlandshire; County Council for Sutherlandshire is one of the rs of the scheme, a fact to which Sir Courtenay ade a congratulatory reference in announcing the Trade's decision.

ral Africa Telegraph.—The secretary of the South Africa Company states that the following m was received last week by Mr. Rhodes from R. French, the Postmaster-General at Capetown: h telegraphic communication from Capetown to (British Central Africa Protectorate) was estab- esterday (Wednesday). Congratulations." The approximate distance between the two points mentioned, covered by telegraph line, is more than 2,000 miles.

Telegraph Vessels.—The Spanish Government issued just before the war a decree which gives certain privileges to Spanish and foreign vessels as long as the same are used exclusively for the purpose of cable-laying or maintenance, and provided that they do not carry any cargo other than these cables and such apparatus necessary for their work. These vessels are practically made free of custom dues. All that is required is a manifest signed by the captain showing the occupation of the vessel and the stores on board. The Spanish authorities are in the decree mentioned enjoined to give every assistance in their power to further the work of these vessels.

The Duties of the Electrical Press.—The technical Press in England restricts itself fairly closely to technical matters, with perhaps a dose of educational matters occasionally, but it does not attempt at present to enter into the private needs of the individual engineer. The American electrical Press is far away ahead of us in such respects, and thus several papers advise their subscribers as follows: "Educate your bowels with cascarets." And again: "Don't tobacco spit and smoke your life away. To quit tobacco easily and for ever, be magnetic, full of life, nerve, and vigour, take ——, the wonder-worker, that makes weak men strong," etc. We wonder that cookery recipes for engineers' sweethearts and wives are not added.

A New South African Journal.—We have received Part 2 of Vol. I. of the *Journal* of the Chemical and Metallurgical Society of South Africa. It appears to be a most useful paper to those engaged in gold mining, and we note that the present issue contains abstracts of General Webber's recent paper to our Institution of Electrical Engineers. We also note a confirmation of the old quotation, *in vino veritas*. The proceedings at the annual dinner of the society are reported, and the chairman ventured on the following statements on the Transvaal law: "They were face to face, therefore, with the curious anomaly that while in other branches of science law and knowledge prevailed in that country, in the profession of law itself lawlessness prevailed." Later on he estimated that important changes would be effected in this respect within five years.

The Bell Telephone Company.—We gather from the chairman's speech to the general meeting of this American company that the output of the telephones and the increase in the number of exchange subscribers are still unprecedented in the history of the business. The gain of exchange stations reported for the past two years equals the aggregate gain of the six years which preceded. The underground wire system is now in use in 130 of the exchanges, and 282,634 miles of exchange wire, or nearly 50 per cent. of the total mileage of the United States, are now carried on by means of underground conduits. As regards the limitations of the use of underground lines for long distances, it has been found that with the best class of cables transmission can be accomplished by this means for distances of only a few miles. So far, therefore, as the development of the art has gone, it is still impracticable to employ underground lines for long-distance service between towns.

Tramway Development.—A further development of the Leeds city tramways will be witnessed early next week in the opening of the newly-constructed stretch of line from York-road to Green-road on the Beckett-street route, thereby completing the connection from the Leeds Corn Exchange and York-street, and through Burmantofts to the junction of the line with the electric system at Roundhay-road. For some months the Burmantofts portion

of the line has not been utilised pending the construction of the connecting link. Now that the work is practically finished, it opens up a new route to Roundhay Park that will no doubt be largely made use of by the denizens in one of the most thickly populated portions of the city. The Tramway Committee propose to charge halfpenny fares for each of the three stages—namely, from the corn exchange to Green-road, from Green-road to the cemetery, and from the cemetery to Roundhay-road. The building used as a generating station by the Thomson-Houston Company has been converted into tramway stables to accommodate 25 horses.

Self-Praise.—A reply to some of the recent attacks on the National Telephone Company was made last week by the general manager, Mr. W. E. L. Gaine, at the annual staff dinner at the Trocadero Restaurant. He said that during the past year 90 new exchanges had been opened, making a total of 800 in working order, and the number of subscribers had increased by 12,000. The company courted the fullest enquiry, and he believed that the judgment of experts would be that their service was as cheap and as efficient as it was possible to make it, considering the great difficulties with which they had to contend. Lord Harris, who replied to the toast of "The Health of the Company," urged that he was in a delicate position, as, though vice-president of the company, he represented the Local Government Board in the House of Lords, and it might conceivably fall to his lot to have to propose a Bill granting licenses to municipalities. He agreed that the telephone service must remain a monopoly, either in the hands of the State or in private hands. No competition was possible.

The Trolley Litigation.—The under-running trolley patents in the United States has been the cause of endless litigation, and each time a decision is given a previous one seems to be reversed. Now we learn that in the suit of the Thomson-Houston Electric Company against the Union Railway Company, New York, the United States Circuit Court of Appeals has reversed Circuit Judge Lacombe's decision, in which he granted an injunction pending final hearing in the case, restraining the railway company from using certain overhead trolley car appliances to which the plaintiff claims exclusive right under the Van Depoele trolley patent. The Union Railway Company is using the Walker Company's apparatus, and the officers of the latter company state that under the decision the right to make and use the trailing freely mounted trolley arm pressed up against an overhead conductor is now no longer limited to the General Electric and Westinghouse Companies and their licensees. This seems funny, as it is only an interim injunction which has been refused. The case itself is yet to be fought in the Court of Appeals, and the outcome will be watched with interest.

South-Western Polytechnic.—A special class in steam-engine trials, intended for draughtsmen and advanced engineering students, is to be given at the above Chelsea Polytechnic by Prof. Pullen, Whit.Sch., A.M.I.C.E., and Mr. H. A. Clark, Whit.Sch., A.I.E.E. These classes will be held on Tuesday evenings from 7.30 to 10 p.m., commencing May 17 and terminating June 28, 1898. The ground covered will include the use of planimeters and averagers for obtaining the mean effective pressure from the indicator diagram; experimental determination of the indicated horse-power, brake horse-power, steam consumption and the dryness of the steam entering the engine, together with the construction of a balance-sheet of heat distribution. The main object of the trials will be the determination of the indicated horse-power, brake horse-power, mechanical efficiency, steam consumption and heat used per indicated horse-power and brake horse-pow[...] when cutting off steam at the following fractions [...] stroke—viz., $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, and $\frac{5}{8}$, at speeds of 200 and 35[...] lutions per minute respectively at full load for each [...] expansion. The fee for the course is 10s.

Germany's Municipal Stations.—The [...] States Consul at St. Gall, in a report to his Gover[...] states that in the following cities in the German E[...] the municipal authorities own and manage the [...] works that supply light and power: Bremen, B[...] Cassel, Darmstadt, Düsseldorf, Elberfeld, Hanover, Co[...] Königsburg, Lübeck, and Pforzheim. All of these [...] with the exception of Hanover, also own the gas[...] The following cities have constructed the electric [...] for the purposes of light and power, but have leas[...] management of the same to private operators: A[...] Chapelle, Chemnitz, Frankfort, Strasburg, and Stu[...] all of which, with the exception of Chemnitz, are [...] where the gasworks are under the management of p[...] corporations. In the following cities, private com[...] have established electric works with the agreement [...] under certain conditions, the municipal authorities [...] have the privilege of securing absolute control and [...] ship by purchase: Altona, Dessau, Gera, Hagen, Heil[...] Leipsic, Mülhausen, Stettin, and Zwickau. Of these [...] the gasworks are under private control in Dessau, [...] Mülhausen, and Zwickau.

A Recuperative Battery.—From the *Journal* [...] Chemical Society we take the following abstract [...] article, headed "Electrical Energy caused by the [...] Action of the Atmosphere," by Henry N. Warren, [...] appeared in the *Chemical News*. Plates are prepare[...] special porous compressed graphite, and about one-q[...] of each plate is rendered active by immersion in p[...] oxalate, drying and igniting in an atmosphere of hyd[...] In contact with a solution of ferrous sulphate, the pl[...] surface induces oxidation of the iron by the oxygen [...] atmosphere. Several of these plates are attached [...] circular lead beam, which surrounds a porous diap[...] containing as negative element a rod of amalgamate[...] the carbons being so arranged as to allow the pla[...] portion to project above the solution, which consi[...] strongly acidified ferric sulphate. On completion [...] circuit, a powerful current is at once generated [...] continues until the complete reduction of the ferric s[...] taken place, which naturally terminates the action [...] now withdrawing the zinc, the platinum surface cond[...] the atmospheric oxygen steadily reoxidises the ferrou[...] and thus renews the action when required.

Statistics on English Electric Lighting P[...] The first of a series of articles on the above subject a[...] in the *Electrical Engineer* of New York for April [...] Mr. Claud P. D. Oyly is the author, and we cannot [...] ment that gentleman on his production. As a first [...] he takes a series of nine station returns, of which si[...] a loss and three a profit. The author does not sta[...] the municipal undertakings are scheduled as giving [...] if they cannot pay interest and sinking fund ave[...] up to 5 per cent. Then the wideawake author, wh[...] so much about "American vim," gets hold of old r[...] although new ones are at hand of several of the stations [...] To give an example, Bristol is quoted as showing a [...] £5,000 per annum. The other returns are from Ki[...] on-Thames, Newport, Taunton, Pontypool, Brighton, [...] ford, Bedford, and Dover. The author naively say[...] the Brighton plant would show a large profit under a [...] of directors, but under municipal control much that i[...] profit is charged to depreciation, sinking fund, etc. W[...] the author will improve both in the data of these fa[...]

powers of comprehending what is the aim of muni- management before giving himself away in further ...

ater Resistances.—The use of the water in canals rivers as the resistance for alternator testing is rather ... on the fish in the water. This we saw demonstrated ... canal by the Amberley Wharf station of the Metro- ... Electric Light Company some years ago. Now ... the States comes the story that the Edgerton Electric ... Company were recently engaged in testing some of ... chinery employed at the power station on the Rock ... at Indian Ford. The wires leading from the dynamo ... out of the station into the tail race for the purpose ... ing the necessary resistance. The wires carried ... at 2,000 volts, and, of course, charged the water ... iately about with electricity. The river was high ... of fish endeavouring to work themselves up over ... Whenever a red-horse sucker or pickeral got ... near the live wires it took a shock that sent it ... surface, when it would roll upon its back with mouth ... wide open. Occasionally one more cautious would ... close enough to the danger line to get a touch of the ... when it would take a shoot across the river, but ... reater portion were easily caught in the trap. A ... string of fish could have been taken there in a very ... oments.

mployers' Liability.—The question of compensation ... a person has been run down and damaged by a ... is discussed in a leader in the *Western Electrician.* ... up that, as far as the general public are concerned, ... little, when valuing the damages, whether the ... are due to the carelessness and incompetency of ... or to defective and inadequate apparatus and ... ive devices. Where the deceased was a servant of ... mpany, the American courts are not very unanimous ... the liability of the tramway company to compensate ... tives. For instance, one American court declared ... that it has been settled in that country and in ... that if a servant chooses to enter employment ... danger of personal injury, which the master ... have avoided, he takes upon himself the risk of all ... ards incident to the employment, the existence of ... is known to him, or which are plain and obvious, and ... he has no reason to expect will be counteracted or ... d, and that no action will lie against the master for ... to the servant resulting from such dangers. We ... know where the court in question got its English ... ent from in such matters, as such a decision is ... an infringement of even the old Employers' ... y Act.

Accuracy of Electric Meters.—Of all com- ... apparatus on which popular abuse has been heaped, ... has needed less defence or had to stand severer ... than the electric meter. While, of course, it is ... ible to guarantee absolute accuracy with this kind ... ratus, yet the electric supply companies are always ... to improve on the styles in use, and to charge the ... fairly for what they use. As an example of ... the Edison Electric Illuminating Company, of New ... have achieved good results. In its annual report ... 897, the following reference is made to meters: ... meter bureau had under its care on Dec. 31, 1897, ... meters, of which 6,744 were Edison meters and ... mechanical meters. There were 1,530 complaints from ... rs, and of these only 215 were found to be ... , of which 138 errors were clerical and 77 ... d. In calibrating the mechanical meters care ... that they do not run more than 2 per cent. ... 5 per cent. slow. The error thus caused is very slight, and special discounts are arranged for very heavy consumers, which cover any inaccuracy. Meters are inspected at regular intervals, or are checked at the customers' request. The meter, if not tampered with, fulfils the duties required of it remarkably well."

Labour Legislation.—The council of the Free Labour Protection Association invites members of the House of Commons to oppose the following Bills as affecting the freedom of the individual and causing State regulations of industries in favour of one special class: the Miners' Eight-Hour Bill, the Steam Engines and Boilers (Persons in Charge) Bill, the Boilers Inspection and Registration Bill, the Common Employment Abolition Bill, and the Workmen's Houses Tenure Bill. The second of these Bills would, if passed in its present form, empower the Secretary of State to prevent anyone having charge of a steam engine or boiler of more than 5 h.p. (except when used exclusively for domestic, agricultural, or farming purposes, or on her Majesty's railways, steamships, and roads) unless such person has obtained from him a certificate by examination, or application with proof of practical experience. Certificates by examination are to be ranked as first class; certificates on application, with proof of practical experience, are to be ranked as second class. It is objected that this Bill, introduced by the Labour leaders, will give "the highest ranks of labour a monopoly of the market, which, in the interests of wage-earners generally, is not desirable. The Bill is wholly unnecessary and uncalled for; there is not, and never has been, any genuine demand for it among working men; it is unsupported by facts or statistics; it may work enormous injury and injustice to every employer in the United Kingdom using steam power."

Stage Mechanism.—Mr. Edwin O. Sachs, in his lecture at the Society of Arts on Wednesday last, lamented the fact that England is so backward in stage appliances of the more modern pattern. With few exceptions, only the old wooden stage, with heavy, cumbersome wooden drums, ropes, etc., was in use. The new theatre at the Haymarket was instanced as an example of some advance; there for the first time in England the "flat" stage had been introduced. The sloping stage had always been a hindrance to those who wished to adopt some mechanical power for the working of the scenery. After describing various wood-and-iron and iron stages, he went at length into the Asphaleia system, where everything is moved by hydraulic power. Practice, however, does not support theory in so radical a change. The only electric stage was the one in use at Munich. This system seems to work well, and is extremely simple if abundant space and abundant means are at the disposal of the manager. The stage is circular in shape, and from three to four times larger than prescribed by the requirements of the play. All machinery is quadruplicated and worked by electricity. Electricity turns the stage around, so that while the play proceeds in the section turned to the audience the next following scenes can be built up in the sections behind, all requisites being brought up from below. During the discussion which ensued the absence of a philanthropist with £60,000 or £80,000 to play with, or to give to other people to play with, was deplored by various managers, who thought that, as far as they were concerned, such a stage was all "very large and fine," but wouldn't pay.

Electrical Conductivity in Mixed Solutions of Electrolytes.—K Hopfgartner contributes the following abstract to the *Journal* of the Chemical Society: In a solution of two different electrolytes, if n_1 and n_2 be the concentrations of the cations and u_1, u_2 their migration velocities, then the ratio of the number of the respective

cations passing in the same time across any section towards the cathode is given by n_1u_1/n_2u_2. If this ratio, d_1/d_2, be directly obtained from the alteration of the anode liquid, then if the migration velocities are known, the concentrations of the ions can be calculated $n_1/n_2 = u_2d_1/u_1d_2$. The ratios of the concentrations of the hydrogen and sodium ions were thus obtained in the case of mixtures of equally concentrated solutions of sodium chloride and hydrogen chloride, and the values compared with those obtained by means of Rudolphi's expression. The agreement was satisfactory, indicating that the admixture of these highly dissociated solutions has little effect on the dissociation. In the case of mixtures of similar hydrogen chloride and barium chloride solutions, however, the agreement was not good, probably owing to the assumption that the dissociation of the barum chloride is entirely to Ba'' and Cl ions. The values of the transference ratios of the ions was also obtained for the three salts examined at different dilutions; for sodium, the transference number increases with increasing dilution, whilst for both barium and hydrogen the reverse was found to obtain. The quantity of the cations deposited as a result of the purely electrical action was calculated from these numbers, and the results were found to agree well with the silver deposited in a voltameter included in the circuit.

Society of Arts.—A series of four Cantor lectures on electric traction will be commenced next Monday, at 8 p.m. The lecturer is to be Prof. Charles A Carus Wilson, M.A., M.I.E.E., the professor of electrical engineering at the McGill University, Montreal. The synopsis of these lectures is as follows: Lecture I. (May 2)—The action of a motor—How to find the force for a given current—Relation between force and power—Conditions of uniform motion—Speed and torque curves—Series winding—Variation of speed with load and tension of line—General description of a railway motor—Relation of motor torque to draw-bar pull—Design of equipment for given output. Lecture II. (May 9).—Acceleration—Conditions under which a train is started—Method of drawing acceleration curves—Uniform and variable acceleration—Example—The City and South London Railway—Control—Comparison of different methods—How to ensure a smooth start — The series-parallel controller — Example — The Liverpool Overhead Railway — Different ways of handling the controller — Example — The Buffalo and Niagara Falls Electric Railway—Effect of the slipping of the driving wheels. Lecture III. (May 16).—Energy diagrams—Sub-divisions of energy expenditure—Case when final speed is fixed. Possible ways of reducing the expenditure—Effect of series winding is to reduce the heat loss—Highest economy limited by the weight of the motor—How to find the best values of gear-ratio and driving-wheel diameter—Example—The Baltimore and Ohio Railroad—Effect of reduction in train resistance—Use of roller bearings. Lecture IV. (May 23).—Case when the final speed is not given—Design for covering a given distance in the shortest time for a given current—Time curves—Effect of using driving wheels of different diameters—Design for covering a given distance in a given time, with the least possible expenditure of energy—Influence of the weight of the motor on the economy—Advantage of gearing—Example—The Chicago Metropolitan Elevated Railroad.

The Welsbach Electric Lamps.—Referring to our note on this subject from the *Journal of Gas Lighting* last week, the following are the "claims" made by Dr. Welsbach, as set forth in his Austrian patents: (1) illuminating filaments for electric lamps, consisting of (*a*) osmium; or (*b*) osmium containing other platinum metals, such as platinum, iridium, rhodium, ruthenium; or (*c*) a core of
osmium, and a coating of thorium oxide; or (*d*)
an alloy of osmium and the platinum metals sp
(1) (*b*) or of these metals or their alloys, and a c
thorium oxide. (2) A process for the productio
illuminating filaments named in (1) (*a*) and
said process being characterised thus — (*a*)
or compounds therewith, are deposited in the
state on a thin metal wire or core by the r
of a volatile osmium compound such as the
in a reducing atmosphere, and the metal core
sequently volatilised by intense heating; or (*b*)
or compounds therewith, are applied repeat
thin layers by the aid, for instance, of some cem
medium to a thin metal wire or core, and the metal
subsequently volatilised by intense heating; or (*c*)
or compounds therewith, are deposited electrolyti
a metal wire or core, and the metal core is subse
volatilised by intense heating; or (*d*) osmium,
pounds therewith, are applied in a state of pulp,
tion, for instance, of a cementitious medium repea
thin layers to a thread of vegetable or animal ori
the thread is converted by ignition to osmium
osmium, or compounds therewith, are formed
emulsion with collodion, denitrated, and ignited.
process for the production of the illuminating f
for electric lamps named in (1) (*a*), (*b*), (*c*), and
said process being characterised thus: thin l
thorium oxide are successively and repeatedly ap
the filaments described, which are ignited aft
application; and this procedure is continued until
coating of thorium oxide has been formed on the f

Royal Meteorological Society.—The
meeting of this society was held on Wednesday
the 20th inst., at the Institution of Civil Engine
F. C. Bayard, LL.M., president, in the chair. Maj
Rawson, R.E., read a paper on "Anti-Cyclonic
and their Movements." Cyclones and anti-cyclon
long been recognised as powerful weather contr
their movements studied, but up to the present ve
has been written in this country upon the pro
movements of the cores of the permanent high-
areas which are found to be associated with certain
at different times of the year. The author refe
previous investigations by Abercromby, Scott,
H. C. Russell, and Buchan, and then proceeded to
results of an examination which he had made of
available synoptic weather charts for the 11 years
1891. During this period there were 212 cases i
ths centre or core of an anti-cyclonic system was
British Isles, and of these 130 were due to the
system, 41 to the Scandinavian, and 17 to the Gr
22 to the Atlantic and Scandinavian systems extend
merging together, and two to the same thing occu
the case of the Atlantic and Greenland systems. It
evident that we owe the greatest number of o
cyclones to the Atlantic system. They occur in all
but more especially in January, June, and October,
least frequent in April and November. When a
cyclones move away from our area the direction
much influenced by the season of the year. By
largest number drift off in some direction between no
through east to south, and take the more southerly
in January and February. Some few between Ap
July move west or south-west, and still fewer
north-west. The Hon. F. A. Rollo Russell descri
results of observations which he had made on h
transparency during 1897. He found that the
clearness occurred with winds from the westward,
least clearness with winds from the eastward. The

n visibility was 24 miles with west winds, and the st mean visibility was 10·6 miles with north-east winds.

America's Electrical Men.—Captain Eugene Griffin, the General Electric Company, formerly of the army, undertaken to organise an auxiliary corps of tricians to serve either in the army or navy the present war. It seems that Captain Griffin went Washington to enquire of the chief of the Engineers' s if he had at his command a sufficient force skilled electrical workers to prepare and plant subine mines and torpedoes in case such work had to be in haste. General Wilson replied that he had not, g that there were then in the service only enough to assign one man to about every 40 miles of the coast. sing this, Captain Griffin offered to undertake the formaof an auxiliary corps, providing the Secretary of War d approve. This approval was readily obtained, and it went the Secretary's grateful acknowledgment of in Griffin's offer. Captain Griffin returned to New and immediately went to work. He obtained a list e most skilful workmen in the employ of his own any. By letter he informed each of them what he ed, and asked if they would volunteer for the service. is correspondence Captain Griffin made it clear that e of war the volunteers might be called upon to needed repairs on warships after their service in army was over. He also stated that in case the nment had need of their services they would draw pay from the company during all the period of e, as well as pay from the Government, with the ge of going back to their old jobs when the war ever. He then wrote to other electrical companies in York, Boston, and Philadelphia, telling them what he d to do and what he had done, and asked them to ate with him. The result was that in less than a more than 1,000 men had been enrolled. Captain obtained the day and night address of every eer. These were sent to the office of the chief of gineers' Corps at Washington, where they are now . Some of the men have already been called upon rk in New York Harbour, and others will be at work ston and Philadelphia. A few have been sent to in the harbours along the South Atlantic coast. We o read of this united stand, but the double pay d to volunteers puts rather a low price on the men's tism.

Motors.—The *Electrical World* of New York has issue for April 2 a most complete article on electric otors. It is pointed out that one great disadvantage all induction motors, whether used for fan or other puris the lagging currents they introduce into the system. is particularly true of small motors, such as those for driving fans, and while this low power factor is g in the matter of one or two motors, when several ed or thousand are in operation in hot weather, it s an alternating central-station man wonder why his tors will not hold up their voltage and what causes tremendous drop on his lines. To overcome this lty, and also to gain some other advantages, Mr. rt Lundell has designed a most ingenious and effective eous motor for driving buzz fans. The external y is built up of laminated iron with eight internally ing poles, each wound with a coil supplied with ting current. No auxiliary coils or phase-displacing ments are used whatever. The internal rotating r armature is laminated, slotted and wound with rcuits, one of which is short-circuited in a suitable act as a secondary to the eight primary poles. The s connected up to the disc-shaped commutator. A pair of brushes bears on this commutator, connecting it in series with the field circuit. On starting, the machine acts as does any series motor, both armature and field magnetisations reversing simultaneously, thus giving a pulsatory torque always in the same direction. As the machine runs up in speed the short-circuited secondary winding takes hold and gives a powerful torque, running the speed up almost to synchronism. At synchronism the commutator obviously acts as a rectifier, giving a pulsatory direct current to the rotor winding connected to it. This pulsatory direct current, of course, sets up direct magnetic poles in the rotor, which react on the alternate-current field and make of the machine a synchronous alternating motor with an internal rotating field magnet energised by the rotary transformer action of its commutator. At synchronism, of course, the short-circuited winding exerts no torque at all, but it does serve in connection with the self-induction of the rotor windings to smooth out by the currents induced in it the pulsatory magnetisation of the rotor teeth, and thus renders this magnetisation practically constant. This field can be made very strong, thus giving a high power factor or even leading currents.

The Present War.—We gather from the *Daily Mail* that Messrs. Edison and Short are not to have the monopoly of extraordinary war engines. This paper gives details of a submarine worker invented by Count Piatti dal Pozzo, and constructed at Vitry-sur-Seine, in the workshops of M. A. Delisle. It was originally intended to be used in salvage operations on submerged wrecks, and was about to proceed to the locality of the wreck of H.M.S. "Victoria." The rupture between Spain and America, however, has altered this arrangement, and four days ago the machine, leased to the Spanish Government, was taken by a vessel crossing the Atlantic for the United States coast. "The submarine worker is a large steel sphere, belted and strutted so as to be able to resist all sea pressure at practically any depth. Its external diameter is 9ft. 9in., and the thickness of its shell 4in. It weighs 10 tons, and contains sufficient compressed air for the consumption of its crew of three men during 48 hours. All motive power is supplied by electrical accumulators, which work a screw ensuring a speed of eight or nine knots. A large rudder the depth of the sphere keeps its direction well under control, and a powerful electric light lens enables the steersman to guide his strange craft amid the hindrances of the ocean bed. Should the accumulators run out the driving gear can be worked by hand, and by taking in or rejecting water ballast the worker is enabled, with the assistance of two other screws, to sink into lower depths or rise to the surface, according to the wish of the captain. If considered advisable, by means of wires, the worker may be connected with the deck of an ironclad, and thus the path of the vessel in mined or torpedo-laid waters be guided free of these dangerous obstacles. From the front of the worker a strong grappling or cutting arm protrudes, by means of which anchor cables and electrical connections to submarine mines may be severed, endangering the enemy's fleet when off shore or rendering harbour defences absolutely useless. It can also lay a mine under a vessel, and after retiring to a safe distance explode the same by means of an electric spark without the slightest risk to itself." We are further told that we expect to have a practical demonstration of the submarine worker's arrival at New York Harbour within a very short time. This vessel has come under our notice before, but then, we believe, it contained no method of propulsion and no armament. These latter must have been added remarkably quickly, and even now the speed of eight to nine knots reads rather high when the space for propelling machinery is considered.

NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

CII.

Before quitting the subject of pyroxylin, I may mention that the frequently-recurring instances of damage and injury resulting from the inflammability of this material in the form of celluloid have caused steps to be taken to place its storage and sale, as well as its manufacture, under the stringent provisions of the Explosives Act. This is no doubt as it should be, for the material in its present form constitutes, as stated in the daily papers, "a grave public danger." But it should also be pointed out that there are scientific chemists and potential inventors in this country and elsewhere who are already acquainted with, or are competent to devise, effective means for counteracting in most cases the dangerous qualities of what would otherwise be a useful as well as beautiful material. But in such a case the votary of pure science stands aloof, *de parti pris*, for reasons which are to him sufficiently cogent. And however it may be in Germany or in America, the scientific inventor here, in nine cases out of ten, would, if he could avoid being an inventor, do well to follow the example of the more transcendental scientist, and leave improvement to be effected by a slow process of time. As to the non-scientific and more enthusiastic inventor he can scarcely be prevented from doing some harm to others, if not to himself; he unconsciously, perhaps, preys upon them instead of being preyed upon. But in the case of the more competent worker, it may be asked why should he not come forward to secure a substantial advantage for the community, and presumably for himself? Why should he? I would enquire, considering the question in the light of my own experience. He is not a manufacturer, and may not wish to be one. If he merely says that the thing can be done, he is called upon to make good his statement, under pain of being considered non-veracious. If he gives time and brains to the production of a tangible proof, he is asked what is the practical good of so small a sample? If, leaving his congenial pursuits, he gives time, brains, and money (for the inventor in these days must also be a capitalist, or, at least, take the place of one) to the production of comparatively large quantities, he is told that his invention is no use until it has stood the test of time and experience. In the meantime he must secure and perfect the invention at his own expense, *en attendant* the privilege of answering the rational or irrational questions and objections of ignorant and offensive financiers, and of persuading a manufacturer, company-monger, or capitalist to make money without risk. Ultimately, he may obtain his reward in the shape of shares which bring him into association with an enterprise which seems suspiciously like a swindle; such shares being rendered valueless by the subsequent issue of "preference shares." But enough of this. *Liberavi animam meam!*

CIII.

The attentive reader of these notes can scarcely have failed to obtain at least an inkling of a fact which is still sometimes overlooked both by those who make and those who test accumulators—viz., that any given battery of this description is, whether intentionally or not, designed to work most advantageously during a certain definite period of *time*. This is more especially and obviously true in the case of traction batteries. In other words, every accumulator is so constructed as to work most advantageously at a certain rate of discharge. Let us consider the case in which this rate is exceeded. Both capacity and E.M.F. then become diminished by reason of the undue augmentation of the density of the current. The surfaces of discharge have, in fact, become insufficient; to meet the augmented rate of discharge without increasing weight the surface must be increased and the thickness or weight of active material diminished. The cathode (peroxide) surface being insufficient, the quantity of hydrogen thrown upon it per second is greater than can be absorbed in the given time, whilst the quantity of water formed at this surface may yet be too great for effective diffusion. This electro-negative surface consequently becomes "pol
by hydrogen; the normal E.M.F. is not maint
and energy, instead of being, as is commonly su
merely held back in reserve, is wasted and lost
subsequent absorption of hydrogen, and by an ineffecti
bination between PbO (reduced from PbO_2) and sul
acid radical.* The anode (spongy lead) surface, mo
becomes clogged with sulphate which otherwise woul
become distributed over a larger area.

Let us also consider the case in which the most
tageous normal rate of discharge is not reached.
the weight of the battery is unnecessarily great, sin
given metallic surface would suffice for a larger quan
active material, or the weight of the latter could b
advantageously increased by a proportionate diminu
the weight of the support.

In traction batteries, it must be borne in min
normal rate of discharge must be three or four tim
than that which the battery will support without inj
periods of a few minutes.

CIV.

When the rate of discharge is not excessive, the
of sulphuric acid absorbed during the discharge sho
simply proportionate to the capacity. The amper
equivalent of H_2SO_4 being 1·826 grammes, it is
from equation ϕ (LXI.) that, calling Q the capa
ampere-hours, the quantity (A) of H_2SO_4 absorbed
discharge of an accumulator will be:

$$A = Q \times 1{\cdot}826 \times 2 = Q \times 3{\cdot}652 \text{ grammes.}$$

The value of A in grains $= Q \times 56{\cdot}4$.

" " " oz. avoird. $= Q \times {\cdot}129$.

" " " lb. " $= Q \times {\cdot}00805$.

If this weight of acid only were supplied, the elec
after the discharge of the battery, would be merely
Or, rather, the battery could not practically be who
charged by reason of the increase in its internal res
It is necessary, therefore, that a percentage of H_2SO_4
remain in the electrolyte after the discharge of the b

If N = the percentage of H_2SO_4 in the electrolyt
to discharge, and n = the percentage of H_2SO_4 in the
lyte after discharge, then the weight of dilute acid r
will vary, *cœteris paribus*, inversely as N, and also, i
measure, directly as n; and it will be the same
lead accumulators having the same capacity.

CV.

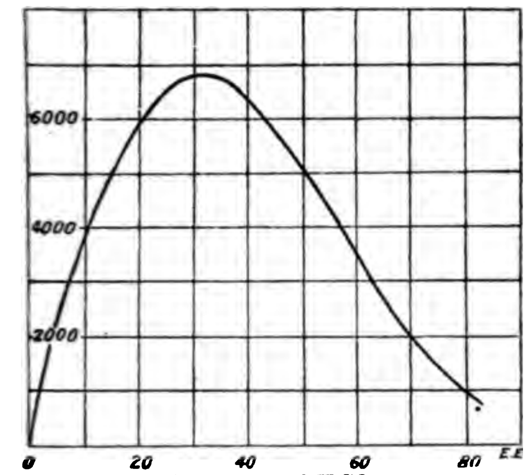
In determining the values N and n, circumstanc
to be taken into consideration, and judgment as
knowledge is required; so that it is impossible
down a hard-and-fast rule as to the weight of dil
required per ampere-hour in an accumulator. For i
in the case of a battery to be discharged within
three hours, and which is invariably to be recharged
diately after discharge, it would be safe to use ac
stronger than could be employed in the case of
discharge cell with ample time for sulphatation
recharge. And where it is very important that th
ance of the battery should not increase towards the
the discharge, a point might be strained to give to
close upon that corresponding to dilute sulphuric
the maximum conductivity.

In fixing the above-mentioned values, we have
into account not only this strength of maximum condu
but also, on the one hand, the higher E.M.F. obtain
strong acid, and, on the other hand, the fact that
taining more than 35 per cent. of H_2SO_4—*i.e.*, of
gravity over 1·263—acts much more energeticall
spongy lead than acid of lower strength.

The following diagram gives the relative conduct
dilute sulphuric acid of any strength up to 70 per
H_2SO_4, or specific gravity 1·615. The curve sho
acid of maximum conductivity contains about 30 p
of H_2SO_4—*i.e.*, that its specific gravity at 50deg
about 1·223.

* See LXIII. "The formation of the second molecule
is a secondary reaction, though it is subsidiary or
provided it occurs *simultaneously* with the liberation of
PbO_2."

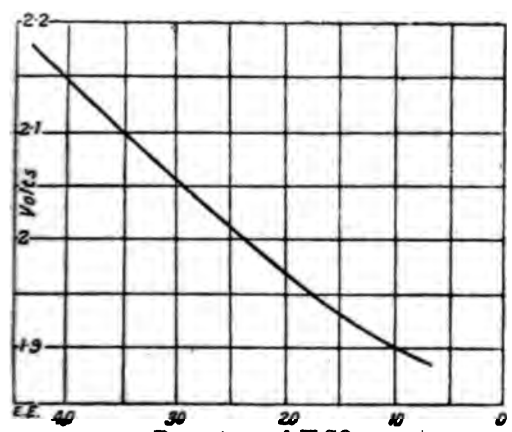
some experiments made by Dr. Gladstone and Mr. rt, a peroxide and a spongy-lead plate were successimmersed in eight portions of dilute sulphuric acid ng in strength from 6·5 to 43 per cent. of H_2SO_4, the



Percentage of H_2SO_4.

Pickering's Curve of Conductivity.

.F. being in each case carefully observed. The following ram represents the results of the experiments. The containing 43 per cent. of H_2SO_4 (specific gravity 3) was found to act vigorously on the spongy lead, so this experiment could not be continued with stronger s.



Percentage of H_2SO_4.

Gladstone's Voltage Curve.

another series of experiments, the same investigators ed a voltage of above 2·47 volts by immersing the plate in acid containing 99 per cent. of H_2SO_4, d plate being in 25 per cent. acid.

atever latitude may be allowed, it appears certain the value of N should not exceed 35, and that to the most steady discharge the value of n should not ry much below 25, the densities corresponding to percentages being respectively 1·263 and 1·182.

CVI.

he construction of secondary batteries has yet to be lished upon a scientific basis, and one of the first ments in this direction is to calculate the weight of quired in any given case. For traction batteries especially necessary; the additional weight when id is in excess or the loss of energy when it is deficient often of serious detriment. Quite recently I had n to test an accumulator imported from the other the Atlantic, and I found that one of the reasons did not fulfil the expectations that were based upon that the weight of acid was deficient to the extent ly 50 per cent. of that which was necessary to the estimated capacity under a given rate of ge. Nor would it be difficult, even in batteries for , to find cases in which the acid is either considerexcess or considerably deficient. The reason is that nobody has taken the trouble to calculate the of acid required for the chemical combinations and for conduction, and that the given quantity of acid of a certain strength has been arrived at somehow by rule of thumb.

As we have seen above, Q being the capacity in ampere-hours, the weight of H_2SO_4 actually absorbed in the working of the cell will be

$$A = Q \times \cdot 129 \text{oz. avoird.}$$

It must be borne in mind that a certain proportion of this acid is *water*; since $H_2SO_4 = SO_3 + H_2O$. The molecular weight of H_2SO_4 being 98, and that of H_2O being 18, the weight of water in A will be

$$aq = A \times \frac{18}{98} = A \times \cdot 1837.$$

Let N be the percentage of H_2SO_4, in the electrolyte prior to discharge, and Aq be the weight of water requisite to make up acid of this percentage strength, then

$$N : 100 - N :: A : Aq.$$

whence $$Aq = \frac{(100 - N)\,A}{N} \text{ oz. avoird.}$$

Now, a certain additional weight, viz., $x\,(A + Aq)$ of N per cent. acid must be added to $Aq + aq$ (left after the absorption of $A - aq$) to produce the residual n per cent. acid.

And $$n : 100 :: xA : x\,(A + Aq) + Aq + aq.$$

$$\frac{100}{n} = \frac{x\,(A + Aq) + Aq + aq}{xA},$$

$$\frac{100\,x\,A}{n} = x\,(A + Aq) + Aq + aq,$$

$$\frac{100\,x\,A}{n} - (Aq + aq) = x\,(A + Aq),$$

$$\frac{100\,A}{n} - \frac{Aq + aq}{x} = A + Aq,$$

$$\frac{Aq + aq}{x} = \frac{100\,A}{n} - (A + Aq)$$

$$x = \frac{Aq + aq}{\dfrac{100\,A}{n} - (A + Aq)} \text{ oz. avoird.}$$

Thus the total weight of acid $[A + Aq + aq + x\,(A + Aq)]$

$$= W = A + Aq + aq + \frac{Aq + aq}{\dfrac{100\,A}{n} - (A + Aq)} \times (A + Aq) \text{ oz.}$$

THE DISTRIBUTION OF ELECTRICAL ENERGY IN PARIS.

BY J. LAFFARGUE.

The following is a reprint of an article appearing in the Paris supplement of the *Contract Journal* for April 20, 1898:

The distribution of electrical energy in Paris dates only from the commencement of 1889. It was not until the end of 1888 that the Municipal Council of Paris granted concessions to certain companies. At this period, however, there already existed in Paris a certain number of private installations; and in 1887 Messrs. Mildé and Clerc had established in the Rue du Faubourg Montmartre distributing works on a small scale, which were subsequently absorbed by the Edison Company.

The main conditions imposed upon the concessionaire companies were as follow: The authority to lay cables in Paris was granted for 18 years; the mains were everywhere to be underground. The grantee was free to regulate his own tariffs on condition of not exceeding the charge of 14·4d. per kilowatt-hour for lighting, and 6d. for motive power and various applications. The municipal dues amounted to £4 per annum for every kilometre or fraction of a kilometre of conduits laid beneath the pathways, and also 5 per cent. on the returns. This last to be ascertained either by the amount of the bills or by the indications of the meters. The area to which the distribution was to

extend was to have the form of a sector, passing from the centre to the circumference. Consequently upon these

et de Force par l'Electricité, and La Compagnie Comprimé d'Electricité. Simultaneously the city o

conditions, adopted by the Municipal Council in 1888, three companies commenced the distribution in 1889—viz., the Edison Continental Company, the Société d'Eclairage

established, at the Halles Centrales, municipal works supply of lighting to the markets and to other subs in the district. In 1890 a new company was estab

the name of the Society for the Sector of the Place , and it undertook the distribution in another quarter. quently, in 1892 and 1895, two other companies were d, that of the Champs Elysées sector and that of the de la Rive Gauche.

II.—CONSIDERATION OF THE VARIOUS DISTRIBUTING NETWORKS.

We will now pass on to review the different distributing networks, whilst indicating the peculiarities of each.

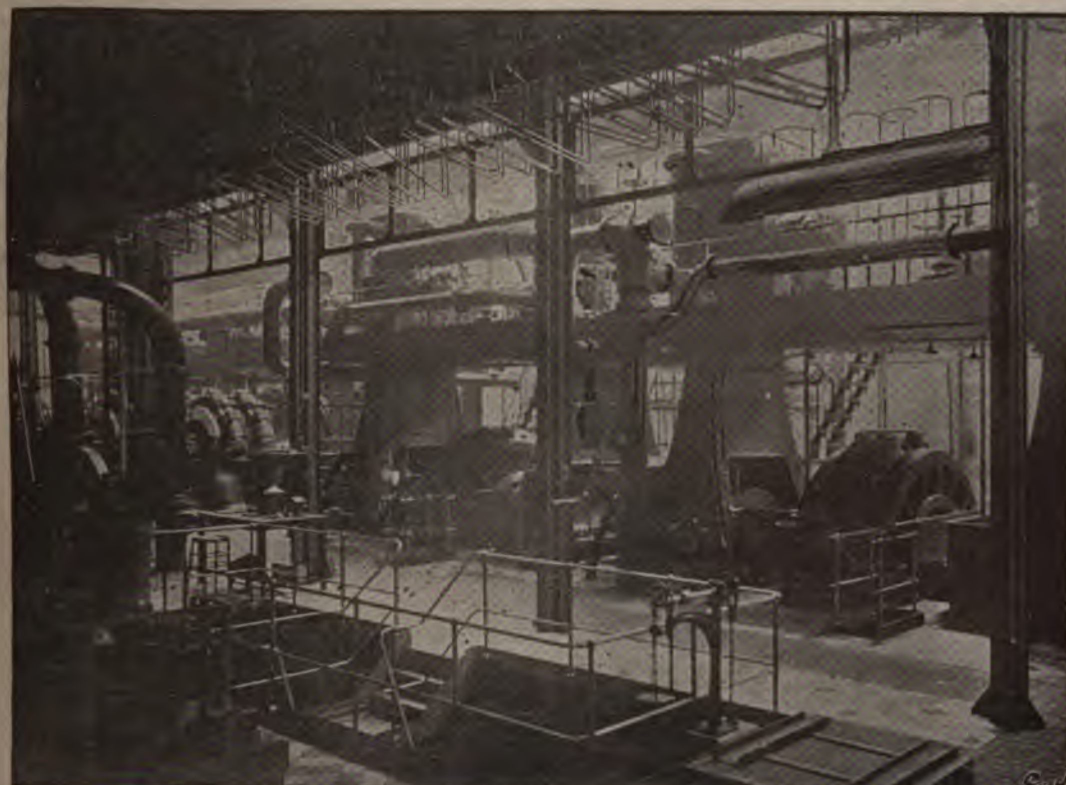


FIG. 2.—View in the Electricity Works at the Avenue Trudaine.

the present time, therefore, the distribution of electric energy is undertaken within Paris by six concessive companies and by the municipal works at the

The Edison Continental Company.—The Edison Company carries out the distribution of electrical energy in one of the finest quarters of Paris, including the boulevards and

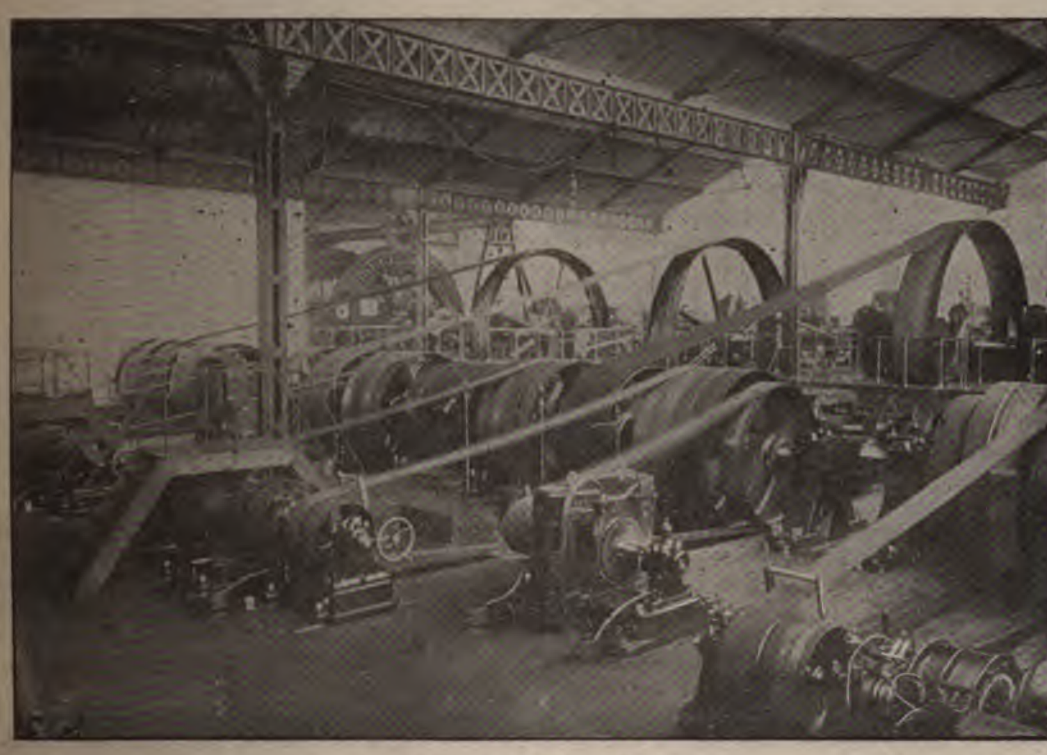


FIG 4.—The Engine-Room at St.-Ouen.

The accompanying map, Fig. 1, taken from the published on this subject in *l'Industrie Electrique*, the distribution and the exact position of the sectors, and also the position of the different and the boundary of the distributing network.

the Place de l'Opéra. The distribution is by three-wire feeders in ring circuits, with 120 volts between each, and by continuous currents. The distribution is effected by naked copper cables supported on porcelain insulators fixed in concrete conduits ; these latter are lined with slates

The central stations are two in number: one at No. 8, Faubourg Montmartre, and the other at No. 11, Avenue Trudaine; these two works are connected together. There is also a sub-station for accumulators—38, Rue Saint-Georges. A third station, although specially used for the lighting of the Palais Royal, is also connected to the works in the Avenue Trudaine. When working, these three works are connected in parallel.

The station in the Rue du Faubourg Montmartre contains four Belleville boilers, yielding 1,600lb. of steam per hour; also four other boilers of the same type, giving 2,100 kilos of steam per hour at the same pressure—*i.e.*, 210lb. The steam-engines are five in number, of which two are Corliss horizontal engines of 300 h.p., making respectively 45 and 62 revolutions per minute. Two are vertical triple-expansion Weyher and Richemond engines

FIG. 3.—View in the Electricity Works of the Avenue Trudaine.

of 300 h.p. at 132 revolutions per minute, and one is a Willans engine of 700 h.p. at 300 revolutions per minute. Each of the four 300-h.p. engines drives by belting two Edison dynamos of 100 kw., with eight poles, at 130 volts and 350 revolutions per minute. The Willans machine is directly connected to a Fives-Lille dynamo, of 450 kw. at 230 volts. At the works there are also two batteries of 70 accumulators of the Society pour la Travail de Métaux, having a capacity of 3,000 ampere-hours, and a maximum rate of discharge of 1,000 amperes. The switchboard is installed on the first floor, in a room above the engine-room.

The central station of the Avenue Trudaine (Figs. 2 and 3) is by far the most important. It occupies a large area. It includes nine Belleville boilers, of which three give 6,600lb. of steam per hour, and six give 8,000lb. under a pressure of 210lb. The steam-engines are six in number, of which four are by Weyher and R vertical, triple-expansion, of 300 h.p., at 132 r per minute, and two Corliss, Bonjour system, o at 105 revolutions per minute. The 300-h.p. each drive directly two Edison dynamos of 10 eight poles, giving 130 volts. The Bonjour en work a Brown dynamo with two commutators an of brushes, giving 600 kw. at 130 volts. The dy placed between the two vertical cylinders. Fig. general view of the machine-room. The meters buting apparatus are placed in a room on the It is from this room that the feeders proceed.

A sub-station is established in the Rue Saint-G the registered address of the Edison Company. the rooms are two batteries of 74 Tudor cells, capacity of 3,000 ampere-hours with a dischar amperes. These accumulators are charged during time, the number being varied according to the difference of distribution. A booster is placed with the charging feeder when necessary. Thi consists of an Edison dynamo of 390 amperes at coupled direct to an electric motor of 99 kw., ru 700 revolutions per minute.

The Palais Royal station was originally int supply the Palais Royal, the Cour des Comptes, Comédie Française Theatre. The company has la which allow of their works being connected wi above mentioned, by placing boosters in series allow of coupling up in parallel. In these works ar nine Belleville boilers, giving 4,100lb. of steam at a pressure of 170lb.; also seven vertical steam yielding 190 h.p. These are of the triple-expans made by the Weyher and Richemond Compan

drives by means of belting an Edison dynamo, 100 kw. at 130 volts and 390 revolutions per

ontinental Company is one of the most important supplying electrical energy in Paris. At the close it had an available power of 3,300 kw. in machines kw. in accumulators. On March 31, 1897, the had connected 113,346 incandescent lamps distri- amongst 1,812 subscribers. In the course of 1896 buted 2,555,550 kilowatt-hours at the average price l. On Dec. 31, 1896, it had on only 27 motors of for various uses, and 22 motors for lifts of 65 kw.

é d'Eclairage et de Force par l'Electricité. — This y effects the distribution of electrical energy in means of sub-stations fed from the general central of Saint-Ouen, which is outside Paris, and by stations in the interior of Paris. The central of Saint-Ouen (Fig. 4) is used to supply continuous to a certain number of workshops in its neighbour- It also supplies electrical energy to Saint-Denis and , and to several feeders for Paris, notably that for thern Railway terminus, and that for the Boulevard An installation for transmission by two-phase is also provided for the supply of the Landy s outside Paris, and of the La Chapelle terminus Faubourg Saint-Denis station in Paris. The Saint- ntral station is furnished with 10 tubular boilers of er type, yielding 4,400lb. per hour at the pressure b., and also with four sets of two Lecouteux and horizontal engines of 150 h.p., coupled with a flywheel, and with two single-cylinder Garnier , each of 350 h.p. The eight 150-h.p. horizontal work by various countershafts eight Marcel Deprez ous-current double-ring dynamos, yielding 72 kw. volts, four Hillairet 30-kw. dynamos for excitation, mme 36-kw. dynamos for excitation, and one 24-kw. giving 1,200 volts for arc lamps in series. The gle-cylinder engines of 350 h.p. each work a Hutin blanc alternator of 250 kw. at 88 volts, with a cy of 42 periods per second. By means of trans- the outgoing currents are raised from 88 to 6,000

continuous current at 2,500 volts is transmitted to ks at the Boulevard Barbès in Paris, where five Deprez double-ring motors actuate directly 10 ing dynamos, of which six are of the Edison type, w. at 175 volts, and four are Bréguet dynamos, of t 150 volts. At these works there is also a battery accumulators of the Société pour le Travail des , yielding 3,300 ampere-hours with a current of peres. The continuous current from the Saint- works is also transmitted to a station at 183, rg Saint-Denis, to work two rotary transformers to the preceding ones. At the same works are ated two Belleville boilers and one Solignac boiler; ertical Weyher and Richemond engines, of 150 h.p.; ee Desroziers dynamos, of 97·5 kw. at 130 volts. lso we find a battery of 70 accumulators, of 4,000 hours, at 500 amperes, and a Hutin and Leblanc mer, converting two-phase into continuous currents, ctly from the Saint-Ouen works.

(To be continued.)

UTION OF ELECTRICAL ENGINEERS, April 21

DISCUSSION.

the discussion on the paper on the "Cost of Generation ribution of Electrical Energy," by Mr. Hammond, recom- the **President** said he had received a letter from Mr. gretting his inability to be present. He desired to thank mond for the figures which he had given, as these had f much service to him.

. B. W. Kennedy then said he endorsed the opinions d by Mr. Crompton. To those who were in the habit them every day, the great accuracy of the figures he care with which the paper had been compiled. He did rage the idea of taking the two or three most favourable and lumping them together and saying that the same expected of their best stations in the future. The efficient working of electric light stations was a very complex question, which could not be obtained in the lump thus. Speaking of load factor, although it was a very important thing, yet he did not agree with Mr. Hammond in placing it so high in the scale of importance. The two Newcastle companies, for instance, shown in Table XII., their costs were practically the same, but in one the load factor was 27 per cent. and the other 17 per cent. There was not much difference between the Charing Cross and Westminster Companies' costs, and yet the load factors were 26·75 per cent. and 15·4 per cent. respectively. From the figures he did not see that difference in load factor gave very different results. Referring to Diagram 3, he did not think there was any relation at all between works' cost and the units sold per lamp per annum. He quite agreed with Mr. Crompton that the engineer factor was a very important item indeed. On p. 342 Mr. Hammond dealt with the quantity of electricity generated, sold, etc., and he thought that, divided in a certain fashion, this information would be useful to people concerned. It was worth while for the engineers to know these things. One thing he would like to point out was with reference to Diagram 9A, in which the rates, taxes, etc., were dealt with. This diagram showed that as the output of the companies increased the rates also rose considerably higher.

Mr. J. S. Raworth said he had to thank the author for taking up the cudgels on his behalf in the recent attack made upon him by the *Engineer*. There was no doubt that station work brought out the personal element very strongly. Mr. Mountain had managed to get his oil, waste, etc., at Huddersfield boiled down to the remarkably low figure of ·02d. per unit sold. There were 40 stations which doubled that cost, while others also burned less value of coal per unit than the cost of oil, waste, etc. The private companies did not cut down prices like the municipal works. The City of London Company, for instance, could not hope to establish any records, as their daylight load was so uncertain, rising and falling very irregularly as a sudden fog or darkness came on. In fact, he thought some members wished the sun would give up shining there altogether. The cost of output would necessarily go down as the load factor rose.

Mr. J. N. Shoolbred said that he thought that great saving might be made by the use of accumulators in stations with a small load. They were very useful to have as a reserve in case anything went wrong with the ordinary plant. Electric companies, also, should not be behind the gas and other similar companies in this respect. The use of batteries on smaller plants made a great reduction in the cost of production. In the early days of the Bradford installation, for instance, when batteries only were used, the cost was very much less than at present. At Birkenhead, also, the installation was run most of the time for the first 12 months by batteries, until the load became too large for this means to be successful. The batteries were recharged every three or four days, and the average cost of production was only ¾d. per unit. He strongly advocated the use of batteries for relieving the plant while there was only a very small load, such as a great many companies had during the daytime. He mentioned an incident which occurred in Bradford, when he and some other gentlemen were working by the electric light and the engineer came and reported that as the fuse of the 1,200-ampere dynamo had blown the batteries had been switched on. This had been done without attracting the notice of any of them.

Mr. W. H. Patchell said that he should like to congratulate the Institution, as he had received a clean copy of the paper before the discussion was ended. The table on p. 305 of the aggregation of lowest costs in the United Kingdom, was, he thought, a mere piece of crazy patchwork. In all cases the cost of the fuel should be given. Some of the figures given on p. 57 (in the old proof) did not agree; for instance, the Westminster figures, to agree with the paper, should be 15·4, and not 13·3 as given. As to the use of batteries, he wished they could get a big battery and rely on it. On p. 59 it mentioned battery loss as being charged to distributing loss. He thought that the more natural thing would be to charge it to generating loss. He measured how much electricity was generated by fixing a wattmeter on his dynamo, and found that the record did not agree with that obtained by integrating the product of the ammeter and voltmeter readings. He thought that the cost per unit generated was rather misleading, and it should be cost per unit sold, this being much more reliable. Prof. Kennedy did not like the sudden rise in the new assessment, and this was a very natural feeling. He (the speaker) differed from Mr. Crompton in saying these lists were the best thing possible, as he was inclined to think that some engineers in their efforts to appear at the top of them neglected more important things. The low price of ¾d. per unit obtained by the batteries mentioned was not, he thought, quite correct. The cost, when reckoned also with the cost of maintenance of the accumulators, really came up to 1¾d. per unit. Mr. Wright had done very great service by directing their attention towards the item of works' costs, but he thought he had gone rather too far. Although his figures were very valuable, they should not be taken as absolutely correct.

Mr. A. J. Lawson wished it had been possible for the author to have given the figures for last year. His figures of possible lowest cost might lead the public to think they should get their electricity at ¾d. per unit. This was, of course, impossible, and after all expenses had been reckoned with, they would find that they would be unable to sell under 4d. per unit. A great mistake was made, in his opinion, by every small vestry giving an electric supply, instead of leaving it to two or three large company stations already established. At Dover, since the introduction of electric traction, the cost had been reduced by a penny per unit. Batteries, he thought, were very useful and economical in small stations, or where the daylight load was practically nil, such as at Richmond.

Mr. H. M. Sayers said he also wished to thank Mr. Hammond for producing such a useful paper. He thought there should be no loss unaccounted for. Engineers should know the amount produced at the works, and should know exactly how much was lost in distribution, etc. He himself had always had wattmeters connected to his dynamos, on the pressure side, where possible. He thought the readings should often be taken to find out the production and loss of the machines, and this might be done on any bright day. As regarded the engineer factor, the cost of the units sold did not entirely depend on the engineer, as he could not control the output; but he was a very important item. As to load factor at Bournemouth, in 1895, when the price charged was 8d. per unit, and the rebate was nil, the load factor was 7·1 per cent. In 1896, when Wright's system was introduced and 7d. per unit was charged for the first hour only, the load factor increased to 11·2 per cent.; and in 1897, under the same conditions, it rose to 12·25 per cent. It was impossible to compare different stations on equal terms, as the coal item was so much different in different stations. Batteries were a good thing to use for a small daylight load, or for very small stations, but he did not advocate their use in stations at which there was anything like a heavy load.

Mr. D. Gadsby said he noticed that the question of capital cost had been entirely left out of the paper. This might be all very well for the purposes for which the paper was compiled, but it would be of immensely greater value if the question were taken into consideration. As regarded the supply of energy to tramways, taking the mean load for tramway plant at 15 or 16 hours per day, a load factor of about 50 per cent. was obtained. On the basis of the lighting figures, the lighting companies should be able to supply the power for the tramway at 1d. per unit cheaper, as there were not so many expenses connected with power supply as with lighting. He had worked it out, and he used the following equation:

$$y = \cdot 002\,x + 100.$$
$$y = £ \text{ monthly charge.}$$
$$x = \text{units monthly.}$$

Regarding the question of measuring electricity generated, he had tried connecting wattmeters to his plant, but had not found the readings come out accurately. He thought that on the credit side of these accounts there should be something more than only the units sold.

Mr. J. S. Swan, in thanking Mr. Hammond for his paper, said that these figures showed the effect of improvements in the design of the apparatus. They seemed to realise then, perhaps for the first time, that there was some good in the Electric Lighting Act of 1882, when it nerved men to go so thoroughly into statistics as this paper went. Mr. Hammond's figures whipped them up, and made them think of how the cost of electricity could be more reduced.

Mr. R. Hammond, in replying, said he had been greatly encouraged by the request that he should extend his researches. General Webber seemed rather doubtful whether these figures would be of any use at all. He himself thought that if the figures were only of use to the men who had charge of the stations, he had fulfilled his purpose. If all these engineers tried to work up to some of the better results, he thought a great deal of good would be done. They all had the desire to introduce electric energy into domains in which it had not formerly been, and the only way of doing this was to cheapen it. If there was one thing more than another they wanted in improvements, it was to get the Board of Trade to amend their form so that, instead of being allowed to fill in the last statistics or not, just as they pleased, the whole should come under the signature of the auditor. The figures he had given were as accurate as it was possible to obtain. He thought also that there should be no difference in the forms supplied to corporations and private companies. The salary of all assistant engineers should be put down to the management item, and also half of that of the managing engineer. The real basis of all costs was the consumer. Prof. Kennedy amended the form to three items—viz., electricity generated, quantity utilised, and quantity used in distribution. Prof. Kennedy's form, if sanctioned by the authorities, would be a great improvement. Any gas engineer would be able to tell at once how much gas was lost in distribution, and electrical engineers should be able to do the same. The reason he did not bring the battery question into the paper was because he did not wish to enter upon any petty discussion on the different systems. The records relating to load factor were not kept properly, and reliable information was difficult to obtain regarding it. Some companies had benefited greatly by their increased load factor. No company had yet reached the final of its capital account, and he for one did not wish any of them to. Many of them wished to know the cost of coal at the Leeds station. This he had no objection in telling them was ·25 per unit. This coal was the veriest muck which the engineer could get hold of, and as long as it would burn at all, it went into the Lancashire boilers.

MEETING, APRIL 28.

At last night's meeting of the Institution the following papers were read:

Notes on Electric Tramways.

BY MAJOR P. CARDEW, R.E., AND A. P. TROTTER, MEMBERS.

The accompanying note on return feeders for electric tramways has been forwarded to me by Mr. A. P. Trotter; and, as it contains a neat graphical method for deter[...] fall of potential in the return with uniform distri[...] current, and the proper points of application to retur[...] I think it may prove interesting in connection with Mr. [...] paper. As Mr. Trotter alludes to previous suggesti[...] own on this subject, I also forward a note which was [...] by me in May, 1894, and sent to the South Sta[...] Tramways Company, advocating the automatic regu[...] this fall of potential.—P. CARDEW.

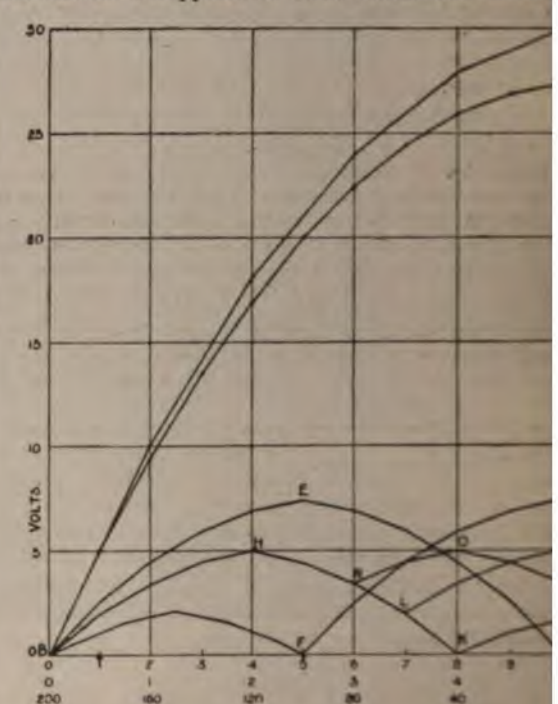
NOTE ON RETURN FEEDERS FOR ELEC[...] TRAMWAYS.

By A. P. TROTTER, *Member*.

While great ingenuity has been expended in [...] bonds for electric tramway rails, and while these [...] assisted in some cases by bare copper conduct[...] between or near the rails, form a considerable [...] the cost of building a line, little attention has be[...] to the use of return feeders. The use of return co[...] provided with a small dynamo was suggested by M[...] Cardew several years ago, and it has been indep[...] proposed by Mr. G. Kapp. The system has been in [...] some time in Geneva, and has recently been appli[...] success to the extension of the Bristol tramways. T[...] mode of arranging such return conductor does not a[...] have been described, and the present communication is [...] to afford an opportunity for discussing it. Assume a [...] line with passing places, five miles long, and 10 cars [...] The most even distribution will, of course, be when [...] equidistant, and a less even distribution is not likely [...] than when all the cars are in pairs at passing places. [...] car take 20 amperes, and let the resistance of the bond[...] be 1-20 ohm per mile. When the cars are evenly dis[...] half a mile apart, the rail resistance between each [...] 1-40 ohm, and with 20 amperes the drop on half a mile [...] is half volt. The series is as follows:

Cars ...	1	2	3	4	5	6	7	8	9	10
Volts ...	0	½	1½	3	5	7½	10½	14	18	22½

The first car is supposed to be at the extreme end of [...]



The case is an extreme, but not an imaginary, one. Th[...] total fall of 27½ volts over five miles should, of course, be [...] in the first instance by more ample bonding, but the [...] serves the better to illustrate the problem. When the [...] all passing, in pairs, at a mile apart, the drop due to 40 [...] over one mile is two volts. The diagram shows the dist[...] for these two cases; the line A B showing the fall of [...] 10 cars evenly spaced half a mile apart, and the curve [...] fall for cars in pairs a mile apart. Mathematically, the [...] is the origin of the curve to which the line A B is an [...] mation; but, as it is not intended to treat the problem [...] matically, the point A is for convenience placed at [...] right-hand corner. The volts in the two cases differ [...] compared with the fluctuations of energy on an electric tr[...] that this question of distribution of the cars will [...] referred to again, but the line A B will be considered as [...] The return feeder method by which this fall of vo[...] be reduced consists in connecting a feeder to some p[...] the rails, and tapping off some of the return curren[...]

ity of the feeder is not relied upon for this, but a ıcting as a negative "booster," may be said to suck ıt back. By this means the point at which the feeder ails may be brought down to zero potential, or might ıegative to the generating dynamo.

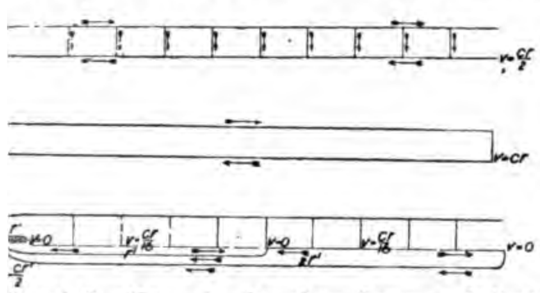
›blem to be considered is : (*a*) to reduce the volts below ıximum, (*b*) to use as little copper as possible, and (*c*) little energy as possible. Disregarding the two latter s, a simple plan would be to run a feeder the gth of the line, and to reduce the volts to zero at the f the line D. The distribution is then symmetrical: half rrent goes to the generating dynamo, and half to the ıeder. To draw the curve of distribution cut out a ıard to the shape of the curve of volts A B, and fitting cal axis to the ordinate 5 place it so that it pesses the point D. Turn the card over and complete the ough A in the same way. The maximum volts at the ıre 7½. But there is no occasion to reduce the volts at f the line to zero, and there is evidently a maximum ıre of copper and of energy in the feeder. The middle the line is evidently not the best point to tap, for the ıld be distributed as shown by the line B F G, which easily drawn by means of the template. Here the ı is, as before, 7½, and the volts near the works are ırily low—viz., two volts at 1¼ miles out. It is clear line B F G that the feeder would draw off three-fourths ıal current. It would be still worse to tap the rails at at which the volts rise to one-half the maximum—viz., 1½ miles from the works.

g now in a different manner, let it be given that the volts are not under ordinary circumstances to exceed ring a margin of two below the Board of Trade limit. line B H by means of the template, and fitting the so that its axis is vertical, that the top touches the line ts at the point H, and that it passes through the point it over and draw the line H K. But as it is not from the "undertakers'" point of view, to reduce :o zero at the point K, set the template again, allowing at the end of the rails at the point M, and, drawing ıckwards, it is found to intersect the line H K at L. at this point are two, and this is the best that can be a single return feeder. This feeder will be 3½ miles will draw off 0·65 of the current.

NOTE ON ELECTRIC TRAMWAYS.

By MAJOR P. CARDEW, R.E., *Member*.

believe, generally admitted that where the rails are ıe collection and partial transmission of the return ıe best means of preventing injurious action on pipes nise the diffrence produced by the current between ıal of the uninsulated return at different points, and ny part of such return and the earth. On account of ance offered by all conductors to the current, the on of a current by means of a conductor causes a fall ial throughout the length of the conductor, the of potential being greatest between the ends of the . This is the case whether the whole current is



2, and 3.—*Note*: In the above figures *v* indicates potential with regard to earth.

ed throughout the length of the conductor, or is fed in case of a tramway line) at different points along the rovided that the direction of the current throughout h of the conductor is the same, which must be the case ı conductor forms the only path for the current back to ıting machine. But if additional conductors are used ırrent from the main conductor, which receives the istributed along its length back to the generator, the ifference of potential in this main conductor may no ist between the ends of the conductor, and the amount ifference may be greatly reduced. The extent of the ı will depend upon the position of the junctions effected esistance in the auxiliary conductors.

assume, for example, *n* auxiliary conductors, all of istance, connected to the main conductor at equal throughout its length, and one from the extreme the main conductor of twice the resistance of the others, a resistance equal to this last being interposed between the generator and the near end of the main conductor, then with a uniform distribution of current all the points of junction will be at the same potential, and the extreme difference of potential between any points of the main conductor will be reduced to $\frac{1}{4\,(n+1)}$ of what it would be without these auxiliary conductors or feeders. Thus with one feeder to the distant end alone the fall of potential in the main conductor can be reduced to one-fourth, and with a feeder to the centre as well, to one-sixteenth of that due to the same distributed current without feeders; and it will be seen that under such conditions the variation of potential in the main conductor can be reduced to any required limit. But, unless these feeders are of very large cross-section and conductivity compared with that of the main conductor, there will still be a considerable fall of potential in them, and, in consequence, a considerable difference of potential between the main conductor and the terminal of the generator to which it is connected by means of the feeders. In place of adjusting the resistances of all feeders to equality, varying E.M.F.'s may be introduced into each feeder proportionate to its resistance, and thus the potential of all feeding points may be kept the same as that of the terminal of the generator if desired.

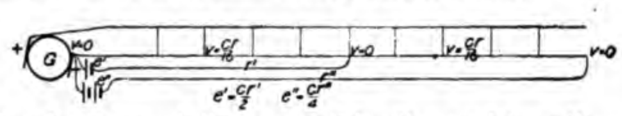


FIG. 4.—*Note*: *v* indicates potential with regard to earth; *e′* and *e″* auxiliary E.M.F.'s.

In considering the application of the feeding arrangements described above to the special case of minimising the leakage to earth from the rails of a tramway used as a return circuit, it must be borne in mind that, although the load under normal conditions may be fairly uniformly distributed, yet the exigencies of traffic may require far more current to be supplied to one section of the line than its proper share, other sections at the same time being lightly loaded. The position and slope of the various gradients on the line also considerably affect the distribution of current in the rails. The number of cars at work, and, therefore, the total load, also generally varies during each day's running, and from day to day. The disposition shown in Fig. 4 can be adapted to meet the special requirements; but unless the auxiliary E.M.F.'s are continually adjusted to the variations of load, both as regards amount and distribution, the arrangement must be defective at times.

In order to provide auxiliary E.M.F.'s for the efficient working of the feeders to the return, automatically adjusted to the requirements, I would suggest the following arrangement: Let the tramway be divided into several sections according to its length and the amount of traffic gradients, etc. Let there be two insulated feeders for each such section —one for the line and one for the return—the latter being connected to an uninsulated conductor as provided in Regulation 4. Let the currents in these feeders pass through a "motor-generator" at the generating station, the "field

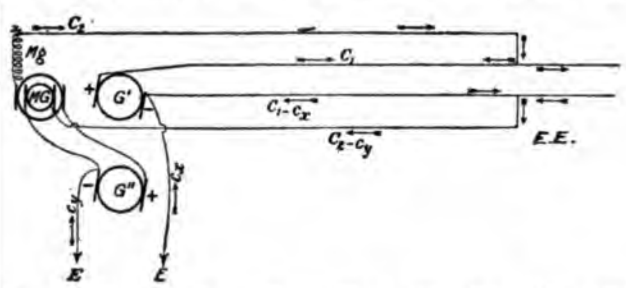


FIG. 5.—G′=generator; G″=auxiliary generator; MG=motor-generator; Mg=magnetising coils of motor-generator.

magnets" of which are excited by the current to line alone, while the armature is wound with two circuits—one for each current, so as to oppose each other—the circuit through which the current to line passes being made slightly the more powerful. The motor-generator will then revolve as urged by the line current, and will generate an auxiliary E.M.F. for the return current. The generator for each feeding circuit should be of rather higher E.M.F.'s than that supplying the near end of the line and return; but as the extra volts will be taken by the motor-generator in the station, there will be no need to exceed the limit allowed by the Board of Trade on the line outside. The expense involved may probably prevent the adoption of any such system in its entirety at present, but it possesses the advantage that it can be adapted to existing tramways, and a pair of feeders run to any part where the difference of potential from earth of the rails is found to be excessive. Such an arrangement with one pair of feeders is sketched in Fig. 5.

Earth Returns for Electric Tramways.

BY H. F. PARSHALL, MEMBER.

Considering the small difference of potential at which electrolytic action may take place, a matter of primary importance in electric tramway systems in which the rails are used as return conductors is in reference to the rate of fall of potential, and the difference of potential between the rails and the general mass of earth, the magnitude of which may vary according to such local conditions as the locality of gas and water pipes, the conductivity of the earth between the rails and such pipes, and the conductivity of the pipes themselves.

The exposed surface for leakage of the track is very great; thus in the ordinary four-track tramway system there is some 50,000ft. per route mile. With so great a surface, and with, as is generally the case, considerable conductivity of the concrete and earth, a large fraction of the current may be diverted from the rails, even in short lines, and with a maximum drop as small as that specified by the Board of Trade. Thus in tests recently carried out in a line some eight miles long, it was found, by cutting the track at the middle of the line and inserting an ampere-meter, that some 60 per cent. of the current was returning through the earth itself. Tests made as to the conductivity of the earth return showed as a whole that it was about one and a half that of the rails, bonds, and fishplates, which would indicate that on an average about 33 per cent. of the current was leaving the rails. In other words, the voltage drop in the earth return was but two-thirds of what it would have been had the current been wholly in the rails. In laying the rails, therefore, it seems desirable to adopt such methods of construction as will, to a considerable extent, insulate the rails from the adjacent mass of earth. The conductivity of the earth is considerable, and with differences of potential up to the limit established by the Board of Trade is so great that, in the cases I have examined, stray currents are not diverted from the mass of earth by gas and water pipes. I have made tests by cutting the rails and measuring the currents at different points, and, so far as could be determined, the neighbouring gas and water pipes were not traversed by the current. In one special case two lines of the tramway formed two sides of an acute angle triangle, and a very large water-main formed the third side, and, even though some 50 per cent. of the current did not come back through the rails, the tests showed beyond doubt that there was no current whatsoever coming across the third side of the triangle through the water-pipe. Of course, with the small difference of potential common in practice in this country, the C.E.M.F. of polarisation which accompanies currents flowing between conductors when electrolysis takes place is an important element in determining the law of current-flow.

The tests carried out by the writer have in every case shown that the joint conductivity of the rail and the earth is considerably greater than that of the rails themselves. For this reason there exists the necessity of determining the conductivity of the rails, fishplates, and bonds before the track is laid in the earth, so that after a roadway is completed the measured drop may be taken as an indication of what percentage of current is straying from the rails; further, so that tests made from time to time may indicate the general condition of the bonding. In general it is desirable that the earth return be isolated to the greatest degree practicable from any other metallic conductors liable to be affected by electrolysis. In some cases, however, where the drop in the earth return has been comparatively great, attempts have been made to prevent electrolysis by bonding the rails to the adjacent gas and water pipes. The results have been more or less satisfactory. It is obvious that if the rails and adjacent gas and water pipes can be kept at the same potential electrolytic action can be effectively prevented. Considering, however, the very considerable conductivity of the earth, it would seem doubtful whether such bonding would prove effective with any considerable drop in the rails, since in this case stray currents would flow from one part of the system to another, and at such a difference of potential as would cause electrolysis.

In the case of lead-sheathed cables running parallel to earth returns of tramways the results have been entirely satisfactory, and are conclusive, since in the absence of bonding the lead sheathing was rapidly eaten away. This instance, however, is not to be relied upon as an indication that it would be safe to carry out the same process in dealing with gas and water pipes. The lead sheathing is homogeneous, of comparatively high resistance, and with small surface exposed to the earth, whereas the reverse holds true with gas and water pipes as ordinarily laid down. I have no doubt that there are cases in which effective bonding of the rails adjacent to conductors might give entirely satisfactory results, but I should hesitate to make any general recommendation to this effect, since in very many cases a result directly opposite might be obtained. There is such a difference in soils—first, as to corrosive properties; second, as to electrical conductivity—that a general rule which would prevent electrolysis in every case would be unnecessarily severe, and in many cases prohibitive. It is obvious that, where currents stray generally
into the earth so as to enter metallic conductors, the
of potential should not be allowed to exceed that
electrolysis begins, plus the drop in the earth itself. In
system of distribution the controllable features in
return are practically limited to the method of joi
cross-section of the rails, and the chemical compositio
rails. The chemical composition of the rails cannot b
greatly, since rails low in carbon, but of high electrical
tivity, are found to wear away so rapidly that high-car
are a practical necessity. The cross-section of the
practice is largely determined from mechanical conside
and in the best practice rails of from 80lb. to 10
running yard are used.

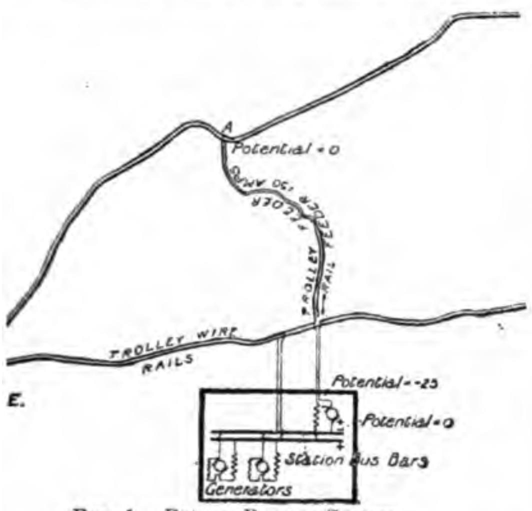
The method of making the rail joints is practically,
only factor controlling the resistance of the rail return
susceptible to wide variation in practice. The electric
of the rail joints has been tried in the United States,
far the results have not been such as to encourage th
facturers to advance the use of the system, or the
companies to adopt it. The joints in electrical tram
are equally objectionable from either a mechanical or
point of view, so that a system of perfectly weld
would meet with general favour. In practice th
of temperature in causing expansion and contract
been noticeable in long lengths of welded rails,
effects thereof have not been of such a serious n
might be expected from the range of temperature.
the reports I have at hand it appears that the
unexpected results of the welding process that made th
evident in the course of time. First, the electrical con
of the welded section was less than that of a solid rail.
the portions of each rail near the weld were so soften
wear away unevenly. Another unexpected result
owing to the sudden increase and decrease in tempera
rail took a very high temper at the weld, so that
to withstand shock was decreased. To the writer's m
not improbable that these mechanical difficulties could
come. Welding apparatus of sufficient capacity, ho
costly, and it is frequently difficult to arrange for the
power required; so far, therefore, the process has
employed in this country.

Another method of somewhat the same nature as th
of welding is that known as the "cast weld," or th
joint." This joint is made by pouring molten met
metal mould clamped round the rail joint. The surfac
cast metal that come in contact with the mould and
rail joint are chilled, and are thus prevented from f
perfect weld. I believe it has been asserted that a
effected. It seems, however, extremely doubtful, since
the use of a flux a weld is almost impossible betw
wrought steel and molten iron. The rail expands a
metal is poured around it, and remains expanded until
cast iron has set, and finally resumes its former si
affords a slight clearance for expansion and contract
accounts for the mechanical success of the joint,
carefully applied, makes when new a perfect mechanic
although, in the writer's mind, the difference of
between the part surrounding the casting and the r
part of the track may eventually cause uneven wearing
the rail. The clearance above spoken of undoubtedly
certain amount of moisture, so that by the formation
the resistance of the joint increases in the course
From the results of test which I have at hand, it also
that the electrical resistance of this joint, even when ne
considerably, so that, considering the low-voltage restri
this country, it should be used in connection with an
form of bond. Owing to the rigidity of the joint,
copper bonds will undoubtedly be found more du
conjunction with it than with a fishplate form of joint.

Bonds.

The bonds generally used up to this time are of the
contact type, and in making any general statements
naturally assumed as the basis. In the discussion of
read some time ago before this Institution the writer
out that, according to experience with pressure co
central-station work, 100 amperes per square inch h
found the limit in best central-station practice;
considering the trying conditions to which bonds are
in the earth, one-half of this value would more likely
factory. In actual practice I have found it advisable
to a still lower limit, and in most of the systems which
designed the current-density at surface of contacts
exceed 25 amperes per square inch. Experience sh
limit a safe one, and that the contact resistance is negl
compared with the resistance of the rails. Conside
complicated phenomena accompanying a junction of co
iron, in respect to the difference of potential caused
contact of dissimilar metals, it seems in the normal
all E.M.F.'s would balance each other, since in the cas
current keeping uniformly through the rails the E.M.F.
positive ends of a bond are balanced, and in the case of

ıg its contact the additional resistance would be greatly in the unbalanced contact E.M.F. The design of copper ıld be largely in reference to the permanency of the ırface. If there is any working between the surfaces, later there will be a film of oxide, so that the value ntact is destroyed. The working of the surfaces may by heating from excessive current density or by lack ity in the bond. Numerous types have been forth- Many of the bonds brought forward during the last ıree years have been designed with a recognition of the ce of greatly increasing the area of the contact surface, red with the cross-section of the body of the bond itself. beyond the scope of this paper to discuss all the types of bonds that have been brought forward from time. Samples of many of the different types are . The copper bonds that the writer has tested, ey have been more generally used in this country, r of the "Chicago," "Crown," or "Columbia" nples of which are before you. Flexible bonds are sirable for use where the mechanical conditions are short bonds can be used, in which case the added of the bonds to the track can be made as low as t., or less. Bonds of this type have been frequently the United States, and with good results when the made of drop forged copper. When, however, the been made of cast copper, and cast on to the con- the results are not generally satisfactory. The resist- cast copper is so much greater than that of drawn at it is not best suited for use in bonds. Further, the ween cast copper and drawn copper wires is imperfect, e electrical resistance is much higher than between s of pure copper fused together. The remaining type hat I propose to discuss is that known as the "plastic" ich was invented by Mr. Edison several years ago. results obtained from a line bonded over five years ears that this plastic alloy, which consists of mercury ingredients, as to the nature of which I am unin- s much more permanent than might be expected from nical nature. The bond is placed between the fish- the rail, in a cork receptacle, which is compressed to f its thickness when the fishplate is drawn up tightly.



E.

FIG. 1.—Return Booster System.

ount of copper required materially to increase the vity of well-bonded rails is so great that in ordinary auxiliary track feeders are not commercially practicable, ey be connected in circuit with a source of E.M.F. to ate for the drop in the feeder, so that this may exceed the track return. I believe Major Cardew was the first st employing E.M.F.'s in feeders to compensate for the rein. In the arrangement, however, of the earth return ally devised by him, it was necessary to use generators ent E.M.F.'s in the generating station. I have used in k a generator that is separately excited through a coil s with the trolley feeder, so that the voltage generated armature is directly proportional to the current output, d the field magnet is not saturated. The armature is in ith an insulated feeder connected with the rail at what- at it is necessary to take off current. The results in are most satisfactory. It has been found that the works perfectly automatically, and limits the voltage the earth return to any desired amount by an adjust- a rheostat in parallel with the field-magnet coil. Fig. 1 liagrammatic representation of the system.

(*To be continued.*)

night's meeting of the Institution the following were dates balloted for.

Associates.—J. R. Bedford, 43, Callcott-road, Brondesbury, N.W.; E. W. Beveridge, Tramway Department, Colombo; J. H. Brennand, care of Messrs. J. Fowler and Co., Leeds; W. R. Brown, 14, Mill-street, Macclesfield; W. Burr, 3, Camden-grove, Peckham, S.E.; H. A. Campbell, Jamaica Electric Light and Power Company, Limited, Kingston, Jamaica; E. Coote, Harley-ford, The Avenue, St. Margarets, Twickenham; L. F. Davis, Jamaica Electric Light and Power Company, Limited, Kingston, Jamaica; J. H. Durant, the Brigade Office, Q.D.F., Brisbane, Queensland; F. Fairley, care of W. C. C. Hawtayne, Esq., 20, Bucklersbury, E.C.; Samuel C. Gibson, Electric Light Department, General Post Office, Manchester; Frederick S. Hanning, 1, Rundall's-road, Vepery, Madras, India; H. Hartnell, engineer-in-chief's office, G.P.O., E.C.; R. J. Hughes, Hazel Hill, Guysboro' County, Nova Scotia; F. Hutchins, 13, Victoria-street, S.W.; E. L. Ingram, 21, Elms-road, Clapham Common, S.W.; H. W. Morisset, care of Messrs. Callender and Co., 90, Cannon-street, E.C.; A. E. Pepper, care of Messrs. Clark, Chapman, and Co., Newcastle-on-Tyne; N. Smith, 12, Chesterfield-street, W.C.; R. H. Sperling, British Columbia Electric Railway, Ltd., Victoria, British Columbia; A. E. Tessier, Electricity Department, Town Hall, Southport.

Students.—W. A. Del Mar, Central Technical College, South Kensington, S.W.; A. N. Dixey, 58, Leigh-road, Highbury, N.; D. Hills, 2, Eastbrook-road, Blackheath, S.E.; H. H. L. Prendergast, 2, Heron-court, Richmond, Surrey.

MUNICIPAL ELECTRICAL ASSOCIATION.

A conference of municipal authorities of England and Scotland, convened by the Municipal Electrical Association, was held at the Westminster Palace Hotel on Monday last at the early hour of 9.30 a.m., to ascertain their views as to what course should be taken before the Joint Committee of the two Houses of Parliament which is now considering the question of electrical energy, generating stations, and supply within extensive areas. Manchester, Wolverhampton, and Glasgow have already agreed to take common action, and the representatives of the other municipalities agreed at Monday's meeting to support the course that they had decided to take before the Select Committee, and that their interests should be represented by Mr. Worsley-Taylor, Q.C., Mr. Pritchard, Q.C., and Mr. Lewis Coward. After debate, the conference unanimously decided that, notwithstanding the provisions of the Electric Lighting Act, 1892, powers should be given to municipalities for acquiring land compulsorily for generating stations, and that as to liability for nuisance and notices to owners they should be under the same statutory powers as railway companies as to their liability for compensation or damages for neglect; that compulsory powers should be given for acquiring land for generating purposes not within the area of supply; that power should be given for breaking up streets between the generating station and the boundary of the area of supply; that powers should be given for the supply of electrical energy over an area including districts of numerous local authorities, with the consent of such authorities; and that powers ought to be conferred on promoters seeking to supply electrical energy "to other undertakings, and not directly to consumers," with the consent of the local authorities.

FORTHCOMING EVENTS.

FRIDAY, APRIL 29.

Institution of Mechanical Engineers.—At Institution of Civil Engineers, at 7.30 p.m., "Steam Laundry Machinery," by Mr. Sidney Tebbutt.

Royal Institution, Albemarle-street.—At 9 p.m., "Magneto-Optic Rotation and its Explanation by a Gyrostatic Medium," with experimental illustrations, by Prof. Andrew Gray, M.A., LL.D., F.R.S.

MONDAY, MAY 2.

Society of Arts.—At 8 p.m., first of a series of four Cantor lectures on "The Electric Locomotive," by Prof. Carus Wilson.

TUESDAY, MAY 3.

Society of Arts.—At 8 p.m., "Senefelder and the Centenary of Lithography, 1798-1898," by Joseph Pennell.

THURSDAY, MAY 5.

Institution of Electrical Engineers.—At Society of Arts, John-street, Adelphi, at 8 p.m., extra general meeting; for subject see front notes.

Iron and Steel Institute.—At Institution of Civil Engineers, at 10.30 a.m., general meeting; annual dinner at 7 p.m., at Hotel Cecil.

FRIDAY, MAY 6.

Royal Institution.—Albemarle-street, at 9 p.m., "Living Crystals," by Edward A. Minchin.

Iron and Steel Institute.—At 10.30 a.m., at the Institution of Civil Engineers, general meeting for discussion of the papers listed in previous issues.

Institution of Junior Engineers.—At 8 p.m., at the Westminster Palace Hotel, "Evaporative Condensers and Independent Air-Pumps for same," by Mr. Harry Fraser.

THE

ELECTRICAL ENGINEER.

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TO CORRESPONDENTS.

CABLES IN WAR TIME.

Never since submarine telegraphy was m
tical has the question of cables in war tim
acute till the breaking out of hostilities bet
United States and Spain. It is not nece
discuss why in previous wars there has
trouble about cables; sufficient that atte
thus early directed to the question
present time. Spain's condition, so far
communication with Cuba is concerned,
much our own position with regard t
communication with some of our in
Colonies. The United States holds the k
position in the present case, as the cab
Havana pass to the States, and thus one
the hands of the Americans. No message
in that direction from Cuba to Spain witho
through the hands of the Americans, and
as soon as war broke out cypher message
no longer be forwarded. These cables
to the Western Union Company, an A
company. Other cables from Cuba com
somewhat roundabout way *viâ* Jamaica,
these cables the Americans have no
It seems somewhat absurd to ask whet
Americans would be within their rights in
these cables, but that is what many peo
been doing. All arguments to the contrary,
no doubt the Americans are perfectly wit
rights if they disable these cables, altho
cables are owned by companies which are
Spanish nor American. Practically Mr.
answer to Mr. Nussey in the House of C
on Tuesday is to this effect. He sa
convention, to which Great Britain, Sp
the United States were parties, was conc
Paris on March 14, 1884, providing for
tection of submarine cables. But by Arti
thereof in time of war a belligerent sign
the convention is free to act with respect
marine cables as if the convention did not
am not prepared, therefore, to say that a bel
on the ground of military exigency, would,
circumstances be justified in interfering wit
between the territory of the opposing Power
other part of the world."

We say the position of Spain is so
analogous to the position in which this
might be placed under easily imagined co
Hence we have so often insisted upon the
of cables other than for purely commerci
No doubt the existing cable system of th
has been developed almost entirely with a
the requirements of commerce, but the t
certainly come when other considerations
taken into account—especially by this count
every effort should be made to have con
with our important Colonies that could
no circumstances be controlled by an en
the friends of an enemy. From anoth
of view the present state of affairs
watched with great interest. Will the Am
cut the cables referred to, keeping the ends
their cable ships, receive and transmit mes
if the ends were connected to their normal

ments? Cypher messages will assuredly pass over the cables—will these messages be gathered and garnered and the more peaceful messages sent on to their destination? We expect that course will be followed unless a Spanish cruiser happens upon the scene, or the Spaniards outwit their opponents. The future will have to tell what has been done—at present we can only foresee what might be done. That the cables, or any cables, can be easily cut goes without saying, and that fact has been one of the arguments used against the necessity of strategic cables. In the case of Cuba, probably the number of purely business messages over the cables will now be few, and the great aim of America will be to stop cypher messages, while the Spaniards will try to get them through, a task which ought not to be insurmountable.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

BAD WIRING.

SIR,—Referring to Mr. Jos. A. Jeckell's letter *re* "Bad Wiring" in your issue of last week, I fear that, speaking from personal experience, the days of jerry-wiring are far from over, nor will they be until the wiring contractor and his agent are better overlooked than at present. In the case of large buildings, such as hospitals, churches, etc., this does not so much apply, as the contractor usually has to work under the supervision of an expert, and to a specification drawn up by him; but in the case of house and shop wiring he is, as a rule, allowed to work his own sweet will, and as the prices for this work are cut very fine, the wiring as often as not suffers in consequence.

A few months ago I was asked to examine the wiring of a house which had been completed a short time previously, but had not been tested by the supply company. On making tests I found the insulation to be so bad that I decided to have some of the wiring taken out and examined. The contractor evidently had not thought that his work would see daylight again so soon. The insulation of the wire was of the poorest quality. A few of the joints were soldered—that is, the solder had adhered to the copper—but in the majority of cases the wireman (?) had only succeeded in making the solder stick to the resin, with which the joints were freely covered, while in a number of the joints the wires were merely twisted together without being soldered at all. The insulation consisted of 2in. or 3in. of rubber wrapped round the joint, with a few turns of tape on the top. It is needless to say that the house had to be rewired.

Until architects and private persons see the necessity of having proper specifications drawn up, and the work supervised by a competent person, also that it is not always the best policy to accept the lowest tender, jerry-wiring will more often than not be the order of the day.—Yours, etc.,

London, E.C., April 26, 1898. CHAS. C. WARDROP.

GENERATION OF ELECTRICITY AT GASWORKS.

SIR,—According to the *Daily Mail*, Jan. 26, 1898, there are in the United Kingdom 433 private gas companies and 208 municipalised gas undertakings, the majority of which are at the present time making a considerable profit from gas and the by-products or wastes. During the year 1897 an application for provisional protection for "generation of electricity at gasworks by utilising the waste gases and heat" was passed by the Patent Office, and the applicant is of opinion that it is possible to generate 30 to 50 units (?) of electricity as well as 9,000ft. to 10,000ft. of coal gas from a ton of coal as well as the usual by-products, coke, etc. If such is possible, what will be the ultimate cost of electricity? The capital expenditure of these gas undertakings is stated to be about £66,500,000, and the expenditure on electrical central stations is increasing so fast that the figures can hardly be correctly stated, but it is certain that a large amount expended on land and buildings (if it were possible or practicable to make gas and electricity at the same works) would be saved, besides which there would be considerable saving in the departments of distribution and collecting. Another feature is the question of Dowson or power gas made from cheaper coal having less illuminating but greater motive power, and the combination of some of the systems would obviate the necessity of storing the electricity, which forms the most costly part of an electrical undertaking when "works' cost" is calculated. The great increase of electrical traction and the comparative low cost and advantage of electrical motor power and its distribution and the question of "day load" may be solved by utilising gasworks for the production of electrical light and power as well as illuminating and power gas All this hinges upon one question, Is it possible or practicable to utilise the present waste gases or heat at gasworks for the generation of electricity? Also, whether the gas companies, which for many years have supplied us with light, heat, and power, are to be superseded? Now, as many municipalities are owners of the gas undertakings, and have made applications for electric light, would it not be worth their while to consider these questions? Gas engineers have been studying how to improve their light and electrical engineers how to cheapen theirs, and both have overlooked the fact that it is possible to produce gas and electricity at the same time from the same coal. What the public want is cheap and good light, heat, power, and quick transit, and the profits thereof to go to the reduction of the rates, and it may be found practicable by combining the production of gas and electricity at one and the same time at gasworks.—Yours, etc., SAM. THOS. WHITE.

SELECT COMMITTEE ON ELECTRICAL ENERGY.

Generating Stations and Supply.

This committee met for the first time on April 21, when evidence was given by Sir Courtenay Boyle, the Right Hon. Earl Morley, and the Hon. Chandos Leigh, Q.C. There were present Lord Privy Seal (Viscount Cross), in the chair, Earl Spencer, Viscount Knutsford, Lord Monkswell, Mr. Ashton, Lord Balcarres, Mr. Kimber, and Sir Leonard Lyell.

At the conclusion of this evidence the committee considered the course of procedure they should adopt, and on readmission of counsel and parties,

The **Chairman** (Viscount Cross) said the committee have been considering the course of procedure in this matter, and I want to call attention very specially to this particular point. The order of reference, which I will read, is the order which we shall most strictly follow, and allow nothing to go outside it: "(1) Whether, notwithstanding the provisions of Section 12 (1) of the Electric Lighting Act, 1882, powers should be given in any cases for acquiring land compulsorily for generating stations; and, if so, under what conditions as respects liability for nuisance, notices to surrounding owners and otherwise. (2) Whether compulsory powers of acquiring land for generating stations, if proper to be given in any case, should be given where the proposed site is not within the area of supply. (3) Whether in case of a generating station, however acquired, not being situate within the area of supply, power should be given for the breaking up of streets between the generating station and the boundary of the area of supply. (4) Whether powers should be given in any case for the supply of electrical energy over an area including districts of numerous local authorities, involving plant of exceptional dimensions and high voltage, and, if such powers may properly be given, whether any, and what, conditions should be imposed: (*a*) with respect to system and plant, and to the construction and location of generating stations, in view of the powers of purchase conferred upon local authorities by Section 2 and 3 of the Electric Lighting Act, 1888; (*b*) with respect to the

relations of the promoters to other undertakers and to local authorities within parts of the area. (5) Under what conditions (if any) ought powers to be conferred upon promoters seeking to supply electrical energy to other undertakers and not directly to consumers." You will be pleased to observe that we are not going to travel out of that order by one inch, and we will have nothing whatever to do with the particular Bills which are before Parliament at the present moment; we are only here to discuss the questions of general principles. I hope I make that quite clear; and I shall take upon myself to stop any witness or counsel who attempts to deal with any particular Bill and does not confine himself to general principles. We have also decided that all applicants to be heard be requested to state, in writing, the particular points or propositions on which they wish to be heard, and to state the names of the witnesses they wish to bring and upon what subject. Upon receiving this information the committee will give further directions. Be it understood that we shall probably only hear one counsel upon one particular head, as in the last committee, and that you must agree among yourselves, as far as you can, as to the witnesses the various parties wish to bring, the points they wish to raise, and as to the counsel they wish to produce. The committee will now adjourn till three o'clock, and will then hear what you have to say.

Sir Courtenay Boyle.—In his evidence Sir Courtenay Boyle said that the Board of Trade, under the Electric Lighting Acts, could grant power for the supply of electricity either by license or by provisional order. The former is granted for seven years, but the method is discouraged by the Board of Trade because it is considered that it was only intended as a temporary expedient till it was seen how the provisional order worked. The provisional order has to be confirmed by Parliament, and the tenure given is, as a rule, for 42 years. Since the passing of the 1888 Act, 316 provisional orders have been granted, of which 274 are in force, the remainder having been revoked principally in consequence of non-user. Of licenses, 25 have been granted, only three of which exist now. In two or three cases procedure has been by Bill, as the promoters were unable to get the consent of the local authorities, this being necessary for a provisional order, unless the Board of Trade dispense with the consent, and make a report to Parliament giving their reasons for so doing. Anyhow, procedure by Bill is very exceptional, and only successful in such exceptional cases. Parliament has not allowed the Board of Trade to authorise the holder of provisional orders to take land compulsorily; thus no lands are scheduled in the orders, nor is any notice given by undertakers to neighbours; but to make the legal rights of the neighbours quite clear a clause is inserted in all orders to the effect: "Nothing in this order shall exonerate the undertakers from any indictment, action, or other proceedings for nuisance in the event of any nuisance being caused or permitted by them." Many objections have been made to this clause, but it is invariably put in the order. Undertakers find it very difficult to acquire sites for generating stations. These stations must be an inconvenience, though they need not necessarily be a nuisance. The order gives certain powers for breaking up streets within the specified area, but some authorities have exceeded their functions and given permission to break up streets outside the area. If Parliament authorises the generating stations outside areas, then, when the time of purchase comes, one authority may have a station without mains and another mains without a station, and there must be an inconvenience in that procedure. As regards pressure of distribution, high pressure is any pressure exceeding 500 volts continuous or 250 volts alternating, but not exceeding 3,000 volts either way, anything over 3,000 volts being extra high pressure. In direct reference to the General Powers Distributing Company's Bill, the points were briefly stated. The map shows a circle of area of supply embracing Doncaster, Sheffield, Chesterfield, Derby, Nottingham, Newark, Lincoln, Gainsborough, Retford, and other important places, with a generating station at a place called Worsop, the intention being to supply energy in bulk all over that large area. In dealing with that proposal you have to consider the question of pressure, you have to consider the question of a large generating station, you have to consider the question of purchase, you have to consider the question that several of these local authorities have already powers of supply themselves, and you have to consider whether the new undertakers can, by supplying wholesale, really supply energy at a sufficiently low price to make it desirable that they should have those powers. The promoters of the company claim that, if authorised, they will be able to supply electric energy for the use of mines and factories as well as for lighting at a very low price. That would be advantageous for trade generally, but the difficulties are very considerable. The formalities of getting a provisional order were said to be: they have to give notice in June to the local authority; then they send in their provisional order; then they have to prove the consent of the various local authorities, or ask us to dispense with the consents of the local authorities (a step which we have taken, but very rarely taken); and then they come before us and the provisional order is settled. The local authorities are trusted to know their own business, and it is very rarely that an order is granted unless their consent is given. As to the question of permission to go outside the area, it was pointed out that if granted for one thing it would be wanted for others; and although instances are not infrequent with water and gas, it should be done with great hesitation.

The Right Hon. Earl Morley.—The evidence of Earl Morley was largely explanatory of procedure, and why Parliament had not granted compulsory powers to holders of provisional orders; such powers are generally restricted to incorporated bodies. An important point was to the effect that the whole principle of electric legislation is that the undertaking should eventually be sold to the local authority. The objections to stations outside the area, though there is nothing in the provisional orders to prevent such a course, except a difficulty in breaking up the roads, were stated. One of the first difficulties is under the Electric Lighting Act, 1882. Under Clause 2, the local authorities have power, after the lapse of 42 years, to purchase, but only to purchase works within their jurisdiction. Then what will happen if the generating station is outside the district and the mains and wires are within the district? Then, again, it would be somewhat complicated if a single generating station were to supply half a dozen or more districts. Is the district within which the generating station is placed to have the power of purchasing that generating station, and another only the wires within its own district? If so, it will have a generating station far in excess of its requirements, and the other districts will have nothing but wires. If compulsory powers were granted, one district would have powers exercisable in another district. As regards the company's Bill previously mentioned, there would under it be 12[illegible] or 130 different local authorities to deal with in three or four different counties.

(To be continued.)

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answ[ers] of a practical character relating to central-station wor[k,] tramway work, or construction work; and for each sui[t-]able question offer *one shilling*, and for the best sol[u-]tion of any question we offer *ten shillings.* We al[so] give *five shillings* for every other answer we print. T[he] answers to any question should be sent within 10 da[ys] after the question has appeared, and should be written [on] one side of the paper only. We would call the attenti[on] of those sending in answers to the fact that the neatn[ess] of any sketches sent in is considered when marking [the] relative values of these answers. Questions may be s[ent] at any time.

QUESTIONS.

58. Describe with sketches one good form of sight-feed lubrica[tor] for cylinders and explain its action.—R. O. G.
59. Why are compound-wound direct-current dynamos not u[sed] in electric light stations?—P. T.

ANSWERS.

No. 53.—**Describe, with sectional sketches, a good of self-oiling bearing for dynamos.**

r to No. 53 (*awarded* 7*s.* 6*d.*).—There is a great of bearings which are adapted for self-lubrication on dynamos. They may be divided into two (1) the ordinary step bearing, and (2) the swivel Both classes may be lubricated in similar and some methods are better than others. ed or drop lubricators require watching and g. They cannot be called "self-lubricators," nor "wick" type. When the oil is "forced" through ngs, it might be called self-lubrication, in that it atic, but pumps are required to do the forcing. plest method, and one which is truly self-oiling, is s shown in the accompanying diagrams. The oil

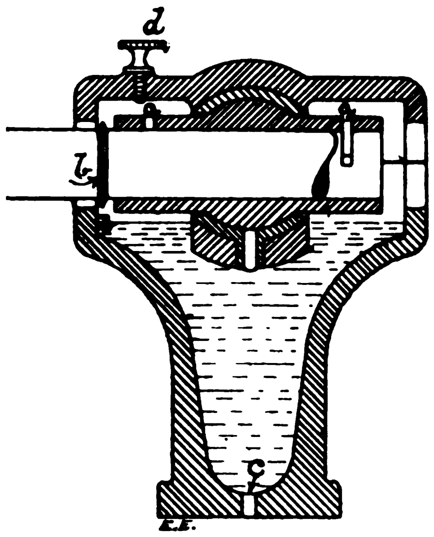


FIG. 1.

ed in the base of the pedestal, and is conveyed to by means of chains or rings, which are caused to y their contact with the shaft. Slots, *a a*, are cut pper part of the sleeve or step so as to allow the yors to rest upon and turn with the shaft. The he slots, which are on the horizontal diameter of ng, are cut obliquely with the slope in and down the shaft, so that as the chain or ring passes the of the oil is caught in the little recess, and so finds along the shaft. Outside the sleeve or step, lled "throw rings," are turned on the shaft, at *b*. These rings act as centrifugal fans, and oil along between the shaft and brass, and throw

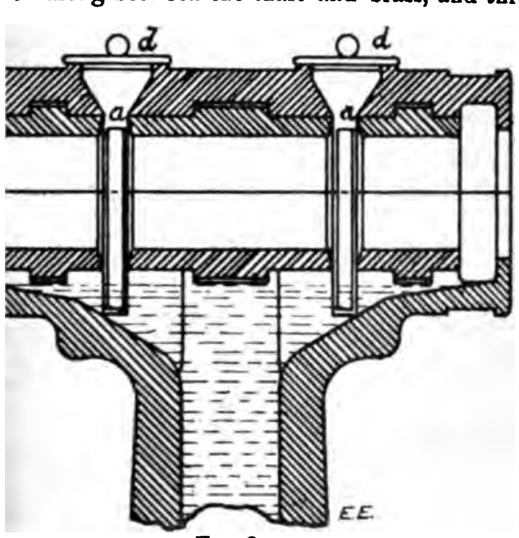


FIG. 2.

their peripheries into the cap and sides of the whence it runs down again into the base. When s been circulated often enough, and has become with dirt, etc., it may be drawn out of the through a tap connected to the hole, *c*, fresh oil plied through the plugged hole, *d* (Fig. 1), or the covers, *d d* (Fig. 2). Sometimes it is found that rings will not lubricate properly. Then chains of various forms are used. They may be bicycle chains or oval linked chains. In some cases these may not be found satisfactory, and helices of wire, with their two ends joined together, may be used. The size of the shaft and the speed at which it runs are the chief things which control the choice of the oil conveyor.—T. A. LOCKE.

Answer to No. 53 (*awarded* 7*s.* 6*d.*).—The term "self-oiling bearings" is applied to those kind of bearings which carry no lubricators, but are provided with a well or recess filled with oil immediately below the journal. Into this oil a chain or a plain ring dips, and this ring, which is about one and a half times the diameter of the shaft, is in contact with the shaft, so that when the shaft revolves the ring rotates in the same direction, constantly bringing up a supply of oil from the oil-well on to the top of the journal. Gaps are cut in the brasses to allow the rings to rest on the shaft. In Fig. 1 three brasses are shown with the rings in position. The brass shown at *a* is cut so that a ledge is formed between the brass and the shaft, and it will be seen that when the shaft and ring are rotating, as shown by the arrows, oil is brought up by the ring and lodges in this ledge, from whence it is conducted by oil-grooves through the brass, thoroughly lubricating the bearing and exuding

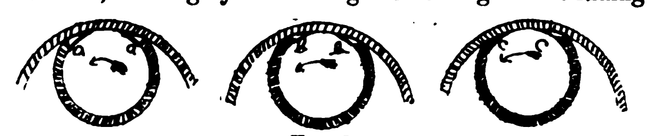


FIG. 1.

from the ends, and descends by means of oil-ways to the well once more. If the gaps are filed, as shown at *b*, straight across, or, worse still, in the opposite direction, as at *c*, the efficacy of the method is much diminished owing to the oil being scraped off the shaft. Chains are not used much in practice owing to their being troublesome at times. Care should be taken to see that the oil-rings are made of material which is not affected by oil. I remember a dynamo furnished with self-oiling bearings which had fibre rings for the ring oilers. After a time the fibre became soft through being in the oil, and one night it stopped running, and a hot bearing was the result. Fig. 2 is an example of an entirely different principle for raising oil from the well. This is not done by means of a ring, but through the agency of a fixed collar, *a a*, on the

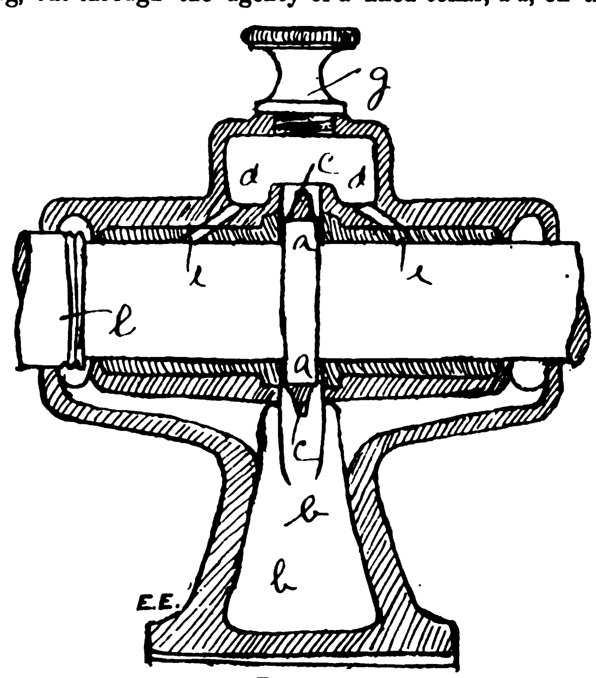


FIG. 2.

shaft. This collar carries a paddle-wheel, or collar, *c c*, whose lower periphery dips in the oil; when the shaft revolves the oil is flung up by the centrifugal force into the chamber, *d d*, from whence it is conducted by suitable passages to the brasses and journal to maintain their lubrication, and exuding from the bearings returns once

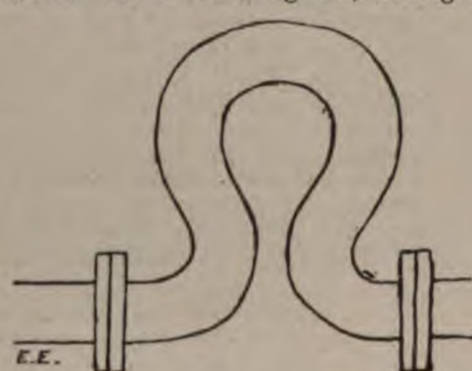
more to the reservoir, *b b*, below. A brass plug is screwed in the bearing at *g* to prevent the oil from leaking. This design (Fig. 2) is patented by P. R. Jackson and Co., and used on many of their dynamos and motors. It is a trifle more expensive, and possesses no advantage over the ring oilers, to my idea. The grooves cut out at *l* are for the purpose of preventing the oil from creeping up the shaft. The disadvantage of self-oiling bearings is that the bearings have to be made in two parts, without a chain is used, which is not advisable.—F. M. M.

[We have divided the 15s. equally between these two, as the differences between the sketches and matter make it difficult to award either the preference.—Ed. *E. E.*]

Question No. 54.—Discuss the advantages and disadvantages of expansion joints and expansion bends for long steam-pipes. What amount of expansion do you want to allow for in a steam-pipe 120ft. long working at 180lb. pressure steam?

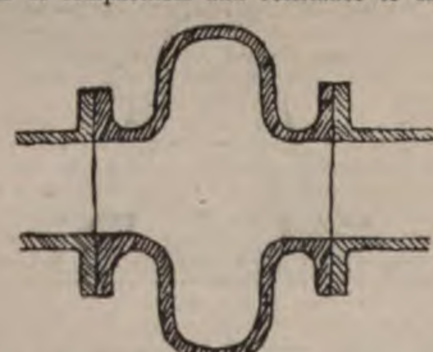
Best Answer to No. 54 (*awarded* 10*s.*).—As all metals expand and contract appreciably with variations of temperature, the elongation of a steam-pipe when steam is admitted has to be provided for; otherwise severe strains would be set up on the supports of the pipe, or on the boiler and engine fittings to which it was connected. The least trouble that this would cause would be injury to joints and much leakage of steam; but it would also tend to produce bending and twisting of boiler and engine parts, or shearing of bolts. If steam were alternately admitted and cut off, this straining would in time produce fracture. Three principal types of expansion joints and bends for steam-pipes are shown below, each having its own advantages and disadvantages.

The first is the simple loop bend. It is generally made of copper, and is a U-piece flanged at each end and inserted between two lengths of the steam-pipe. As these elongate they force the arms of the U together, meeting very little



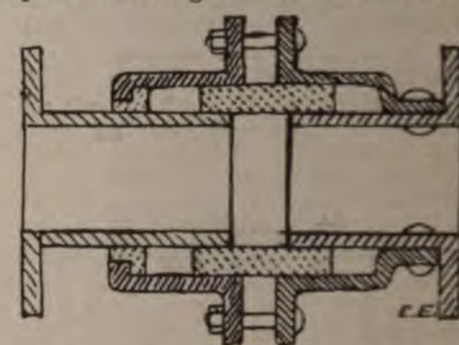
resistance. Being made of copper it will stand such bending for a long time, the bending being very slight at any particular point. It has the advantage of being of the same cross-sectional area as the steam-pipe. Owing to the sharp bend it acts as a water separator. It is easy to cover with non-conducting material; also, it is cheap. Its disadvantages are: first, it takes up a good deal of room; also, it makes the pipes more liable to sag.

The next type is a corrugated copper bend, and has the advantages of compactness and resistance to sag. It is,



however, more difficult to make than the former, and is not of uniform cross-section. The non-conducting covering also presents some difficulties. It collects water, and should be fitted with a drain cock. In large sizes the corrugations are repeated, thus getting a more flexible bend without
increasing the diameter. This approximation
diameter of the steam-pipe is an advantage where
necessary to run two pipes—*e.g.*, steam and exhaust-
together.

For large steam-pipes, the best way of providi
expansion is by means of an expansion joint as show
is really an arrangement by means of which one tub
slide within the other, the joint being protected by a
and stuffing-box. The sliding surfaces are sheathed
brass to prevent sticking. If iron were in contact



iron, it would become corroded under the influence
steam, and a rust joint would be formed. This j
rather expensive, but compact, rigid, of practically u
cross-section, and the cost of its manufacture decrea
proportion to that of the bends shown above as th
of the pipe increases. To find the amount of exp
required as stated above: Pressure of atmosphere =
per square inch ∴ absolute pressure of steam at
pressure per square inch = 194·7lb., or, roughly = 195

Now, temperature of steam at 195lb. absolute p
= 379·7deg. F. (by tables). Taking average tempe
of engine-room at 60deg., rise of temperature in
pipe when steam is admitted = 379·7 − 60 = (about) 3

Linear coefficient of expansion of cast iron = ·0
∴ in 120ft. of the cast-iron pipe expansion produc
1deg. F. rise of temperature = ·000011 × 120ft. ∴ exp
produced by admission of steam at 180lb. pressure

= ·000011 × 120 × 320ft. = ·000011 × 120 × 320 ×
= 5·07in.

If 5½in. be given for expansion the most extreme
will have been covered.—J. A. Seager.

[The coefficient of expansion taken Mr. Seager is
and hence his result is too high.—Ed. *E. E.*]

Answer to No. 54 (*awarded* 5*s.*).—The points to be d
in any arrangement for taking up the expansion in
range of piping are: (1) all the expansion should
place in the portion of piping set apart for it; (2)
should be no straining of pipes due to the expansion
place where no provision is made for it; (3) there m
no loss of steam at the expansion joint.

Expansion joints of the stuffing-box type requir
pipe to be firmly anchored, or they fail in their p
In a long range of piping it is a very difficult matter
the ends so fixed that all the expansion takes place
box. On board ship, where there are many places to
the pipe can be firmly fixed, expansion joints are fo
work well, but in land installations they generally
take up the expansion as they should. Expansion
should be steam-tight, or the waste of steam is great. In
boxes, if the gland is steam-tight and the pipe is a lo
the packing in the gland prevents the joint sliding, a
pipe finds it easier to expand at its ends, where it c
be more firmly fixed than in the box. On the other h
the gland permits the joint to slide freely, it will in
bability leak; so that if one evil is prevented, another
up. If the pipe expands and the box does not take
expansion, the anchor plates being fixed, there wil
great strain upon the pipes, much greater than
expansion was allowed to take place naturally. It
necessary in the sliding stuffing-box type to have a
ring to prevent the pipe being drawn through th
The bolts in the ring do not expand in the same r
the pipe, and it is not efficient. The most efficient,
as the cheapest, method of providing for expansio
means of the judicious use of bends in the pipe of co

thin steel. In a long straight length of piping there ought to be several U-bends, and the range may be anchored at places to ensure each bend taking up its fair share of the work; even if the pipes are not anchored, the bends will provide for the expansion. The legs in the bends should be as long as possible, then the expansion is taken up without putting undue stress upon the joints. Moderate lengths of steam-piping may be judiciously arranged with two or three right-angled bends of big radius, which will provide for expansion by reason of the elasticity of the pipe and joint packing.

From the above it will be seen that for ranges of piping in use in land installations, where the pipes are often slung from roofs and walls, the best method of taking up the expansion is by means of bends, as the anchoring of the pipes is a difficult matter; but if the pipes are of moderate length and firmly fixed, then expansion joints may be used. But, taken all round, the expansion bend is the best method, as there is no escape of steam from it if the joints are properly made.

The temperature of steam at 180lb. pressure is 373deg. F. If the initial temperature of the pipe is 60deg., which is low and on the safe side, the pipe will be heated through 313deg. Take a copper pipe 120ft. long, coefficient of expansion of copper is ·00001095. The amount of expansion that will take place in the above pipe when steam of 180lb. pressure is in it is

120ft. × 12in. × 313deg. × ·00001095 = 4·935in.

In a wrought-iron pipe of the same length the expansion will be 120ft. × 12in. × 313 × ·00000642 = 2·893in.—T. A. C.

Answer to No. 54 (*awarded* 5s.).—In all steam-pipes provision should be made for expansion and contraction to take place without unduly straining the pipes. Expansion socket joints have the advantage of giving a straight way for the steam, but otherwise they are not desirable in central-station work where there is generally considerably more room than aboard ship. The socket joints frequently give trouble by leaking. Inexperienced hands then tighten up the glands to an entirely unnecessary extent, sometimes making the joint as rigid as the pipe itself. I remember a case where the bore of a copper main steam-pipe was reduced ½in. by this means. If the glands and stuffing-boxes are not entirely of gunmetal, there is the possibility of their rusting up and consequent jamming.

Fatal accidents have occurred owing to the absence of guard bolts to prevent the pipe from being blown out of the stuffing-box, but this is entirely a fault in design. An arrangement of bends to allow for the expansion anticipated often becomes very difficult and complicated, but once properly fitted there is no fear of their giving trouble. The greatest care should be taken to keep the pipes and bends in the same horizontal plane as far as possible. A "pocket" in which water can collect must never be permitted. Sharp rising bends are specially dangerous. Water that has once left the boilers and entered the steam-pipes can never, with any ordinary arrangement of pipes, drain back to the boiler in the face of the issuing steam. Suppose the water gradually accumulates at the bottom of a rising bend until the area for the passage of steam is considerably diminished, then the steam would pick up the water almost as a solid piston and deliver it somewhere, possibly into the atmosphere. For a long range of pipes, a couple of bends introduced horizontally are very efficient. They may be of copper, wrought iron, or steel. Care should be taken, if copper pipes are used, that they are not "burned" or overheated during brazing, since the elastic limit of the copper is only about 5,500lb. per square inch, and would be considerably reduced if injured in the brazing. The strains may be reduced one-half by pulling the pipes out of their normal position when cold, in a direction opposite to that they will assume when hot. Those who have charge of the fitting-up of the pipes should have full and clear information as to the amount of expansion anticipated. Unquestionably expansion bends, when properly arranged, are preferable to socket joints for shore work. Their first cost may be greater, but that depends on circumstances, but the extra loss by radiation of steam in a good long bend is not worth consideration. As to the second part of the query, in a wrought-iron or steel steam-pipe working at 180lb. above atmosphere the range of temperature would be about 300deg. F., and the expansion and contraction 2·908, or nearly 3in. in 120ft.—F. R. S.

COMMERCIAL FORMS OF ELECTRICAL RESISTANCES USED FOR LIGHTING AND POWER PURPOSES.*

BY LL. B. ATKINSON.

(*Concluded from page 501.*)

Adaptation of Resistances for Special Purposes.

Resistances for Regulating Dynamo and Motor Shunts.—Almost any of the forms which have been described are suitable for this purpose. As to capacity, the maximum amount of power to be dissipated is reached when the resistance is equal to the resistance of the shunt, and when the current comes down to half its original value. Resistances working by compression, and therefore giving a perfectly steady graduation between maximum and minimum, have the advantage of allowing the E.M.F. to be regulated very exactly, an advantage where dynamos are being run in parallel.

Arc Lamp Resistances.—These form an important class, as very large numbers of them are used. Fig. 9 shows the usual form, consisting of a porcelain cylinder, having a spiral upon it, in which is wound a German-silver wire. The resistance is regulated by a movable clamp placing more or less of the wires in circuit. Fig. 8 shows the same arrangement, with a perforated cover to allow of ventilation. Fig. 10 shows three forms of arc lamp resistances, designed by the writer some years ago, in each of which the base is an iron cylinder covered with asbestos, on which the resistance is wound. All these forms of resistance have the disadvantage that as the wire is heated and cooled it is subject to very considerable strains, and the wires are frequently fractured. This difficulty is diminished in the form shown in Fig. 10, as the asbestos gives a little, and so releases the strain on the wire. Figs. 11 and 12 (which is the same resistance with a cover on it) show a form of arc lamp resistance used a good deal on the Continent, and consists of two earthenware discs having a groove on the periphery, round which a wire coil is stretched. The adjustment is made by a movable contact sliding over one of the coils. Fig. 25 shows the form of arc lamp resistance in which "relugite" is utilised as the resisting material, and the resistance is adjusted as required by tightening or slackening the end on the top. An important advantage possessed by this latter form of resistance is that as the coefficient of temperature variation is negative, the resistance is higher when first the current is switched on than it is when the arc has been burning a short time and the resistance becomes warm, thus assisting in keeping the current to its normal value, whilst the arc becomes of a proper length.

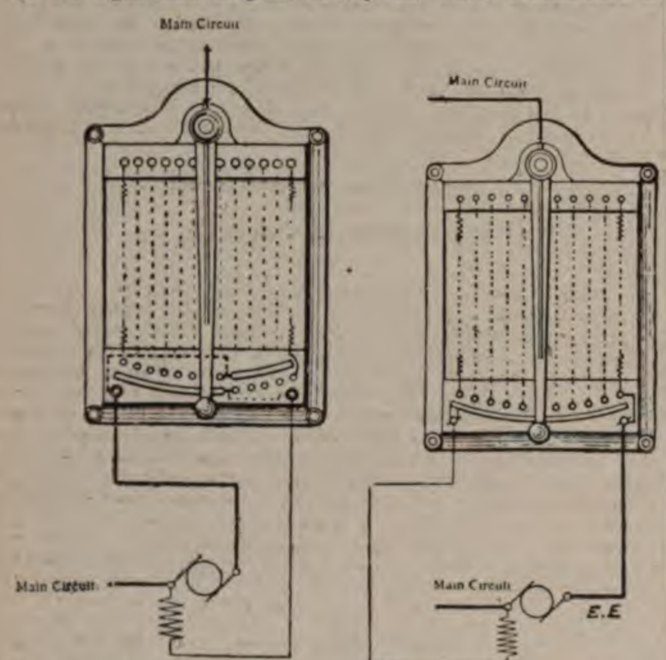
Resistances for Lowering Lamps.—These are mostly used for stage effects, and if made with switches should have a large number of contacts to make the graduation imperceptible, or liquid resistances, or resistances worked by pressure variation should be used. Owing to the peculiar nature of the fire risks in the theatre special care should be taken that the rise of temperature should be small. In the case of resistances designed by the writer for the Drury Lane Theatre, the specification was that the resistances should not rise more than 80deg. F. above that of the atmosphere.

Resistances for Meter and Instrument Testing.—For this purpose resistances with sliding wire, or liquid resistances, have been generally used, enabling the current to be kept at an exact value. The "relugite" pressure resistances shown in Fig. 26 is now being adopted for this purpose. It has the additional advantage with alternate currents that the resistance being inductionless no errors are introduced.

Motor-Starting Resistances.—It has frequently been a subject of complaint that the resistances for starting both continuous-current and multiphase motors, particularly for small powers, cost almost as much as the motor itself. This has been largely due to want of standard designs specially suited for the purpose. In general the resistance is not required for more than, say, one minute, but should be capable of carrying the full load of the motor for that time. Some forms recently introduced will only carry the load for 20 seconds; this is not safe. Figs. 13, 14, and 15 show forms of resistances specially adapted for this purpose. Fig. 13 embodies a resistance and switch only. Fig. 14 embodies also a main switch and cut-out—a point of importance—as some of the fire insurance companies make a rule that there must be a switch independent of the regulating switch. In the case of Fig. 14, the switch arm is controlled by a spring, so that the only points at which it will remain are the

* Paper read before the Northern Society of Electrical Engineers, April 18, 1898. Figs. 1 to 31 were given in our last issue.

position when the circuit is broken, and the position when the resistance is short-circuited, and when the arm is held by a catch. The moment it is released from this catch it travels back over the contacts and breaks the circuit, thus preventing a careless attendant leaving the switch in an intermediate position, when the resistance would be overheated and damaged. Fig. 15 shows a similar arrangement, except that two automatic safeguards are provided; the first of these is that in place of the catch holding the switch arm at the on position an electromagnet is substituted, this magnet being excited by a shunt coil, the result being that if the current is taken off the motor, either by the main switch or by the failure of the supply, the switch arm being released inserts the resistance and then opens the circuit. The second electromagnet is adjusted so that if the current exceeds a determined value the armature is raised it breaks the circuit of the holding-on magnet, so that the switch arm flies back and breaks the circuit. Fig. 16 shows an automatic cut-out designed to prevent motors being left on the circuit when the resistances are cut out if the current supply fails, and in this case there is a series winding on a magnet coil, and so long as the current passes through this coil the switch is held closed. When the current fails, the catch is released and the weight falls and opens the switch. Fig. 30 shows a form in which the resistance is gradually removed by the motion of the motor after starting. For the purpose of regulating the speed of motors, the resistances must be made larger, and must be capable of carrying a load depending on the range of regulation; but if this is a wide one, practically the full load of the motor must be provided for. The simplest way of regulating the speed of a shunt motor is shown in the right-hand diagram of Fig. 32, where a resistance is



Starting Resistance with Shunt Regulation

Starting Resistance without Shunt Regulation

Fig. 32.

placed in circuit with the armature of the motor, the full line pressure always being on the shunt coil. The left-hand diagram of Fig. 32 shows a modified arrangement, in which part of the speed regulation is effected by varying the strength of the current in the magnet coils. In this case the method of working is to have, in the first instance, the full line pressure on the magnet coils and resistance in the armature circuit. The resistance is gradually taken out of the armature circuit, and resistance is then inserted in the magnet circuit, thus weakening the field and allowing the speed to rise. If this form of regulation is to be adopted, the magnet windings should be specially arranged for the apparatus to have a low resistance, so that the motor is considerably over-excited at starting. Figs. 18 and 20 show resistances also well adapted for motor starting, and pressure resistances filled with either carbon or "relugite" are also used for this purpose. In order to avoid the possibility of a motor being switched into circuit rapidly it is preferable to fit such resistances with a screw motion, but if this is done, arrangements must be made by a separate switch or otherwise, so that the circuit can be broken instantaneously in the case of accident or emergency. An important point in connection with regulating resistances, particularly where the variation in resistance from point to point is considerable, is the question of the switch contacts, as considerable sparking occurs on the contacts, which from this cause becomes dirty or roughened, and causes considerable trouble. In a form of switch pillar for starting and regulating speed of motors designed by Messrs. Royce, inde[...] quick-break contacts are fitted at each resistance point, [...] final break is effected by a carbon contact. In a form d[...] by Pochin, the switch arm itself carries a small wipe[...] takes the spark, and it may be renewed as required. [...] case of pressure resistances, these precautions are unne[...] and even in the case of resistances with multiple contac[...] filled with "relugite" material, owing to the fact th[...] resistances are inductionless, the spark on the cont[...] practically eliminated.

Conclusion.

In conclusion, the writer desires to point out the a[...] which have taken place in the last few years in the des[...] manufacture of resistances owing largely to the increased d[...] and, therefore, to the specialisation which this has allow[...] hopes that the notes contained in the foregoing paper wi[...] of interest to the members of the Northern Society of E[...] Engineers, who have doubtless had considerable experie[...] only of the merits, but of the disadvantages to which th[...] of apparatus is liable. From a manufacturer's point [...] it is greatly to be desired that engineers designing pla[...] endeavour to avail themselves of manufacturers' existing [...] and standards rather than to specify for particular arrang[...] as it is only in this way that the cost of accessories of the [...] light and power plants can be brought to a point which w[...] the effect of greatly stimulating the use of electrical ap[...] in many cases where at present the admitted advantage[...] outweigh the expenditure necessary.

SPRING.

From an Electro-Waltwhitman Point of Vie[...]

The spring has come, and there is much delight about t[...]
In the hearts of the men who are responsible for a co[...]
electricity supply,
In the hearts of the men who reign over its safe an[...]
paratively wasteless distribution,
And more particularly in the hearts of those who are a[...]
to grievously overloaded stations.

For months past, in one-hundred-and-one generating s[...]
The sets have worked the peak without a spare!
Sometimes with even a ten-per-cent. overload!
The boilers have been forced for hours with highly calori[...]
The low-tension 'bus bars have become of hellish tempe[...]
While the mains outside might have been armature cond[...]
Such was the current density that the insulation oozed and[...]

Then have the souls of the men in charge waxed wroth [...]
and wroth again,
Then have they spoken in congressional terms of the pe[...]
blame:
The consulting engineer who, in autumn, hath opined t[...]
plant could do it on its head;
Or the cheeseparing municipal committee that did not [...]
borrow any more that year;
Or the firm of contractors whose promises of delivery [...]
the nature of 27's fuse wire.
All these have been trebly (and gutturally) damnēd fo[...]
omission.

But now that the worst is over, and the chance of fog[...]
to-one against,
The most-to-be-dreaded machine can be taken to pie[...]
re-bushēd.
Or turnēd-up as to commutator, or rewound as to [...]
armature coil;
Also the twenty-and-seven stock jobs on boilers and pu[...]
be started upon.
The contentment of work will replace the helpless a[...]
waiting for something to go,
The reciprocated joyfulness of connecting-up customers [...]
months have wept for the light,
The supreme facility of a daylight interval long en[...]
replace an earthēd distributor;
All these joys are now here, and the season of nightmare[...]

Yet stay; there are some ill-pleasēd because of the ad[...]
springtime.
They come sometimes to inspect the log-book, if the [...]
is agreeable;
And they sigh for the output that was, for their fame or [...]
will sense the decreasement.
They would like to stay the earth's rotation at midni[...]
that as soon as possible.
A fog is ecstasy to them; they prefer clouds unto the [...]
empyrean.
(That is the worst of holding electric scrip, or servin[...]
committee).
Bless them! but more particularly bless the coming of [...]

J. H.

LIGHT RAILWAYS.

The London United Tramways Company have given notice of their intention to apply to the Light Railway Commissioners next month for powers under the Light Railways Act of 1896 to extend their system to Hampton Court, at a point close to the Trophy gates. The company's lines at present terminate on the north side of Richmond. It is proposed to continue the line through Richmond, past the Star and Garter, on Richmond Hill, by way of Queen's road, thence through Petersham, Ham Common, and Kingston, over Kingston Bridge, and along Hampton Court-road to the Palace gates. The cars will run on a 4ft. 8½in. gauge, and it is proposed that the motive power shall be electricity.

The British Electric Traction Company, Limited, have decided to make application to the Light Railway Commissioners for an order under the Light Railways Act, 1896, to authorise the construction of a line commencing in the centre of Johnstone and running along the High-street, up Thorn Brae, through Thornhilll, Elderslie, and effecting a junction with the present line at the west end of Paisley, and onward, connecting at the terminus at Ibrox.

Messrs. Greenwood and Batley, Limited, Albion Works, Leeds, have given notice of their intention to apply for authority to construct a light railway to be run by electricity between High-street, Dundee, and Broughty Ferry. The cost to the promoters is estimated at between £60,000 and £70,000. The railway would be managed on the overhead principle, and the route would be from High-street, Dundee, thence along Seagate, Blackscroft, and Ferry-road, crossing the railway at the oil mills, and onwards to Broughty Ferry, along Queen-street, Monifieth-road, to Barnhill.

Application is to be made during next month to the Light Railway Commissioners by the Railway Corporation of Great Britain, Limited, for authority to construct a light railway from Worksop to Newark, the proposed route passing through the parishes or places of Worksop, Welbeck, Corburton Budby, Edwinstowe, Ollerton, Wellow, Ompton, Kneesall, Kersall, Caunton, South Muskham, Kelham Averham, and the borough of Newark. The total length of the line is 22 miles 7 furlongs 7 chains. At Worksop it is intended to have a junction with the Great Central Railway, whilst at Newark there would be connections with both the Midland and Great Northern systems. For the most part the route runs along the side of the main road, and there would be depôts and sidings at several places. It is proposed to construct the railway on a gauge of 4ft. 8½in., and the motive power will be electricity.

At the Penzance Chamber of Commerce the light railway schemes for connecting Penzance and St. Just was discussed. The promoters are the Penzance, Newlyn, and St. Just Light Railway. The proposed line would start with a junction with the Great Western Railway at Ponsandane, near Penzance, passing to the north of the town by Gulval and Heamoor to Sancreed, and from there diverging in two branches—one to St. Just, and the other to St. Buryan and Sennen. Electricity is to be used between Newlyn and Penzance. During the discussion Mr. Goodman explained that there was a possibility of electric traction being used throughout the route. The Chamber decided to adjourn for a week, when both schemes will be discussed.

A report adopted by the Bournemouth Corporation states: "(a) British Electric Traction Company—Mr. Sellon, C.E, and Mr. J. Vincent Kitchener, of the British Electric Traction Company, Limited, attended the meeting, and submitted amended proposals for a tramway scheme; (b) Bournemouth, Poole, and District Light Railway Company—a letter from Mr. Pressland was read, stating that the Bournemouth, Poole, and District Light Railway Company proposed making an amended application to the Light Railway Commissioners. It was agreed to recommend that the following resolution be passed by the Council: 'That in view of the result of the recent enquiry, the Council is still of opinion that it is undesirable to allow tramways to be constructed in the borough of Bournemouth, and authorises the town clerk to take whatever steps may be necessary to prevent power being granted to any company to construct such tramways.'"

Next month application is to be made to the Light Railway Commissioners, under the provisions of the Light Railways Act, 1896, for powers enabling the promoters to construct light railways in and between Redditch, Headless Cross, Crabb's Cross, and Astwood Bank. No definite announcement has yet been made as to the motive power the promoters intend using, but it is understood that it will be electricity. From the starting place, near the Midland Railway station, to the furthest point it is as yet intended to go, the distance is a little over three miles. Messrs. William Webb and Co., of London, are the parliamentary agents.

At the last meeting of the Llandudno Urban District Council, some correspondence was received in reference to the Council insisting upon underground wires in carrying out the light railway scheme. It was referred to the Electric Lighting Committee in conjunction with Mr. Preece, engineer to the electric lighting scheme.

A protracted enquiry has been held at Chatham by the Light Railway Commissioners, and evidence heard for and against the application to carry out an electric tramway system for Chatham, Rochester, Strood, Brompton, Gillingham, and district. The commissioners were the Earl of Jersey (chairman), Mr. G. A. R. Fitz-Gerald, and Colonel Boughey, R.E., C.S.I., Viscount Emlyn, acting secretary. Counsel for the promoters were Mr. H. F. Dickens, Q.C., and Mr. Morton W. Smith, recorder of Rochester (instructed by Messrs. Hayward and Smith, solicitors, Rochester). For the opponents, Mr. Cripps, Q.C. For Mr. Henry Jasper, promoter of another project, Mr. Wedderburn, Q.C. For the Rochester Corporation, the Chatham Corporation, and the Gillingham Urban District Council, Mr. Ashton (instructed by the town clerks and the Urban District Council). For the local water company, Mr. Freer (instructed by Messrs. Prall, Son, and Prall). For the local gas company, Mr. Alick Tassell (instructed by Messrs. George Winch, Son, and Winch). For the Commissioners of Customs, Mr. Henry Carr. For the local electric lighting company, Mr. A. R. Norman, solicitor. For the South-Eastern Railway Company, Mr. J. T. Prall, solicitor. For the London, Chatham, and Dover Railway Company, Mr. J. Lewis Morgan, solicitor.

A scheme is being promoted to construct a system of electric tramways connecting Harrogate, Starbeck, and Knaresborough over a distance of about three miles. The scheme comprises four railways, and the starting point will be in Station-square, Harrogate. The gauge will be 4ft. 8½in. The usual notice of intended application to the Light Railway Commissioners for the necessary powers has been given.

The North Metropolitan Tramway Company intend to apply to the Light Railway Commissioners for an order empowering them to construct eight lines of light railways or tramways in Outer North London. The project covers nearly 30 miles of roads. It is proposed to build a line from Cricklewood along the Edgware-road to Edgware; others through Child's Hill and Finchley to High Barnet; from Highgate Archway to North Finchley; from Wood Green through Southgate to Whetstone on the Great North-road, and converging on the two former lines; another from Wood Green to Enfield; and a third starting from Wood Green and running to Tottenham.

The Lord Mayor of Leeds, along with the town clerk, the city engineer, and a number of members of the Leeds Corporation, had a conference on the 27th inst. with the Parliamentary Committee of the Bradford Corporation in the town hall of the latter city, the object of the meeting being to discuss the scheme for the extension of Bradford. With reference to the question of light railways between Leeds and Bradford, it was resolved to inform the promoters of that scheme that the two Corporations agreed the time was inopportune for the laying of such a tramway between the two cities.

PHYSICAL SOCIETY.

At the ordinary meeting of this society held on April 22 a paper by **Prof. T. C. Po ter**, on **"A Method of Viewing Newton's Rings,"** was read by Prof. S. P Thompson. If a parallel beam of light from a rectangular slit falls at oblique incidence upon a plane plate of glass, the first two reflections occur at the upper and lower surfaces of the glass respectively, and give two corresponding images that may be formed on a screen. If now a second glass plate is added below the first, and parallel to it at a short distance, four images of the slit appear on the screen; but when the lower plate is brought into contact with the upper one, the reflection from the lower surface of the upper plate follows the same path as that from the upper surface of the lower plate, so that only three images are now to be distinguished. For the two glass plates the author substitutes a "Newton's rings" apparatus, and by the above device for eliminating a set of reflections he is able to restrict the illumination to the light that comes from the two interior surfaces. As thus observed, the colours of the rings are very brilliant. When the plates are very clean, the darkest area of the "black" spot has a sharply-defined edge, similar to that of the black film of a soap bubble By using monochromatic light, the various sets of rings may be photographed; they appear as several systems of concentric circles, the systems intersecting one another. This method of illumination by a slit enables Newton's rings to be viewed free from all light, except that due to reflections at the bounding surfaces of the air-space between the plates. It reveals to the eye the subordinate interference systems that coexist with the primary rings, and it demonstrates which of these reflections must be taken into account in the theory of the phenomenon. Moreover, it supplies a means for analysing these systems, and it indicates that the interference of monochromatic light is never complete under these circumstances.

Prof. Herschel said it was rather difficult to follow the arguments of the author without witnessing the phenomena. Much complication was introduced by the successive reflections. It was not clear what became of them. There was no doubt as to the advantage of a narrow slit for the illumination. He thought some of the secondary reflections might be got rid of by using plates that were slightly prismatic.

Prof Thompson had, in his own laboratory, verified the advantages of the author's method of illumination. The result was a very sharply defined first system of rings. Curves of subordinate interference were easily to be observed by this arrangement.

Prof. Boys noticed in the photograph of the ring systems that the independent systems of bands were distorted at the points of intersection. The intersecting curves formed a sort of honeycomb or hexagonal system, instead of a system of curvilinear quadrilaterals. This distortion reminded him of similar effects observed in the photographs of "ripples."

Mr. Edser said he had often noticed similar distortions, but he had always been able satisfactorily to explain them as being the result of imperfect focussing. The author had referred to the fact that a thin film when viewed by reflected light appears black. A

phase-change of half a wave-length takes place either on reflection at a rarer or at a denser medium, but there is no information from which to decide between these two alternatives. The truth of the assumption that the phase-change occurs at the denser medium seems to depend, so far as experimental evidence is concerned, upon the observation that in Lloyd's bands the central one is black. To produce the Lloyd's bands only one mirror is used; the bands produced by Fresnel required three mirrors. Wernicke performed an interesting series of experiments in which white light reflected for various angles of incidence from a thin sheet of glass was examined spectroscopically. The spectrum was crossed with numerous black bands, and from the position of these bands in the spectrum the thickness of the glass was calculated. The calculated thickness when the angle of incidence was great, differed from that obtained with small angles of incidence; the conclusion was that when light is internally reflected, even at an angle of incidence less than the angle of total reflection, a phase-change is produced. If the space between the two plates in Prof. Porter's experiment were filled with a substance of higher refractive index than glass, a confirmation, or otherwise, of this result might be obtained.

Dr. S. P. Thompson then exhibited a model apparatus made by the Helios Company to illustrate the three-phase method of transmitting power. It consists of a small generator, driven by hand, and a small motor. The generator is separately excited by a small secondary battery; it has three independent coils. The six ends of the coils are connected to six commutator rings. The motor has three corresponding pairs of opposite coils; these can be grouped in various ways for connection to the brushes of the generator. The six coils are on a hinged frame, so that, if necessary, they can be laid down flat for other rotation experiments. Two armatures are provided, either of which may be used. The first is an iron wheel with peripheral copper bars arranged like a squirrel cage, the other is a simple iron disc without added conductors.

The **President** proposed votes of thanks, and the meeting was adjourned until May 13.

BLACKPOOL CORPORATION ELECTRIC TRAMWAYS.

We have received a copy of the report of the deputation from Blackpool which recently visited the Continent, and give abstracts from it as follows:

In accordance with the resolution of the Council on Feb. 1, 1898, the undersigned, members of the Electric Lighting and Tramways Committee, together with Mr. Robt. C. Quin, borough electrical and tramway engineer, and Mr. John Lancaster, general manager of the Corporation tramways, have visited the Continent and inspected the various systems of electric traction in operation. It may perhaps be advisable at the outset to briefly recount the history of electric traction in Blackpool. In 1885 the Corporation laid down a tramway from Cocker-street to the end of the promenade at South Shore, and leased the running powers over the same for a period of seven years to the Blackpool Electric Tramways Company, Limited. At the expiration of this period—viz., in September, 1892—the Corporation, having obtained parliamentary powers in this behalf, purchased the company's undertaking and plant for the sum of £15,587, including expenses of purchase. In addition to this sum, the Corporation had expended £13,435 in the construction of the permanent way, upon which, of course, they received interest from the company during the continuance of the agreement. It was found essential, however, on the completion of the purchase, to relay part of the conduit, and to replace and repair part of the plant and machinery which had just been taken over, the cost of this work being placed against maintenance account. Notwithstanding further expenditure during 1893-4, the conduit still failed to give satisfaction, as also did the general plant, and the running of the cars continued to be very uncertain owing to breakdowns. The Electric Lighting and Tramways Committee, therefore, went very closely into the causes of the failure, and instructed their then engineer, Mr. John Hesketh, to furnish a report on the various systems of electric traction in use in England and on the Continent. This report, dated November 17, 1893, gave full details of the conduit, overhead, accumulator, and other systems then in use. The committee, recognising the strong objection which would then be taken if a recommendation were made to adopt the overhead system, decided to make a strong effort to put the conduit and the whole of the plant in a condition likely to ensure satisfactory working. During the winters of 1894-6 the whole of the conduit along the promenade was therefore relaid on a new principle at a net cost of £6,754, and the eight old cars purchased from the company were repaired and repainted, and the armatures rewound, at an additional expenditure of £1,721—all of which went to capital account. In spite of this large expenditure on the conduit—supplemented as it was by a further expenditure, out of maintenance account, of £340 during 1895-6, and of £856 during 1896-7 for repairs, etc.—the trouble increased rather than decreased, and it was felt that some radical change in the system was necessary if the tramways were to be made reliable and popular, and capable of yielding the handsome revenue which it was in their power to do. The committee then instructed Mr. Quin, their borough electrical engineer, to take charge of the electrical portion of the tramways, and to report on the position of affairs. On Aug. 19, 1897, this report was submitted to and considered by the committee, who ultimately came to the decision that it was useless endeavouring any longer to patch up a system which the conditions obtaining in Blackpool conclusively proved to be unsuitable, and they thereupon recommended the Council to abandon the conduit system and substitute for it the overhead trolley system.

The Council by a majority accepted the committee's recommendations, and application was forthwith made to the Board of Trade for permission to convert the system and to borrow the moneys incidental thereto. The Board of Trade deputed Major Cardew, R.E., to hold an enquiry in the matter, and this took place on Nov. 30, 1897. At the enquiry considerable opposition was manifested by a section of the townspeople to the Corporation's proposals, unsightliness of the overhead line, and danger from falling wires during gales, etc., being alleged. On Dec. 23, 1897, the Corporation received a communication stating that the Board of Trade did not see their way to grant the permission asked for, and suggesting the use of accumulators instead of the overhead system. To this the Corporation replied, asking where accumulators were successfully used for traction purposes, and were referred to Hanover and Paris among other places on the Continent. To thoroughly acquaint themselves with the various systems of electric traction, so that they might arrive at an irrevocable decision, the committee subsequently deemed it desirable that a visit should be made to the Continent to inspect the accumulator systems indicated by the Board of Trade, as has already been stated, and the Council duly sanctioned this visit. The deputation accordingly left Blackpool on Feb. 2, and visited Hamburg, Berlin, Dresden, Leipzig, Hanover, Cologne, Paris, Brussels, and Ostend.—[As we have previously described the tramway systems in most of these towns, we omit this part of the report.—Ed. *E. E.*]

Before advancing to the conclusions, the deputation record the great impression made upon their minds by the conditions under which electric tramways are worked on the Continent. Instead of being, as in England, looked upon with suspicion, if not disfavour, they are allowed great latitude, and their progress is fostered by the authorities, so that the public appear to have found electric tramways essential to their welfare by reason of the ease and expedition of transit from place to place, without discomfort or noise. Stopping places are declared, and cars stop at these places only, resulting in a punctual and prompt service. The outcome of these conditions, then, is that tramways serve the cities on the Continent just as railways serve the districts in England; or, in other words, they are street railways rather than tramways.

Conclusions.

As the result of their enquiry the deputation found that Continental tramway practice, like English and American, tended mainly towards the adoption of the overhead system of electric traction. In those cases where conduit and accumulator systems were at work the fact was distinctly stated that those systems were costly, and were only maintained to meet the æsthetic wishes of the various municipalities. Where the overhead system was installed the records show that the system was efficient and reliable, that it gave popular satisfaction, and that it was decidedly remunerative. But the main object of the deputation's visit was to enquire into the advantages, disadvantages, and cost of the accumulator system so as to be able to form a definite opinion upon the Board of Trade's recommendation to adopt this system. They have found as a consequence that the accumulator system has undoubted advantages peculiar to itself. Each car is to all intents and purposes an independent installation. If one car fails, the traffic arrangements are not deranged to the same extent as with the failure of an overhead or conduit system, inasmuch as the whole of the cars on service on the latter systems depend upon the maintenance of the supply of electricity from generators to motor; while in the case of accumulators, one car failing simply puts that car out of service without interfering with the others. The disadvantages, too, which have been urged against accumulators carried on cars on account of the smell of the acid, the injury to the car body and the clothing of passengers arising from split acid, were found by the deputation to be almost negilgible. With modern equipped cars, such as are to be seen on the Continent, these disadvantages with old-type car-carried accumulators have been overcome; the deputation having discovered only the faintest odour of acid, and no trace whatever of the effect of acid upon the car body.

The opinion was formed that the accumulator system was an ideal one, if the question of cost were left entirely out of consideration. Accumulator traction is free from all possible objections on the score of unsightliness of overhead wire, or of the existence of a slot in the roadway, and is certainly satisfactory from a public point of view. But the Blackpool tramways, unlike the tramways the deputation inspected, are owned and

y the Municipality, and the public rightly demand
hall not only be satisfactory as regards punctuality
ility of service, but successful financially. Unfor-
r the adoption of this system, the cost of installing
rs is, at the present time at all events, excessive;
the cells is short, and their upkeep heavy; and the
o type of cell has been sufficiently long in use to
te its efficiency and economy, and that one type of
g constantly displaced by a newer type which in turn
splaced, taken in conjunction with the fact that—with
cells—extra cars are required to run a given service
of the time occupied in charging the cells, effectually
system out of consideration if a remunerative return
pected from the Corporation's tramway undertaking.
ng upon the capital and maintenance cost of accumu-
correspondence with the Tudor Accumulator Com-
ited (the English manufacturers of the Tudor cell,
the Continent as the Hagen cell, and used at Berlin,
sden, Hanover, and elsewhere), already referred to,
low. The questions and the answers were as follows:
1: What weight of accumulators would be required
double-bogie tramcar weighing 11 tons, together with
f 86 passengers, a distance of five miles with one
Answer 1: 5 tons 4cwt. complete with acid.
2: The same running 75 miles with one charge?—
A discharge of this duration is not practicable with
of rapid charging. The battery would be of such
t it would scarcely be able to propel itself.
3: What space would be occupied—see No 1?—
68 cubic feet.
4: What space would be occupied—see No. 2?—
See Answer No. 2.
5: At what maximum speed?—Answer 5: About

6: What is the ampere-hour efficiency you would
?—Answer 6: 75 per cent.
7: At what price per car mile would you be prepared
n the cells for a period of 10 years?—Answer 7:
ar mile.
8: At what price would you be prepared to fit up
ith accumulators?—Answer 8: £370, including erec-
elivery, but not the case in which the cells are con-
he case would form part of the car body.
9: How long will the batteries require charging at
um rate at the end of the five miles journey?—
10 to 15 minutes.
10: Are you prepared to enter into a contract on
terms?—Answer 10: Yes.
sequent question as to the weights upon which these
e based, the following answer was received: "We
our reply upon the following weights: weight of car
ent, 11 tons; passengers, 6 tons; battery, $5\frac{1}{4}$ tons—
ons."
ese particulars it will be seen that the weight of cells
one of our largest cars, carrying 86 passengers; but
small cars carrying an average of 50 passengers each,
e weights given will have to be reduced *pro rata.*
l cars weigh with equipment $7\frac{1}{2}$ tons, the passengers
tely) $3\frac{3}{4}$ tons, and the batteries (taken as above)
aking a total car weight of $14\frac{3}{4}$ tons. Still proceeding
e scale as for the larger cars, the cost of batteries for
ese small cars would be £247. Summarised, the
apital cost works out as follows:

r six large cars, at £370	£2 220
ten small cars, at £247	2,470
	£4,690
ing cases for 16 cars at, say, £15	240
	£4,930

ing, for the sake of comparison, the cost of installing
d system, it would be well to turn to the tenders
These were for overhead line and insulators, posts
ts, trolleys, and that portion of feeding mains which
e required with an accumulator system (£3,377). It
nembered, in this connection, that the posts were
be used both for electrically lighting the promenade
and suspending the tramway trolley wire, and that
f their cost should therefore be chargeable to the
ting fund, which would reduce the gross cost
. Taken as a capital item, consequently, the accumu-
compares unfavourably with the overhead. Another
ring emphasis is the fact that a loan on capital
ld probably not be sanctioned for a longer period
rs, nor would it would be advisable to ask for an
f this period in view of the short life of the cells;
r an overhead system the general practice is to
oan for repayment in 25 years, thus relieving the
ges on the capital account.
on now to the consideration as to the effect the
accumulators would have upon the annual balance-
e tramway undertaking, it is necessary to find the annual cost of maintaining the accumulators, carrying them, and supplying electrical energy to them. The Tudor Accumulator Company, Limited, gave the cost of maintaining the cells at 1·6d. per car mile for the large cars; and the cost for the small cars, taken *pro rata*, may be estimated at 1·07d. per car mile. The mileage of the Corporation tramcars at the present time is about 200,000, or, with the addition of the two large cars now being built, say, 228,640 per year, being an average of 14,290 per car. Every car, for the present purpose, may be assumed to run the same number of miles.

Thus the cost of maintaining the whole of the cells contained in the cars would be:

Ten small cars, 142,900 miles at 1·07d. (say)	£637
Six large cars, 85,740 miles at 1 6d. (say)	572
	£1,209

To this, however, should be added an extra sum for increased supply of electricity, due, in the first place, to the additional weight carried, and, in the second place, to the inefficiency of the cells. As regards the increased weight, every ton of dead-weight carried a mile on a given tramway track requires the same expenditure of energy to carry it, whether it be in the shape of car, passengers, or battery, and it has been seen that the large cars would have to be increased in weight from 17 tons loaded to $22\frac{1}{4}$ tons, or 31 per cent., and with the small cars the increase would be from $11\frac{1}{4}$ to $14\frac{3}{4}$ tons, or 32 per cent. The energy taken per car mile at present is an average of ·9 of a unit, and the large cars running approximately 85,740 miles would take 77,166 units. But with $5\frac{1}{4}$ tons added by way of batteries to each car, the total energy required to run the cars the same number of miles would be 101,087 units, or an increase of 23,921 units. For the small cars, taken on the same basis, the energy would be, without cells, 128,610; with weight of cells, 169,765 units, or an increase of 41,154 units. As regards the inefficiency of the cells, it will be seen from the reply No. 6 of the Tudor Accumulator Company, Limited, that the guaranteed ampere-hour efficiency is 75 per cent., but it should not be forgotten that the cells have to be charged at a higher pressure than they discharge at, and that this difference of pressure amounts to some 20 per cent., making the real efficiency of the cells about 55 per cent. In the present calculations, however, it has been assumed that 60 per cent. is returned. Now, the units given above as requisite to drive the cars refer entirely to the energy given to the motors. Seeing, therefore, that only 60 per cent. of the energy put into the cells is given to the motors, there is a further increase of energy on this account, and the gross increase would be equal to some 245,600 units per annum. Bringing the units together, the following result is arrived at:

	Units.
Current used per annum for six large cars without cells	77,166
Ten small ditto	128,610
	205,776
Plus extra energy required through loss in cells and additional weight	245,600
Total	451,376

If we assume the cost of current to the Corporation themselves to be at the low figure of 1d. per unit, the cost of the additional current per annum would be about £1,023, if cells were used. Put in another way, the estimated annual maintenance account would be with accumulators:

Interest and sinking fund on a capital of £4,930 at $11\frac{1}{2}$ per cent. (repayable in 10 years)	£567
Cost of upkeep of cells	1,209
Additional cost of current to supply cells, due to inefficiency and extra weight carried	1,023
	£2,799

Compared with this the cost of the upkeep of the present conduit amounted last year to £2,238, though probably it will be rather less this year, and the estimated annual cost of the upkeep of that portion of the overhead system comparable with the accumulator system would be a sum not exceeding £600, including interest and sinking fund charges on a 25 years' loan. Hence, the relative costs of maintaining the similar portions—exclusive of repairs to roadway, rails, motors, gearing, cars, etc.—of the three systems are:

Overhead system (line, etc.)	£600
Conduit system (conduit, etc.), cost 1897	2,238
Accumulator system (accumulators, etc., as per statement)	2,799

But even were there no increase in the cost brought about by the installation of accumulators, the deputation are advised that it is the very definite opinion of the borough electrical and tramway engineer (Mr. Quin) and the general manager of the tramways (Mr. Lancaster), that in the event of the accumulator system being adopted it would be necessary to practically relay the present permanent way, owing to the additional load carried, and that the wear and tear of the road would be excessive due to the accumulators, the extent and cost of which increased wear and tear would be difficult to estimate.

From the evidence brought before them, and from the result of their investigations, the deputation have unanimously come to the conclusion that the overhead trolley wire system is the only system of traction which can be made both successful and remunerative in Blackpool. If the Council are prepared to incur what may probably be an annual loss for years to come on the tramway undertaking, then the deputation are not indisposed to the adoption of the accumulator system. But they believe that such an opportunity of relieving the rates by means of the profits which can be derived from their tramways by the adoption of an efficient and economical system should not be lost, and this fact alone leads them to strongly advise the adoption of the overhead trolley wire system. They are also of the opinion that the alleged danger of the overhead system, when properly installed and in conformity with latest electrical practice, is not justifiable; and that the overhead wires, if properly suspended, would not appreciably detract from the appearance of the promenade and streets of Blackpool. One point, however, the deputation wish to emphasise is, that no system, whether overhead or accumulator, can be reasonably expected to work to its highest success until the promenade widening is accomplished and a double track laid, and they would respectfully urge the Promenade Widening Sub-Committee to expedite matters in this direction. At the same time, the deputation are fully of opinion that a change of system must take place immediately.

Finally, the deputation have the utmost confidence in recommending the Council to ask the Board of Trade to receive a deputation from the Corporation to put before the Board the evidence which has been obtained and the experience gained, and to press for the Board's permission to replace the conduit system at present in use in Blackpool by the overhead trolley wire system, in accordance with the resolution of the Electric Lighting and Tramways Committee of Aug. 26, 1897, confirmed by the Council on Sept. 7, 1897.

(Signed)

JOSEPH BRODIE (chairman) THOS. BICKERSTAFFE (councillor).
JAMES CARDWELL (alderman) JNO. GRIME (councillor).
JAMES WARD (councillor) T. H. SMITH (councillor).

(Signed)

ROBT. C. QUIN (borough electrical and tramway engineer), and JOHN LANCASTER (general manager of tramways).

BRIGHTON ELECTRIC LIGHTING ACCOUNTS.

The Brighton electric lighting accounts for the year ending Dec. 31, 1897, have just been published. The total expenditure to this date amounts to £212,334. 10s. 4d. We give herewith the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.

GENERAL BALANCE-SHEET.

Liabilities.	£	s.	d.
Capital—amount received, £198,155. 0s. 2d.; less premiums, etc., on stock issued, £9,611. 6s. 9d.; and less amount appropriated for extinction of stock and accumulations of interest thereon, £19,494. 16s. 10d.	169,048	16	7
Premiums on stock issued, £13,118. 3s. 1d.; less discounts and costs and expenses of issuing stock, £3,506. 16s. 4d.	9,611	6	9
Sundry creditors	8,264	4	9
Customers' deposits	781	0	0
Interest accrued due	938	19	5
Proportion of appropriation in respect of sinking funds accrued due	3,855	13	3
Revenue account—balance at credit thereof	110	13	4
Balance at credit of net revenue account	2,864	5	5
Treasurer, £15,174. 14s. 4d.; less cash on deposit, £6,874. 0s. 2d.	8,300	14	2
Suspense account for estimated liability	350	0	0
Reserve fund	5,901	13	11
Excess of assets—viz, contributions to loans fund for extinction of stock and earnings of fund, to Dec. 31, 1897, £20,124. 9s. 4d.; less premiums and cost of stock purchased for extinction, £629. 12s. 6d.	19,494	16	10
	£229,522	4	5

Assets.	£	s.	d.
Capital account—amount expended for works	212,334	10	4
Stores on hand at Dec. 31, 1897—coal, £182. 18s. 2d.; oil, waste, etc., £338. 12s. 11d.	521	11	1
Sundry debtors for current supplied to Dec. 31, 1897	10,513	8	10
Other debtors	4	16	8
Engineer's advance	20	0	0
Reserve fund investment—Brighton 3½ per cent. stock, £3,000; Brighton 2½ per cent. stock, £3,127. 17s. 6d.	6,127	17	6
	£229,522	4	5

REVENUE ACCOUNT.

Dr.	£	s.	d.	£
To Generation of Electricity.				
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£5,143	7	11	
Oil, waste, water, and engine-room stores	658	18	6	
Wages at generating station	2,941	19	6	
Repairs and maintenance: buildings, £253. 13s. 8d.; engines, boilers, dynamos, accumulators, etc., £1,067. 16s. 3d.	1,321	9	11	
				10,065
Distribution of Electricity.				
Wages, etc., to linesmen, fitters, labourers	444	3	9	
Repairs, maintenance, renewals, etc.	112	11	0	
	556	14	9	
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises	468	9	10	
Outlay for works executed on account of customers	384	4	6	
				1,409
Public Lamps.				
Street-lighting installations	590	5	8	
Attending public lamps and repairs, including materials supplied	2,914	11	1	
				3,504
Rents, rates, and taxes				1,076
Management Expenses.				
Salaries—Engineer's department; Accountant and clerical staff	1,798	13	4	
Stationery and printing	198	9	11	
Registrar of stock and stamp duty	122	13	6	
General establishment charges	209	8	11	
				2,329
Special Charges.				
Insurances	125	8	6	
Law expenses	1	3	9	
				126
Total expenditure				18,522
Amount carried to net revenue account				14,100
Balance to be carried to next account to provide for bad debts				110
				£32,722

Cr.	£
Balance from last account, £53. 2s. 10d.; less bad debts written off, £47. 19s. 2d.	5
Sale of current per meter: 622,290 units at 7d., £18,150. 2s. 6d.; 883,577 units at 1½d., £5,522. 7s. 2d.	23,672
Public lighting: 50,028 units at 7d., £1,459. 3s.; 436,606 units at 1½d., £2,728. 15s. 10d; attending, etc., £2,914. 11s. 1d.; installation works, £590. 5s. 8d.	7,692
Rental of meters and other apparatus on consumers' premises, £763. 19s. 9d.; work executed on account of customers, £567. 11s.; rents receivable, £20. 17s. 2d.; fees for accounts sold, 1s.	1,352
	£32,722

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		2,
Quantity sold — Public lamps	486,634	1,
Quantity sold — Private consumers by meter	1,505,867	
Quantity used on works		
Total quantity accounted for		2,
Quantity not accounted for		
Number of public arc lamps		
Number of public incandescent lamps		

LEGAL INTELLIGENCE.

PURCHASE OF TRAMWAY UNDERTAKINGS—IMPO[RTANT] JUDGMENT OF THE HOUSE OF LORDS.

In the House of Lords on the 25th inst., before th[e Lord] Chancellor, Lord Macnaghten, Lord Morris, and Lord Ja[mes, an] appeal was opened of the London Tramways Company [v. the] London County Council. The appellants claim to be paid [for the] tramway compulsorily taken—not the mere cost of cons[truction] less depreciation, but the value as a going concern.

The question raised is whether Sir Frederick Bram[well was] right in rejecting certain evidence tendered on behalf [of the] appellants, and whether the award is or is not based on [a] principle of valuation of the matters referred to him, havin[g regard] to the provisions as to compulsory purchase contained in th[e] Acts and provisional orders relating to the appellants['] incorporation of the Tramway Act, 1870, and the mate

mstances of this case. The appellants maintained that naterial differences between this case and those of the ınd the London Street Tramways Company decided by of Lords. Sir F. Bramwell had refused to admit to the existing profits at the time of the notice on the the terms of the Tramway Act, 1870, and of the ıppointing him as referee, did not authorise or empower t a method or basis of valuation having reference to e position of the appellants' undertaking as a going and g concern. Sir F. Bramwell awarded £22,872, which ts contended upon their system of valuation should be . The appelants asked the Queen's Bench Division to award, but this was refused, both in the Court of First i the Court of Appeal, on the ground that the case was the decisions of the House of Lords in the two cases rred to.

ɔed, for the appellants, said the circumstances did not ially from those in the London and Edinburgh cases of herefore, the question arose whether the decision of f Lords in these cases was right.

. **Chancellor** said that involved the question whether 'as not bound by its own decisions. The Lord Chanver, with whom Lord Macnaghten, Lord James, and s concurred, held that the House was bound by its :isions, and could not reverse them in any principle of 'as fundamental.

ıl was accordingly dismissed with casts.

ANIES' MEETINGS AND REPORTS.

ELECTRIC SUPPLY CORPORATION, LIMITED.

: Colonel A. J. Filgate, R.E., chairman; E. Boulnois, ; Harrison Hayter, Esq., C.E.; Stephen P. W. V. C.I.E.; Sir Guilford L. Molesworth, K.C.I.E.

ort of directors to be presented at the annual general the shareholders at the City Terminus Hotel, Cannon-, to-day (Friday) at 2 p.m.:

:ely upon the formation of the Corporation instructions to the managing agents in Calcutta to negotiate for e of a site upon which to erect the generating station. little time a suitable site was acquired, but owing to it the land was covered with native buildings, and to ty for the vendors in some cases taking ejectment proget rid of the occupiers, the Corporation has only just tained possession of the site. The question of the use wires in some of the streets of Calcutta has involved cted negotiations with the Government of Bengal, the Department, and the Municipality of Calcutta. These s have recently been concluded so far as to permit of tors making arrangements for shipping the necessary ow that the site for the generating station has been e contractors have entered into sub-contracts for the the buildings and chimney, the whole of the cables and the mains have been ordered, and a good portion of the plant is well advanced towards completion, so that can be made immediately the buildings are ready to plant. The question of the renewal of the company's at the expiration of the period for which it was granted—viz., 21 years—for a further like period, has ubject of negotiation with the Government, and the ave no reason to doubt that the assurance given to the efore the issue of the prospectus will be carried out. rs, Messrs. J. H. Duncan and Co., appointed by the e first instance, offer themselves for re-election.

ΣMOUTH AND DISTRICT ELECTRIC SUPPLY COMPANY, LIMITED.

: Aymor H. Sanderson, A.I.E.E. (chairman); J. Hosker, M.R.C.S.; R. Percy Sellon, M.I.E.E. Con-:ineer: A. J. Lawson, M.I.E.E. Resident engineer: M.I.E.E. Secretary: H. B. Renwick.

f the directors (with abstract of accounts) presented to lders at the seventh ordinary general meeting of the eld at the London offices of the Company, Moorgatelon, E.C., on April 4, 1898:

tal expended during the year amounted to £7,074. king the total to Dec. 31 last £86,408. 13s. 7d. Of ıs expended it will be seen that the chief items are in nains, buildings, and machinery. The revenue account ıl income of £9,863. 8s. 3d., as against £8,243. 12s. 1d. ious year. The working costs, which at Dec. 31, 1896, considerable improvement, have since that date been r reduced. After providing for interest and other i writing off the sum of £1,173. 12s. 2d. for depreciat revenue account shows a loss of £92. 1s. 7d., which rried forward. The equivalent of 26,113 8-c.p. lamps :ted to the mains at Dec. 31 last, showing an increase the year, and applications representing a further 636 waiting connection. The County of London and Brush Electric Lighting Company's interests in the Company aken over by the Bournemouth and Poole Electricity ıpany, to whom the Company is now indebted for the is loan account. Under agreement with the County of Brush Provincial Electric Lighting Company, a sum as paid by that company in respect of an option over the unissued share capital of the Company, and this amount has been appropriated to writing off the suspense account. The 6 per cent. first mortgage debentures issued in 1893, amounting to £10,000, were redeemed in July last, in accordance with the terms of the trust deed, at a premium of £5 per cent. With a view to effecting further economies in the running of the station, certain alterations in the plant will be carried out during the current year, and considerable extensions of mains have been decided upon. The Company's application to the Board of Trade for a provisional order for the districts of Poole and Branksome was confirmed in the last session of Parliament. The retiring director is Mr. A. H. Sanderson, who, being eligible, offers himself for re-election. The auditor, Mr. R. H. Marsh, also retires, and is eligible for re-election.

REVENUE ACCOUNT, YEAR ENDED DEC. 31, 1897.

Dr.		£ s. d.
Generation of Electricity.		
Coal and other fuel	£1,308 15 5	
Oil, waste, water, etc.	453 7 2	
Engineers' salaries	386 0 10	
Wages	778 14 4	
Repairs: buildings, £8. 11s. 5d.; engines and boilers, £272. 10s. 7d.; dynamos and exciters, £13. 18s. 8d.; other machinery, instruments, and tools, £20. 13s. 7d.	315 14 3	
		3,242 12 0
Distribution of Electricity.		
Engineers' salaries	120 10 6	
Wages	107 17 9	
Repairs—Mains	71 0 6	
Transformer stations	14 14 8	
		314 3 5
Rents payable	135 6 0	
Rates and taxes	551 7 8	
		686 13 8
Directors' remuneration	28 7 0	
Salaries, head office	246 0 11	
Stationery and printing	51 3 3	
General establishment charges	148 17 6	
Auditors of Company	26 5 0	
Auditor of County Council	10 10 0	
Carriage	4 12 6	
Advertising	1 17 8	
Stores and works expenses	228 10 10	
		746 4 8
Law expenses		5 2 6
Insurance		102 11 4
Leasehold redemption account		10 8 5
Balance carried to net revenue account		4,755 12 3
		£9,863 8 3

Cr.	£ s. d.
Sale of current per meter	9,212 4 3
Rental of meters	457 2 6
Transfer and probate fees	1 2 6
Discounts	73 1 2
Trading account	5 18 0
Rents receivable	86 4 4
Proportion of pupils' premiums	26 5 0
Testing fees' account	1 10 6
	£9,863 8 3

BALANCE-SHEET, DEC. 31, 1897.

Liabilities.	£ s. d.
Capital account—amount received	92,516 9 10
Sundry creditors on open accounts	2,432 12 5
Leasehold redemption account	70 15 3
Reserve for bad and doubtful debts	38 19 3
	£95,058 16 9

Assets.	£ s. d.
Capital account—amount expended	86,408 13 7
Stores on hand at Dec. 31, 1897: coal, £144. 5s. 8d.; oil, waste, etc., £29. 1s. 3d.; general, £1,025. 0s. 3d.	1,198 7 2
Board of Trade deposit	150 0 0
Sundry debtors	6,338 12 5
Balance from net revenue account	92 1 7
Cash at bankers and in hand	871 2 0
	£95,058 16 9

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated (in Board of Trade units)	513,042
Quantity sold (private consumers by meter)	338,658
Quantity used on works	11,769
Total quantity accounted for	350,337
Quantity not accounted for	162,705
Total maximum supply demanded (kilowatts)	486

SUBMARINE CABLES TRUST.

The twenty-seventh ordinary annual meeting of the certificate holders of the Submarine Cables Trust was held on the 27th inst. at the offices of the Trust, Winchester House, E.C. The Marquis of Tweeddale presided.

The **Chairman** moved the adoption of the report and account for the financial year to April 15, which showed that the revenue for this period, including the balance of £159 brought forward

from previous accounts, amounted to £23,156. The expenses of the Trust amounted to £11,590, and the payments on account of coupons to £21,976, together £23,136, leaving a balance of £20 to be carried forward. The trustees, in accordance with the reasons explained in the last annual report, had sold the balance of their holding (£69,200) in the Anglo-American Telegraph Company, Limited, deferred stock, and had invested the proceeds in sound dividend-paying securities.

The resolution was seconded by **Mr. J. Denison Pender**, and adopted, after which another motion was agreed to confirming the resolution of the trustees and the investments made by them.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Salford.—The Electric Light Committee are prepared to receive tenders for electric cable until May 6.

London, N.E.—The Bethnal Green Guardians invite tenders for electric lighting plant. Tenders by May 17.

Winchester.—The City Council invite offers to light the street lamps for a term of three or five years from November 1. Tenders are to be sent in by May 1.

Harrogate.—Tenders are invited for lighting by electricity Trinity Wesleyan Chapel, Harrogate. Apply to Mr. W. Bentley, 19, North Park-road, Harrogate.

Edinburgh.—The Council are prepared to receive tenders for the wiring of the St. Leonard's police station. Full particulars appear in our advertising columns. Tenders by May 6.

Namur.—Tenders are invited for the construction of an annexe to the central station. Specifications, etc., are to be obtained from W. Weens, rue Leopold No. 5, at 5d. Tenders by May 12.

West Ham.—The Council invite tenders for electroliers, standards, etc., required for their public buildings situated in the county borough of West Ham. Full particulars appear in our advertising columns. Tenders by May 10.

Madras.—The Secretary of State for India in Council announces that the time allowed for the receipt of tenders by the Chief Engineer for Irrigation, Madras, for the utilisation of water power of the Periyar Lake has been extended from Oct. 31, 1897, to July 1, 1898.

Colwyn Bay.—The Urban District Council invite tenders, in connection with the lighting of their new promenade by electricity, for steam engine and boiler (or gas-engine), dynamo, switchboard, cables, etc. Full particulars appear in our advertising columns. Tenders by May 9.

Madrid.—Tenders are invited for the construction and working of an electric cable between Cadiz and Havana, *viâ* Teneriffe and the island of Visques. The deposit required is 150,000 pesetas. Specifications, etc., are to be obtained from, and tenders addressed to, the Colonial Office, Madrid, by May 16.

Esher.—Tenders are invited for the running and maintenance for five years of an electrical installation, comprising gas-engines, accumulators, dynamos, etc., and connected machinery at Millburn, Esher. Further particulars by application to Messrs. O'Gorman and Cozens-Hardy, 21, Embankment-gardens, S.W.

Hyde.—The Technical Instruction and Free Library Committee of the Corporation invite tenders for the supplying and fixing of the wires, fittings, gas-engine, dynamo, etc., necessary to the installation of the electric light in the New Technical School and Free Library. Full particulars appear in our advertising columns. Tenders by May 5.

Aberdeen.—The Town Council are prepared to receive tenders for the supplying and laying of about 10 miles of ·67 single-core feeder cable, about five miles of ·2 three-core network cable, and about 3¾ miles of arc lamp series cable. The cable is to be armoured and laid in wooden casing. Full particulars appear in our advertising columns.

Aberdeen.—The Harbour Commissioners are prepared to receive tenders for the supply and erection of 62 arc lamps on cast-iron posts; also three leading lights, each consisting of four arc lamps mounted on 80ft. posts. All lamps have to be manufactured under either Brockie-Pell or Crompton-Pochin patents. Full particulars appear in our advertising columns.

St. Helens (Lancs.).—The Health Committee invite tenders for the erection of destructor shed, new pail shed, electric light engine-house, chimney, weigh-house, offices, etc. Plans, etc., may be obtained on and after May 6 on application to Mr. Geo J. C. Broom, M.I.C.E., the borough engineer, on payment of £1. 1s., which will be returned on receipt of bona fide tender. Tenders by May 18.

London, E.—Tenders are invited for supplying the necessary plant and installing the electric light at their new infirmary, Palestine-place, by the Bethnal Green Board of Guardians. Plans can be seen and specifications obtained from the architects, Messrs. Giles, Gough, and Trollope, 28, Craven street, Charing Cross, W.C., on payment of £5. 5s., to be returned on receipt of a bona fide tender. Tenders by May 7.

Amsterdam.—Tenders are invited by the Consul-General of the South African Republic at Amsterdam for the supply of (1) insulators with brackets, and (2) hard-drawn copper wire. Tenders not received before 24th inst. at Nicolaas-Witsenkade 9, at Amsterdam, will not be regarded. Specifications (in three tenders) can be procured on demand by Mr. F. J. Belinfante, late A. D. Schinkel, Paveljoensgracht, The Hague, at 1s. each.

Brierley Hill.—The Dudley, Stourbridge, and District E[illegible] Traction Company, Limited, invite tenders for erectio[illegible] completion of power station, with chimney stack, ca[illegible] walling, etc., on site near to Dudley-road, Hart's Hill, B[illegible] Hill. Drawings, specifications, and forms of contract m[illegible] seen on application to Mr. Thomas Robinson, architect[illegible] surveyor, Victoria-chambers, Stourbridge, from whom bi[illegible] quantities and form of tenders may be obtained not later[illegible] May 5 on payment of £1. 1s., which will be returned on rece[illegible] a bona fide tender. Tenders by May 12.

Victoria (Australia).—Tenders are invited by the Coun[illegible] the city of Hawthorn for the supply and erection, or fo[illegible] supply only, of: (Section A) buildings only; (B) boilers, [illegible] heater, pumps; (C) engines, dynamos, switchboard, mains[illegible] mains, transformers, meters, arc lamps, insulators, [illegible] instruments; (D) supply of poles and their erection; runni[illegible] the plant for three years. Specifications and forms of tende[illegible] be obtained at the office of the Agent-General for Victoria, [illegible] General Sir Andrew Clarke, G.C.C.M., Victoria Office[illegible] Victoria-street, Westminster, London, S.W., on payme[illegible] £1. 1s., which will be returned on receipt of a bona fide t[illegible] Sealed tenders, endorsed "Tender for Electric Lighting[illegible] addressed to the Mayor of Hawthorn, Victoria, Australi[illegible] June 24, at 5 p.m.

RESULTS OF TENDERS.

Bootle.—The Corporation have accepted the tender o[illegible] Chloride Electrical Storage Syndicate, Manchester, at £1,0[illegible] supplying and fixing two storage batteries at the elec[illegible] supply works

Salford.—The Council have accepted the tender of [illegible] Thompson, Limited, for wiring the subways at the Salford [illegible] Hall for electric lighting purposes, at £228. 10s. and that [illegible] Bishop and Co., for wiring Broughton Town Hall for a s[illegible] purpose, at £181. 5s.

Newington.—The Electric Lighting Committee have re[illegible] the following tenders for the erection of the electric lig[illegible] station in Penrose-street—viz.:

C. G. Hill, Coventry*	£1[illegible]
T. C. Sharpington, Nunhead	1[illegible]
Balaam Bros., Old Kent-road	1[illegible]
J. Tyerman, Walworth-road	1[illegible]

* Recommended for acceptance.

London, N.W.—The Vestry of St. John, Hampstead, [illegible] accepted the following tenders for the supply, delivery[illegible] erection at their central station, Lithos-road, Finchley, of t[illegible] lowing plant: Siemens Bros. and Co., Limited, 12, Queen A[illegible] gate, Westminster, two 350-kw. steam alternators, W[illegible] Siemens sets, £7,100; S. Z. de Ferranti, Limited, Hollin[illegible] Lancashire, two Ferranti switchboard panels, £111; J. Brow[illegible] Co., Atlas Works, Sheffield, two induced-draught boilers, £[illegible] J. Fraser and Son, Millwall Boiler Works, E., feed-water h[illegible] steam and exhaust pipes, etc., £911; J. Fraser and Son[illegible] duplex compound steam feed pumps, £895; Siemens Bros[illegible] Co., Limited, a 50 kw. exciter in place of existing 23 kw. [illegible] nator, £910 (less allowance for existing alternator, to be re[illegible] by and belong to the contractor, £300).

BUSINESS NOTES.

St. Pancras.—The electric lighting accounts for the pa[illegible] show a profit of £5,717.

Aberdeen.—The bathing establishment at the sea beach i[illegible] fitted with the electric light, the probable cost being £170.

Stafford.—The output of electricity during the past year [illegible] an increase of 32 per cent. compared with the previous year.

Dundee.—The Gas Committee will recommend to the C[illegible] at its next meeting the acceptance of the tender of a local f[illegible] erecting a new economiser-house. The estimate is £600.

Treeton.—The electric lighting plant has run 1,000 hour[illegible] October 3 last, and it has been resolved by the Parish Cou[illegible] discontinue the lighting for the summer months on May 1.

City of London Electric Lighting Company, Limited.[illegible] meeting of the Board on the 27th inst. Mr. George Herri[illegible] elected a director of this Company in place of the lat[illegible] Suffolk.

New Swindon.—The following have been elected mem[illegible] the Electric Lighting Committee: Messrs. Brain, Deacon[illegible] Smith, King, Hill, Jones (Haydon-street), Pryce, Protheroe, Sewell, and Skurray.

Leeds.—The Highways Committee of the Corporatio[illegible] resolved to recommend that the Headingley, Chap[illegible] Dewsbury-road, and Hunslet sections be equipped wi[illegible] overhead electric system.

Longton.—The Corporation of Longton, who have reso[illegible] take up the question of municipal electricity supply, have [illegible] Mr. Robert Hammond as their consulting electrical eng[illegible] lay a scheme before them.

Warsop.—At the annual meeting of the Urban Distric[illegible] the chairman was authorised to sign, on behalf of the Coun[illegible] parliamentary petitition to grant the powers asked for [illegible] Electrical Power Distributing Company.

Glossop.—At a special meeting of the Town Council hel[illegible] 27th inst. for the purpose of considering a resolution, "Th[illegible]

be made to the Board of Trade for a provisional electric g order," a committee of investigation was appointed.

meck.—A deputation representing Greenock and Gourock London on the 21st inst. to meet with the Board of Trade electric lighting question. The deputation on behalf of the British Electricity Company started at the same time.

per - Coles Galvanising Syndicate, Limited.—We are ed that electro-zincing has been adopted by Mr. Peter rhood for his air-compressor tubes, and a plant is now being at his works on the Cowper-Coles regenerative system.

fax.—The committee appointed by the Town Council to r how the municipal jubilee of the borough may fittingly brated have recommended that a special effort be made to nce the running of the electric tramcars on jubilee day,

intments Vacant.—The Corporation of Wakefield have a y for a cable jointer; the Glasgow Corporation advertise sident engineer and a superintendent of mains; and the ment of the Colony of Lagos for an engineer for Govern- essels.

bury.—For the position of electrical engineer to the Corpo- the following names have been selected out of 70 appli- Messrs. C. B. Brown, Huddersfield; C. M. Jones, Great d; E. Marples, Egremont, Cheshire; John Pilling, Bolton; 'ullen, Bournemouth; and M. Smyth, Blackburn.

yn Bay.—With regard to the electric lighting of the ade, it was reported at the monthly meeting of the Urban ; Council that Mr. Clirehugh, engineer, approved of the ently acquired in Ivy-street as suitable for the plant, and ncil adopted that site, the one on the promenade not being le.

gton.—A letter received from the Chamber of Commerce, ig a resolution urging that, notwithstanding Section 12 of ctric Lighting Act, power should be given for acquiring compulsory power for the erection of electric lighting , is under consideration of the Electric Lighting Com- of the Vestry.

rd.—The Town Council have decided to purchase land ng to the Lancashire and Yorkshire Railway Company and Leaf's trustees, abutting on Bedlam-lane, off Strawberry- a site for a new generating station for electric purposes, make application to the Local Government Board for to borrow the amount required.

Asbestos Company, Limited.—The report of the directors Asbestos Company, Limited, for 1897, to be submitted to eral meeting on May 5, shows a net profit of £5,172, which, r with the amount brought forward—£1,968—leaves for iation £7,140. The directors recommend the payment of nd at the rate of 4 per cent. per annum, free of income l to carry forward £2,340.

n.—With regard to the Midland Electric Corporation's ion to the Board of Trade for an order to supply electrical the Council have adopted a resolution to try to get the price from 3½d. to 3d. per unit, and that in the event of failure in this concession they appeal to the Board of Trade to an arbitrator to fix a fair price between a maximum of d minimum of 2d. per unit.

ern Extension Telegraph Company, Limited.—The s of the Eastern Extension, Australasia, and China ph Company, Limited, announce a dividend (subject to ation by the shareholders), of 2s. 6d. per share for the ended Dec. 31 last, with a bonus of 4s. 3d. per share, a total distribution of 7 per cent for the year 1897. The d and bonus will be paid on May 12.

of London Electric Lighting Company, Limited.—This ny advertise the following reduced rates: electric lighting, nd including the first six units per quarter per 8-c.p. lamp d. per Board of Trade unit, above that quantity all con- on is charged at rates varying from 6d. to 4d.; electric for motive power and heating and cooking purposes is d at 3d. and 4d. per Board of Trade unit, upon conditions certained at the Company's offices.

ury.—At the annual meeting of the Council the Clerk said ved the Midland Electric Corporation were now willing to eir application for a provisional order as far as Oldbury cerned, and allow the Council to apply for their own order understanding that when it was obtained an agreement e entered into for them to supply the electricity for motive The company would pay all the expenses incurred by the in obtaining the order, and supply the electricity for cturing purposes.

borough.—The Gas and Electric Lighting Sub-Com- report with regard to the question of establishing the light in the borough, has been adopted by the Council. port recommended the Council to apply for an electric provisional order, and to authorise the sub-committee to expenditure not exceeding £50 for professional assistance the committee deem it necessary or desirable to obtain or the purpose of the proposed application for powers to the electric light in the borough.

—At a meeting of the Electric Lighting Committee the n stated that a print of the draft provisional order had eived from the Board of Trade, and that the Board had e or two amendments to which there could be no objec- e principal one being the deletion of the provision in 4, as to the application the undertakers are empowered to ter the expiration of seven years with reference to the alteration of prices. The meeting then recommended that the order, as adjusted, should be approved of by the Commissioners.

Huddersfield.—The report of the borough electrical engineer presented to the last meeting of the Council showed that the number of consumers of the electric current in April was 650, being an increase on the highest number in the preceding month. The number of lamps connected was 44,047, being an increase of 752 The Postmaster-General, in reply to a renewed application of the Corporation for a license for the municipalisation of the telephone exchange, has signified that he is not in a position to add anything to his former decision declining to accede to the application. The electric mains are to be extended from the nearest available point to Spink Nest-road, Birkby.

Parliament.—Lord Morley's Committee of the House of Lords has passed the City and South London Railway Bill, which confers power upon that company to acquire further lands and construct sidings upon their authorised extensions. The Bill also empowers the company to raise £133,000 additional share and loan capital. The powers originally sought to sell a portion of the undertaking to the City and Brixton Company were struck out of the Bill in its passage through the House of Commons. The latter company's Bill was read a second time at the House of Lords on Tuesday.—The Bristol Tramways (Electrical Power, etc.) and the Bristol Tramways (Extensions) Bills have been reported for second reading.

Glasgow.—At the last meeting of the Corporation, Mr. Stewart asked the chairman of the Electricity Committee whether his committee were doing anything, seeing that they were ending the financial year, to try to reduce to large consumers the price of electricity, and whether they had taken into consideration the question of the utilisation of the electric energy that was lying idle during the daytime. Bailie Maclay replied that they were nearing the end of the financial year, and that this matter would be before them immediately to consider whether it would be possible to make any reduction at the beginning of next year. They were in negotiation with the Clyde Navigation Trustees for a special rate. They had given a special rate for motor power to one consumer, and this question would come before them from time to time.

Bournemouth.—A letter from Mr. W. H. Dore complaining of the excessive charges by the electric lighting company has been referred to the Lighting Committee of the Town Council. Mr. Dore stated that the company charged 7d. per unit, whereas the electric current could be produced for 1d. or 2d. per unit. He hoped the Council would not encourage the company by accepting any tenders on the present basis of supply. It appeared that according to the provisional order the company were at liberty to charge 8d. per unit for seven years from the date of the order. That period expired in August last, and if the local authority at any time after the expiration of the term should make a representation to the Board of Trade that the price or methods of supply should be altered, the Board of Trade after enquiry might alter them, such altered prices to maintain for another seven years.

Leeds.—It appears that the electric tramways are being worked at an estimated annual profit of £6,595, or about 5 per cent. on a total (capital and expenditure) of £140,000. The *Leeds Mercury* published a statement this week showing that the earnings were £656. 16s. 4d., or 10·66d. per mile, or a total of 14,777 car miles. The working expenses are given as 8·60d. per mile, which would leave a profit of 2·06d. per car mile. A detailed *résumé* of the above is attached as follows—Working expenses per car mile: electric car shed, ·57d.; generating station, ·69d.; management and office (one-third), ·32d.; electric engineers' salaries, ·13d.; wages of drivers and conductors, 1·84d.; making a total of 3·55d.; depreciation, renewals, and repairs per car mile, 2·93d.; (7½ per cent. on capital expenditure, exclusive of proportion of cost of old track, etc.); interest on total capital expenditure per car mile, 1·17d.; sinking fund charges expenditure per car mile, ·95d.

Eccleshill.—A provisional order of the Board of Trade is published authorising the District Council of Eccleshill to construct a single line of tramway from the Bradford city boundary in Bolton-road along Stonehall-road and Stoney-lane to a point near the Eccleshill Mechanics' Institute, a distance of three furlongs and six chains, with two passing places of six and three chains respectively. The promoters may, with the consent of the Corporation of Bradford, join the line to the city system of tramways. In that event the Corporation will be entitled to demand licenses to run engines and carriages over the line upon terms to be mutually agreed upon. The line is to be constructed upon a gauge of 4ft., and the power to be employed and the method of its application will require the approval of the Board of Trade. The District Council will be empowered to make by-laws regulating the rate of speed, provided that they do not sanction a higher rate than that authorised by the Board. The amount which they are allowed to borrow for the undertaking is £3,200, to which, however, further sums may be added from time to time with the sanction of the Board.

Mitchelstown.—Major Cardew, of the Engineering Department of the Board of Trade, has held an enquiry (already referred to by us) into the application of the Guardians for a provisional order to light the town with electricity. Mr. W. J. O'Brien, J.P., stated that the proposal to light the town was first discussed at a meeting in the town hall. The general feeling at that meeting was that the lighting should be by electricity. The only difference of opinion was whether the light should be obtained from the Board of Guardians, the existing local authority, or whether the people

should seek the aid of town commissioners, a body that did not exist at present in Mitchelstown. The principal reason why the enquiry was called that day was to decide whether the Town Commissioners or the Board of Guardians were to be the governing body in the promotion of the scheme. Mr. Richard O'Driscoll, engineer to the scheme for the Board of Guardians, gave evidence as to the manner in which it was proposed to light the town. The stream from which they proposed to derive the motive power had a horse power of 17½ on an average. The stream varied very little, though it was occasionally flooded in winter. The average fall in the level would be 3ft. or 4ft. at the very outside. The inspector, quoting from an estimate made by Mr. Harris, of Bray, said he noticed the amount estimated for cost was £825. The inspector visited the stream after the enquiry, and pointed out that considerable expenditure would be necessary in the making of embankments, and expressed an opinion that a cheaper scheme of public lighting than that now proposed could be adopted with advantage to all parties.

Manchester.—In moving the adoption of a resolution approving the committee's recommendation, referred to in our last issue, Mr. Alderman Higginbottom said the money was required for the electricity purposes in the city, Moss Side, Levenshulme, and Withington, under orders which had been sanctioned by Parliament. In Manchester it was needed to provide (1) six new feeders to supply the old network—these would be necessary to convey the current f om the new generators to the distributing mains; (2) distributing mains in Chester-road and City-road—these mains it had already been determined by the committee to lay forthwith. In addition to these, it would be desirable to connect up with Moss Side along Denmark-road and Moss-lane, and also along Preston-street. Borrowing powers would also be required for the erection of cable stores and a testing-room on the land at the Polygon, and for purchasing sites for transformer sub-stations in various parts of the city. The high-pressure feeders would be necessary for supplying some of these sub-stations, and also the sub-stations in Moss Side and Levenshulme. Provision was also made for carrying out the street-lighting which it had been decided to provide for the winter. There had likewise been included a sum for new services and meters in the city area. In regard to Moss Side, the money was required for the distributing mains in the compulsory streets and for the high-pressure mains. At Levenshulme the money was required for a site for a transformer sub-station, for distributing mains in the compulsory streets, and for high-pressure feeders. At Withington the money was required for sites for transformer sub-stations, for distributing mains in the compulsory streets, and for high-pressure feeders. The following is a summary of the estimated cost: Manchester, £73 300; Moss Side, £15,600; Levenshulme, £8,970; Withington, £48,920—total, £146 790. This would leave a sum of £3,210 for sundries and contingencies.

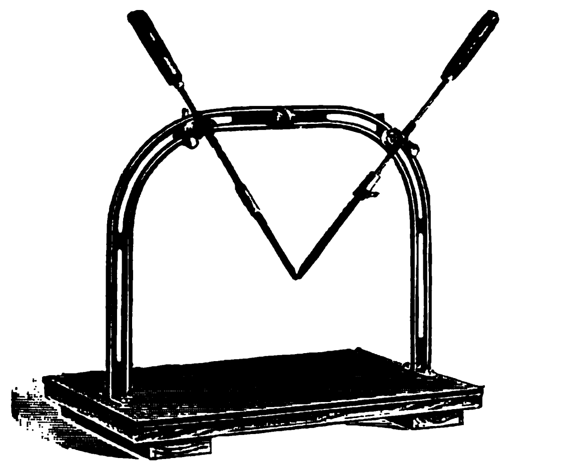
Bangor.—At the last meeting of the City Council, the sub-committee's report recommending the erection of electric lighting works, at a cost not to exceed £10,000, capable of supplying High-street and Garth-road, the mains to be of sufficient size to supply Upper Bangor also when required, was adopted. The Chairman said it was necessary that they should provide in some way a guarantee bond. It was obvious that, in the present state of the finances of the town generally, it would scarcely be right to call upon the ratepayers to bear the burden should there be anything like a loss upon the electric light installation. They were reluctant to dispose of their provisional order to any company or outside authority, and therefore a number of influential ratepayers had signed a bond guaranteeing to be responsible, in the event of there being any deficiency, for about £500 annually for five years, according to the amount standing opposite the names of each signatory. The bond had been drawn out by an eminent counsel. The bond already covered a sum of £515, and it was hoped that would be still further increased. It had a double value, inasmuch as it guaranteed against a possible deficit, and at the same time all the signatories to the document would be customers for the electric light. In conclusion, he said that the extreme cost of the electric scheme now suggested would be £10,000, while it would cost about £3,000 more to extend the mains to Upper Bangor. He thought it was time this controversy over the lighting question should end, but at the same time the opposition to the electric lighting scheme had done good, inasmuch as they had now been able to lay before the Council a much better thought-out scheme relative to the gasworks and the electric light. It was also resolved to apply to the Local Government Board for powers to borrow £10,000 for electric lighting purposes, and that Mr. Medhurst, the electrical engineer engaged by the Council, should prepare the necessary electric lighting plans for the Local Government Board.

Barking.—A Local Government Board enquiry has been held by Mr. W. O. E Meade-King into an application made by the Urban District Council for a loan of £15,000 for purposes of electric lighting. Mr. Barclay Dennis, barrister, appeared for the District Council; Mr. D. M. Watson for the Beckton Gaslight and Coke Company; and Mr. A. J. Ram for the Barking Gas Company and a body of ratepayers. Mr. Dennis stated that the present application was for the first instalment of electric lighting. The Gaslight and Coke Company was one of the largest ratepayers in the town, and although the Barking Gas Company and their predecessors had been there since 1839, and obtained their Act of Parliament in 1867, yet the District Council had never been able [c]ome to terms with them for lighting the town. For years it [be]en lit with oil, and oil alone. The price of gas in Barking Barking offered some exceptional advantages for the ion of electric light. At the present moment they had application for lights to houses and manufactories amounting to 2,087 8-c.p. lamps, and, in addition to that, they estimated that those buildings and the other property belonging to the District Council would require another 300 8-c.p. lamps. The calculations of Mr. Hawtayne were based upon the Council being in a position to get 3,000 8-c.p. lamps for private and public lighting. There could be no doubt that another 500 would be taken up immediately. The effect of the electric lighting scheme already had been to bring down the price of gas from 4s. 6d. to 4s., and if Barking got no more from it he thought the action of the Council would be more than justified. The cost of oil per lamp per annum was £3. 0s. 1d.; gas, £4 per lamp, which was based on the gas company's offer of £4. 2s.; and the estimated cost of electricity was £2. 13s. 10d. It was calculated that the £15,000 when expended would put up buildings and machinery to provide 160,000 Board of Trade units. Mr. Hawtayne, engineer, explained the system which he had advised the Council to adopt, and said he had provided sufficient plant and mains to light all the district now lit with oil. The site at the back of the office was large enough to accommodate five or six times the amount of machinery, etc., that was contemplated. The site was about the best that could be obtained in Barking. The tender received for the generating plant was £2,250; storage plant, £600; switchboard, etc., £478; overhead crane, £70; mains, £4,449; adaptation to existing lamps, £560; arc lamps, £299; building and shaft, £2,666. There would be other matters to be included in the loan—viz., the cost of the provisional order, the engineer's expenses, etc. There was a sum of £828 to provide for the extension of mains outside the compulsory area. The amount of the accepted tenders was £11,472, and there was £3,528 put down for additional expenses, thus making a total of £15,000. He estimated the working expenses at 2¼d. per unit. This was an outside estimate. The gross revenue would be £2,600, and after paying the working expenses and allowing for renewals, and the repayment of capital and interest, there would be a profit of £309 available for the reduction of rates; that was assuming that in addition to the public lamps they would supply private consumers with an equivalent of 3,000 8-c.p. lights. Mr. Hawtayne said that by the low-tension system, which he proposed to adopt, it was possible to shut up the works for 16 hours each day, whereas if the high-tension system was adopted they would have to be kept open during the whole 24 hours. Mr. E. H. Lister (clerk to Council) stated that the first objection to the scheme came from the Beckton Gaslight and Coke Company, who were ratepayers to the extent of £52,000. A petition was also signed by Messrs. Barnett, H. Berry, Garland, and King, as well as the Barking Gas Company, who were rated at £308. They had made many attempts to get the Barking Gas Company to supply gas at a reasonable price. They had also tried to purchase the works, but the company refused to sell. They asked the Beckton Gaslight and Coke Company to receive a deputation on the question of lighting the town, but they refused to do so. Since the provisional order had been obtained, the Barking Gas Company had reduced the price of gas from 4s. 6d. to 4s. This took effect on April 1, but previously the company gave a largediscount, and now the price was net. Mr. Ram made an offer on behalf of the Barking Gas Company for a supply, either with incandescent mantles or with the ordinary burners, as the Council might desire, at £2. 15s. for each lamp per annum. The enquiry, which lasted nearly six hours, was adjourned at 5.30.

Hackney.—At a general meeting of the Vestry on April 27 a memorial was received from a number of ratepayers on the subject of the rates and electric lighting order of Hackney, in which they desire to call attention to new and heavy proposals for expenses which have been the subject of discussion "with closed doors" during several weeks past. While admitting that circumstances do arise which renders such a course advisable for a short period, they wish to point out that a continuance in such a course is objectionable, and trust it will be discontinued. Nearly six years ago an electric lighting order was obtained for 42 years, and it is now necessary that it should be dealt with in order that it may not lapse. The short point is whether the Vestry are to add to the present indebtedness a large sum, perhaps a quarter of a million sterling, on a speculation in electric lighting, or whether they sell the concession to experts who would contract to give some £5,000 or £6,000 per annum in reduction of the rates, without the parish incurring new debts or liabilities, and with the proviso for purchase back, as a going concern, in 12 years, combined with a guarantee of a low rate of charge for private lighting and power purposes, with public lighting at a less charge than in St. Pancras and Islington. The desirability was pointed out of concluding the best arrangements possible with traders rather than embarking upon a speculation in electric lighting, the expense of which must be very large, and in the most favourable event a heavy burden upon the ratepayers, especially for the next few years. There was also a deputation from a meeting of the ratepayers of the parish of Hackney held at the new town hall on Monday, April 18, presenting the following resolution: "That a deputation consisting of 30 ratepayers wait upon the Hackney Vestry for the purpose of conveying to them the terms of the following resolution—viz., that this meeting is of opinion that it would be detrimental to the best interests of the ratepayers of the parish of Hackney to part with the electric lighting order, and therefore earnestly recommends the Vestry to retain the order in its own hands, and hereby emphatically protests against any attempt to create a monopoly." The legal difficulties with Mr. Medhurst do not appear to be settled yet, as we hear of still further correspondence between the Vestry and Mr. Medhurst's

'. It appears that the latter has served the Vestry with a

ric Welding and Brazing.—The investigations and experi- y M Moissan, Prof. Roberts-Austin, and others, as to the ur of metals, alloys, ores, and other materials when sub- to the intense heat of the electric arc, together with the l use of electric furnaces for the reduction of ores—notably aluminium and others of a refractory nature—have resulted lesire of other investigators to enter the same field, and d the subject of some importance in technical education. nt of efficient apparatus at a low cost for the purpose of ent and illustration has hitherto resulted in the operator cturing his own out of material at his command. To e demands for such apparatus the following—originally d some years ago by Mr. W. Clark Fisher for private use— n placed upon the market by R. W. Paul, of Hatton-garden : lesign it was sought to provide an instrument alike suitable ace crucible, open hearth, welding, brazing, hard soldering, : which purpose it was desirable that the carbons should be of universal movement admitting of their being placed at gle in any plane. In order to achieve this, as shown by the tion, the framework supporting the carbon-holders consists



ted arch of metal cast in two halves mounted upon a fire- g and insulating base, and efficiently insulated from each t the top, where they are bolted together. The carbon- have a swivel action fitted with thumbscrews, so that they clamped in any position. The swivel action is attached sulated bolt, which passes through the slots in the frame- d allows of adjustment to any height. Each carbon-holder n action entirely independent and thoroughly insulated h other and the framework, it is easily seen that they may ged, as in the illustration, for crucible, welding, or brazing a suitable angle, or, both placed horizontal or one hori- d the other vertical, etc., for furnace work and to suit ents. The apparatus at present is made in two sizes, one 15 amperes at 50 to 100 volts, the other 60 to 80 amperes 100 volts.

es.—A special meeting of the Electric Lighting Com- f the Corporation was held on the 22nd inst. for the of receiving a report from the sub-committee as to the ken with respect to lighting the borough by electricity, with respect to an offer made by the British Electric Company, which is going to work the tramway system icity, for lighting the town. The offer of the Electric Company was to pay to the Corporation for the transfer ectric lighting order £1,000, and during each year the has the right to exercise the order 10 per cent. of the eipts, the Corporation to have the option to purchase the ing whenever the company's lease is determined. The nittee informed the company it was unable to entertain s proposed, and asked for a further proposal, whereupon pany asked for a counter-proposal. The sub-committee n recommended the Council to erect their own electrical mbined with a dust destructor, and to offer to supply ways company with electrical energy at 1½d. per unit up 0 units and 1¼d. per unit for any quantity supplied that amount per annum. It also reported that Mr. had consequently been instructed to revise the plans for osed electrical station with a view to tenders being for the works, and the town clerk has been directed to with the application to the Local Government Board to to raise a loan of £60,000 to defray the estimated cost of sed station. The committee further recommended that empowered to conclude provisional agreements for the n of the necessary land for the purposes of the scheme. rs, however, that the Electric Traction Company are not to enter into a contract for the purchase of current. A electric lighting was presented by Mr. Manville, the expert, on the capital expenditure necessary for the f the whole borough. This was : (1) capital expenditure nsion continuous-current system as per report of March £32,470 ; (2) capital cost of arc lighting plant in y area, £1,584 ; (3) cost of low-tension feeders to stricts, £7,227 ; (4) additional cost for dust destructor nt if provided, £11,287 ; (5) cost of site, not ascertained—total, £52,568. At a subsequent meeting of the Council the report was finally adopted.

Sheffield.—Apparently we have not heard the last of the purchase of the electric light undertaking. A public meeting of the owners and ratepayers of the city of Sheffield was held on the 26th inst. "to consider and (if so thought fit) to approve of and consent to the promotion by the Council of the city of Sheffield in the present session of Parliament of a local and personal Bill to confirm an agreement for the purchase of the undertaking of the Sheffield Electric Light and Power Company, Limited, by the Corporation of Sheffield, and to confer borrowing powers and other powers on the Sheffield Corporation." The *Sheffield Daily Telegraph* says the meeting was held under the provisions of what is generally known as "Leeman's Act," which requires the owners and ratepayers to be consulted before a corporation can obtain parliamentary powers involving expenditure out of the public funds. In the present instance there appeared to be general approval among the ratepayers of the intention of the Corporation to purchase the electric light undertaking. No special effort was made to get a large attendance, and as a result the ordinary ratepayer did not attend. Several members of the Council were present, and also two or three dozen gentlemen interested in the progress of the city. But advantage was taken of the occasion to bring together some 50 or 60 ratepayers styling themselves "electric light contractors," including, of course, many wage-earners, with the view of putting pressure on the Corporation to discontinue the business of general electrical fitters and wirers. These gentlemen consider their interests will be adversely affected if there is Corporation competition, and they hoped by a snatch vote to gain their ends. They succeeded in out-voting the representatives of the city, and involving the authorities in a poll, which it is estimated will cost £1,000—a sheer waste of money. The Lord Mayor, who presided, said the meeting was called to give ratepayers an opportunity of expressing their opinion upon the Bill of the Corporation for the purpose of confirming an agreement with the electric light company for the purchase of that company's undertaking. He moved : "That the owners and ratepayers within the city of Sheffield approve of and consent to the promotion by the Council of the city of Sheffield in the present session of Parliament of a local and personal Bill to confirm an agreement for the purchase of the undertaking of the Sheffield Electric Light and Power Company, Limited, by the Corporation of Sheffield, and to confer borrowing powers and other powers on the said Corporation." After a lengthy discussion, the Lord Mayor put the resolution, which was moderately supported. When the contrary was put many hands were held up, and his Lordship declared the resolution not carried. The result was received with loud cheers by the electrical contractors and their party. The Lord Mayor did not announce the figures of the voting, but the majority was slight, not more than five or six. About 50 hands went up against the resolution. Mr. H. W. Chambers at once rose and demanded a poll. Mr. Furness seconded the demand. The Lord Mayor announced the arrangements for the poll, which will be taken by means of voting papers issued to ratepayers and owners or proxies. The papers will be delivered on Wednesday, May 18, collected on Monday, May 23, counted at the town hall on May 24, and the result announced on May 25 at noon. Sir Charles Skelton said he was told the poll would cost about £1,000. He wanted to know from the gentlemen below if they were prepared to waste that £1,000. The Lord Mayor then declared the business of the meeting at an end, and left the chair.

PROVISIONAL PATENTS, 1898.

APRIL 18.

8988. Improvements in electrodes for accumulators. Charles Alker and Paul Mennessier, 4, South-street, Finsbury, London.

9002. Improvements in or connected with apparatus for the manufacture of potassium chlorate or sodium chlorate by electrolysis. John Brock and the United Alkali Company, Limited, 47, Lincoln's-inn-fields, London.

APRIL 19.

9047. Hanger for trolley wires of electric railways. William Andrew McCallum, 111, Hatton-garden, London. (Complete specification.)

9070. Improvements in contact shoes for electric railways. William Milton Brown, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

9071. Improvements in and relating to telegraph and like cables. Joseph Arthur Lovel Dearlove, 323, High Holborn, London.

9077. Improvements in enclosed arc lamps. George Thomas-Davies, 40, Chancery-lane, London.

9091. An improved connector for electric wires and cables. Thomas Edward Taylor, jun., and Jesse Collings, 53, Chancery-lane, London.

APRIL 20.

9105. Improvements in apparatus to be used in connection with the electro-deposition of metals. Fred Greenfield, 24, Temple-row, Birmingham.

9122. Improvements in and connected with line selectors for telephones. Hermann Oppenheimer, 55, Redcross-street, Barbican, London.

9154. **Improvements in electric lamps.** T. Sidney Hill and Peto and Radford, Limited, 65, Chancery-lane, London. (Complete specification.)

9178. **Improvements in electromotors.** James Thomas Robson, Charles Henry Marsden, and Henry William Headland, 77, Chancery-lane, London.

April 21.

9197. **Improvements in and relating to telegraphic transmitting apparatus.** Frederick George Creed, 96, Buchanan-street, Glasgow.

9218. **Improvements in secondary batteries.** George Edward Barker Pritchetts, Theodore William Pritchetts, and Archibald Gilbey Gold, 31, Soho-square, London.

9237. **Improvements in holders for high-tension incandescent electric lamps.** George Edward Heyl-Dia, 37, Chancery-lane, London.

April 22.

9292. **Improvements in electrical igniters to be used with gas or oil engines or for similar purposes.** William Baines, jun., 151, Strand, London.

9299. **Improvements in or relating to overhead trolley wires for electric traction, overhead electric cables, or other wires.** Robert Hacking, 111, Hatton-garden, London.

9317. **Improvements in electric igniting devices for cycle lamps.** Georg Moritz Bauer and Ferdinand Krieger, 45 Southampton-buildings, Chancery-lane, London.

9330. **Improvements in controllers for electric motors.** Reginald Belfield, 322, High Holborn, London. (The Westinghouse Electric and Manufacturing Company, United States.)

9339. **Improvements in electrical switching apparatus.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

9340. **Improvements in electric safety fuses or cut-outs.** Verity's, Limited, and Louis John Steele, Plume Works, Aston, Warwickshire.

April 23.

9380. **Improvements in and relating to alarm clocks and electrical alarms.** Harry Garvin Campbell, 41, Reform-street, Dundee.

9394. **A process for electric heating and furnace for realising same.** Albert Roufaut, 8, Rue des Princes, Brussels.

9419. **Improvements in the manufacture of sound-recording materials for graphophones.** George William Johnson, 47, Lincoln's-inn-fields, London. (The American Graphophone Company, United States.) (Complete specification.)

9425. **Improvements in or relating to electrical cut-outs.** John William Manley, 18, Hertford-street, Coventry.

9436. **Improved means for electrically heating second-class electric conductors serving as incandescence bodies for imparting to them the requisite conducting power.** Max Deri, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1897.

2378. **Primary batteries.** Rowbotham.

8048. **Method of regulating the pressure of electric circuits connected with primary or secondary batteries and apparatus therefor.** Heath and Field.

8663. **Dynamo-electric machines or electric motors.** Holmes. (Johnson and Lundell.)

9008. **Dynamo-electric machines.** Fynn.

9564. **Apparatus for raising and lowering arc lamps.** Davy and Thomas-Davies.

10062. **Electric bells and the like.** Dixon.

10822. **Apparatus for the electro-deposition of metals.** Evans and Smith.

11320. **Electric fuse-heads for blasting and for other purposes.** Pettinger.

11701. **Construction of dynamo-electric machinery.** Soames.

11717. **Devices for enabling railway travellers to apply the brakes by electrical means.** Preston and Gill.

12128. **Apparatus for working railway points and signals by electric power.** Webb and Thompson.

13564. **Electric motors and dynamo-electric machines.** Brown.

13617. **Electric arc lamps.** Brockie.

19229. **Electric railways on the sectional conductor system.** Walkins and Dickinson.

21976. **Appliances used in connection with the electro-deposition of metals.** Greenfield.

1898.

729. **Electrically-operated machine or tool for cutting fabrics, paper, and the like.** Gardner and Smith.

1697. **Apparatus for the electrolytic treatment of bleaching liquids.** Haas.

2618. **Supports chiefly designed for electric incandescent lamps.** Weldon.

3998. **Electric ignition devices for internal-combustion engines.** Boult. (The Société Nouvelle des Etablissement Decouville Ainé.)

4999. **Electric railways on a road contact system.** Brown.

TRAFFIC RECEIPTS.

Liverpool Overhead Railway.—The traffic receipts for the week ended April 24 were £1,452, as compared with £1,770 in same week of 1897, being a decrease of £318.

Birmingham Tramways.—The traffic receipts for the week ending April 23 were £3,606. 12s. 0d., as compared with £4,092. 9s. 7d. for same week in 1897, being a decrease of £485. 17s. 7d.

Dover Tramways.—The traffic receipts for the week ending April 23 were £125. 18s. 0d. The total receipts for the year 1898 are £1,821. 2s. 2d. The mileage open at present is 3 miles.

Bristol Tramways.—The traffic returns for the week ending April 15 were £3,273. 4s. 4d., compared with £2,219. 7s. 2d. for same period of last year, being an increase of £1,053. 16s. 9d.

South Staffordshire Tramways.—The traffic returns for the week ending April 22 were £566. 2s. 7d., as compared with £928. 8s. 10d. in same week of 1897. The aggregate receipts for the year are £9,504. 6s. 10d., as against £9,575. 15s. 6d. in the same period of the previous year.

City and South London Railway.—The returns for the week ended April 24 were £998, compared with £928 for same week of 1897, being an increase of £70. The total receipts for the half-year amount to £17,769, compared with £17,612 for the same period last year, being an increase of £157.

Dublin S.D. Tramways.—The traffic receipts for the week ending April 22 were £576. 13s. 0d., as compared with £883. 0s. 7d. in the corresponding week in the previous year, being a decrease of £306. 7s. 7d. The number of passengers carried was 92,160 in 1898 and 117,731 in 1897. The aggregate returns up to date are £6,892. 1s. 5d., as compared with £7,117. 5s. 3d. last year, being a decrease of £225. 3s. 10d. The mileage open is the same as last year—viz., 8 miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	[illegible]
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	[illegible]
—— 6 p.c. Cm. Pf., 30,001-40,000 (iss at £2. 10s. pm., all pd.)	4	[illegible]
Brush Company, Ordinary	2	[illegible]
—— Non. Cum., 6 per cent. Pref.	2	[illegible]
—— 4½ per cent. Debenture Stock	100	[illegible]
—— 4½ per cent. 2nd Debenture Stock	100	[illegible]
Callender's Cable Company, Debentures	100	[illegible]
—— Ordinary	5	[illegible]
Central London Railway, Ordinary	10	[illegible]
——	6	[illegible]
—— Pref. Half-Shares	1	[illegible]
—— " "	5	[illegible]
Charing Cross and Strand	5	[illegible]
—— 4½ per cent. Cum. Pref.	5	[illegible]
Chelsea Electricity Company	5	[illegible]
—— 4½ per cent. Debentures	100	[illegible]
City of London, Ordinary	10	[illegible]
—— Prov. Cert. 90,001-100,000	5	[illegible]
—— 6 per cent. Cumulative Pref.	10	[illegible]
—— 5 per cent. Debenture Stock	100	[illegible]
City and South London Railway, Consolidated Ordinary	100	[illegible]
—— 4 per cent. Debenture Stock	100	[illegible]
—— 5 per cent. Pref. Shares	10	[illegible]
—— " " " '96	10	[illegible]
County of London and Brush Provincial Co., Ordinary	10	[illegible]
—— " " "	4	[illegible]
—— 6 per cent. Cum. Pref.	10	[illegible]
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	[illegible]
—— 5 per cent. Debentures	—	[illegible]
Crystal Palace District, Ordinary 5 per cent. Stock	100	[illegible]
—— Preference 5 per cent. Stock	100	[illegible]
Edison and Swan United Ordinary	3	[illegible]
—— 5 per cent. Debentures	5	[illegible]
—— 4 per cent. Deb. Stock, Red.	100	[illegible]
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	3	[illegible]
Electric Construction, Limited	2	[illegible]
—— 7 per cent. Cumulative Pref.	2	[illegible]
—— 4 per cent. Perp. 1st Mort. Deb.	100	[illegible]
Elmore's Copper Depositing	1	[illegible]
Elmore's Wire Company	2	[illegible]
W. T. Henley's Telegraph Works, Ordinary	10	[illegible]
—— 7 per cent. Preference	10	[illegible]
—— 4½ per cent. Debentures	100	[illegible]
House-to-House Company, Ordinary	5	[illegible]
—— 7 per cent. Preference	5	[illegible]
India Rubber and Gutta Percha Works	10	[illegible]
—— 4½ per cent. Debentures	100	[illegible]
Kensington and Knightsbridge Ordinary	5	[illegible]
—— 6 per cent. Pref.	5	[illegible]
London Electric Supply, Ordinary	5	[illegible]
Metropolitan Electric Supply, Limited, Ordinary	10	[illegible]
—— 4½ per cent. First Mortgage Debenture stock	100	[illegible]
National Telephone, Ordinary	5	[illegible]
—— 6 per cent. Cum. First Pref.	10	[illegible]
—— 6 per cent. Cum. Second Pref.	10	[illegible]
—— 5 per cent. Non. Cum. Third Pref.	5	[illegible]
—— 3½ per cent. Deb. Stock, Red.	100	[illegible]
Notting Hill Company	10	[illegible]
Oriental, Limited, £1 shares	1	[illegible]
—— £5 Shares	5	[illegible]
—— £4½ shares	4	[illegible]
Oriental Telephone and Electric Company	7	[illegible]
Royal Electrical Company of Montreal	—	[illegible]
—— 4½ per cent. First Shares Mortgage Debentures	100	[illegible]
South London Electric Supply, Ordinary	5	[illegible]
St. James's and Pall Mall, Limited, Ordinary	5	[illegible]
—— 7 per cent. Pref.	5	[illegible]
—— 4 per cent. Deb. Stock, Red.	100	[illegible]
Telegraph Construction and Maintenance	12	[illegible]
—— 5 per cent. Bonds	100	[illegible]
Waterloo and City Railway, Ordinary	100	[illegible]
Westminster Electric Supply, Ordinary	5	[illegible]
Yorkshire House-to-House	5	[illegible]

be numbered, and the carriages will be in the charge of experienced motormen. A dinner will be held at the Adelphi Hotel on the evening of Thursday, May 26, 1898. It is expected that the Right Hon. the Earl of Derby, K.G., will preside. All persons attending the trials must wear the official rosettes to secure admission to the depôt. We understand that there is one electric car entered, and wish it every success.

Tests of Electric Traction Plant.—The *Electrical World* gives details of some tests of the power plant of the Brockton Street Railway Company made by Messrs. Stone and Webster, Boston, Mass., the consulting engineers in charge of the construction of the plant. The new equipment described consists of three vertical boilers, with a total capacity of about 600 h.p., one Allis-Corliss horizontal cross compound 750-h.p. engine coupled to one General Electric 10-pole generator of 500 kw. capacity. Tests of the complete plant showed an equivalent evaporation of water from and at 212deg. F. per pound of combustible of 11·36lb. The ratio of the electrical output of the generator to the indicated horse-power of the engine was 88·6 per cent. A steam consumption was found of 15·3lb. per indicated horse-power hour (full load, 112lb. steam pressure and condensing), and coal per kilowatt-hour output 2·4lb. The engine speed varied between 108 revolutions at full load and 112 revolutions at no load. The rise in temperature under full-load eight-hour run was for the armature and commutator 34·7deg. C., and for the main bearings 17·7deg. C.

The Effect of the War.—The *Street Railway Review* circularises the various street railway managers as to what effect they expect the present war to have on their undertaking. The replies are varied, and we quote the following examples. Thus one man writes: "We have your esteemed enquiry, and must admit our inability to reply very intelligently. We do not consider war a very healthful thing at any time, and it is very deplorable that such difficulties cannot be amicably and honourably settled in this enlightened age so near the close of the nineteenth century. Locally we do not feel that war with Spain or with any other country would materially affect our street railway interests, only so much as its affects business generally." Again, here is one from a manager who says in his case war already exists: "The Lord only knows what the effects of war would be on street railway interests. Whatever I might say would be only a guess, and I should dislike to find myself on the wrong side. I leave to-day for ——, where there is a war in the legislative halls on our interests which we know would be fatal to us. We feel that we are too far inland to be hurt directly by a foreign war. It is the home wars that affect us."

Editorial Flittings.—It is in the spring that removals into larger houses usually are arranged. We note that our contemporary, the *Electrical World* of New York, has determined to avoid the spring cleaning of the old offices by moving into the new 12-storey Franklin Building, just erected on the site where a quarter of a century ago the paper occupied its first office. This is 9, Murray-street, next door to the present quarters and 150ft. west of Broadway. The additional space in the new offices permits of a private "spare room" being fitted up for the accommodation of out-of-town visitors. Subscribers, advertisers, representatives of business houses, and members of the electrical fraternity in general, whenever they are coming to New York, are cordially invited by the editor to have their letters addressed care of the *Electrical World*, and to make their headquarters at its office. In the room set apart for their use they can read their letters and dictate replies to the stenographer—of course, free of charge. Anything else the paper can d[…] assist them in the way of information or suggestions [...] will only have to let it know. A good house-warm[…] is evidently wanted, and our contemporary has our [...] wishes for its success in its new offices.

Competitive Telephone Exchanges.—The g[…] demand in England for municipal telephone exchanges [...] perhaps induce the Government to grant licenses, [...] personally we doubt it. At any rate, the corpora[…] must remember that the exchanges, if started, mus[…] better and have more subscribers than those they com[…] with. Otherwise we shall see notices issued like [...] following: "We find it impossible to continue in busi[…] and hereby give notice that from and after this date [...] telephone exchange will be closed. We have tried har[…] give satisfaction and merit the support of the commu[…] but find it impracticable to operate two exchanges in [...] same town, as it creates confusion and increases the exp[…] to the merchants and business people without any ad[…] tages. It is now apparent that telephoning has grow[…] be an interstate business, and a local exchange wit[…] such a system cannot serve the public purposes." Th[…] culled from the columns of *Electrical Engineering*, an Ame[…] contemporary, at one time a staunch supporter of [...] independent telephone companies, and it applies [...] mutual benefit telephone company established in Murf[…] borough. So in England, unless municipal exchanges [...] get interurban connections, they cannot successfully com[…] with the National Company.

Royal Institution.—The annual meeting of [...] members of the Royal Institution of Great Britain [...] held on Monday last, the 2nd inst., Sir James Crich[…] Browne, M.D., F.R.S., treasurer and vice-president, [...] siding. The annual report of the Committee of Vis[…] for the year 1897, testifying to the continued prosp[…] and efficient management of the institution, was read [...] adopted. The following gentlemen were unanimo[…] elected as officers for the ensuing year: president—[…] Duke of Northumberland, K.G.; treasurer—Sir Ja[…] Crichton-Browne; secretary, Sir Frederick Bram[…] Bart.; managers—Sir William Crookes, Sir Edward Fr[…] land, the Right Hon. George Joachim Goschen, Do[…] William Charles Hood, Esq., David Edward Hughes, [...] Alfred B. Kemp, Esq., Hugh Leonard, Esq., Sir Wil[…] Huggins, Thomas John Maclagan, Esq., Ludwig M[…] Esq., Alexander Siemens, Esq., the Hon. Sir Ja[…] Stirling, Sir Henry Thompson, Sir Richard Eve[…] Webster, Sir William Henry White; visitors—Sir A[…] ander Richardson Binnie, Sir James Blyth, Bart., Ch[…] Vernon Boys, Esq., Edward Dent, Esq., James Edm[…] Esq., Maures Horner, Esq., Edward Kraftmeier, Esq., [...] Francis Laking, T. Lambert Mears, Esq., Lachlan Macki[…] Rate, Esq, John Callander Ross, Esq., William J[…] Russell, Esq., Sir James Vaughan, James Wimshurst, [...] Alfred Fernandez Yarrow, Esq.

Crowded Tramcars.—By the English laws a tra[…] is licensed for a definite number of passengers, and to [...] more renders all concerned liable to a heavy fine. [...] America the cars take all that can stand in or han[…] The *Street Railway Review* says that a Maryland reform[…] making the attempt to do away with crowded car[…] fixing the rate at 1½d. for standing room. Wh[…] the Bill now pending in the Legislature will finally [...] and the experiment made cannot now be stated, b[…] might not be such a bad thing to make a trial on [...] road. And if the trial is to be one worthy of the nam[…] should be undertaken on the plan of a Western man [...] who, when he was confronted with the same problem [...] years ago, announced his approval and determinatio[…]

'e the seats from most of his cars, and hang out the " Standing room only." It really would be amusing e how many people of the class who at stated als introduce such impracticable measures would avail elves of the 1½d. standing ride. The editor of our con-rary states that every company should spare no effort ply seats for as many of its patrons as possible, but lers that under the existing conditions in American it is a physical impossibility to take care of the during certain rush hours with a seat for every iger. To have two classes of fares, however, in the car, is something the public does not want and anies could not carry out.

tional Photographic and Allied Trades' bition.—A very successful little exhibition was held g last week at the Portman Rooms. The exhibits leading English firms in photographic apparatus and ories proved an attraction to their country customers ally. During the afternoons and evenings hourly nstrations of X-rays, animated photographs, and dissolv-ews took place, and Mr. T. C. Hedworth delivered short es on "The Wedding of the Microscope with the ra," "X-Rays," etc. Amongst the electrical exhibits ted especially Adamson's patent incandescent system adios, which worked beautifully, and of which more other column. F. J. Borland, Leeds, exhibited the t Scissors arc lamp for projections, photographic ng, etc. This lamp is also used for stage purposes r lantern exhibitions. It is claimed that it fits the ry limelight tray without any alterations being ary, and that the upper carbon can be set at any during working, which ensures the maximum amount it being thrown through the condenser. The coils orking parts being outside the lantern, they are ible to damage by the heat. A self-striking hand-amp and an arc light arrangement in a box giving c.p., which will turn out a ferroprussiate print three minutes, an arc lamp for portraiture, and a ½-h.p. dynamo completed this exhibit. H. W. Cox d induction coils and apparatus for X-rays and wireless aphy.

hting and Power Stations Combined.—We in the *Electrical World* a description of the new ic lighting and power station erected at Toledo, in This station is only recently finished, and we are ore surprised to see the type of machinery used. In he station represents the missing link in the evolution erican notions on direct coupling. Thus Wheelock es are used, and are each direct coupled to a w. General Electric dynamo. In spite of this, flywheels of the engines are grooved for ropes drive a countershaft under the floor at the further of the engine-room. From this countershaft, which ds the full length of the building, a number of ators, arc lighters, and exciters are driven. From ze of the ropes it looks as though the full power of gine could be utilised through them. The counter-is 198ft. long, and is of hammered iron 6½in. in ter. It is divided into four sections of from 42ft. to in length, which may all be connected by means of n clutches. There is also a friction clutch for each r on the shaft. All the clutches are operated from gine-room floor by the hand-wheels. The following s systems are used to deliver electric energy from e station: the three-wire Edison continuous-current n; the 500-volt continuous-current for power; the railway circuits, both feeders and trolley wire; the ating incandescent system; and, lastly, the constant-t arc system.

Mexican Telegraph Service.—Mr. Donnelly, United States Consul-General at Nuevo Laredo, in a report to his Government on the Mexican telegraph service, says: "An interesting phase of Government ownership of public utilities is being presented in Mexico, where the Government operates a telegraph line of its own in competition with the lines of the several railroads. Advocates of Government ownership would doubtless expect the Government service to be the cheapest and the best. Such, however, is not the case. The railroads give the promptest service and generally at lower rates. The following figures show the Government and railroad telegraph rates on 10 words from Nuevo Lareda to the cities named: Monterey, Government rate, 0·40dol., railroad rate, 0·26dol.; Saltillo, ·60, ·51; San Luis Potosi, 1·20, 1·16; and Mexico City, 1·60, 1·61. As a natural consequence, the railroads have done the great bulk of telegraph business, both foreign and domestic. Consul-General Donnelly, however, states that by a recent arrangement entered into by the Government with the Western Union Telegraph Company, of the United States, the latter company cedes to the Government the sole right of the company's Mexican business, and the Western Union, in return, obtains the business of the federal telegraph line. The Government has also issued an order prohibiting the railroads from handling any international messages. The effect of this will probably be to deprive the railroads of considerable business, and to give the Western Union Company control of the international telegraph service.

Niagara Power in Buffalo.—The following scale of charges has just been adopted for power transmitted from Niagara and delivered in Buffalo on the three-phase system with 2,200 volts between adjacent wires. The monthly charge for power will depend upon the actual amount used, as determined by standard meters installed by the conduit company upon the premises of the consumer. The charge for power will be determined by the record of the meter and by calculation from the following schedule: Not exceeding 1,000 units, 1d. per unit. If the consumption exceeds 1,000 units, but does not exceed 2,000 units, the rate will be: for 1,000 units, 1d. per unit, and for the excess ·75d. per unit. If the quantity exceeds 2,000 units, but not exceeding 3,000 units, the rate will be: for 2,000 units, ·75d. per unit, and for the excess ·6d. per unit. For a quantity exceeding 5,000 units, but not exceeding 10,000 units, the rate will be: for 5,000 units, ·5d., and for the excess ·4d. per unit. For a quantity exceeding 20,000 units, but not exceeding 40,000 units, the rate will be: for 20,000 units, ·375d. per unit, and for the excess ·35d. per unit. Finally, for a quantity exceeding 80,000 units the rate will be: for 80,000 units, ·33d. per unit, and for the excess ·32d. per unit. In addition to these charges for power there will be a charge for "service" of about 3s. 6½d. per horse-power per month. We have purposely omitted some slips in the scale. From it we see that if a load factor of 80 per cent. is guaranteed, a factory requiring about 180 h.p. as a maximum gets its power for about £9. 7s. 6d. per horse-power per annum.

Statistics on English Electric Light Plant.—Mr. Claude P. D'Oyly continues his series of articles on the above subject in our New York namesake. We referred to this series last week, but cannot refrain from giving the following fresh extracts: "The Board of Trade requires a special analytical report of all electric lighting companies, and this requires constant book-keeping and analytical work; and as this is in the nature of a public document, all electric light plant managers and engineers were willing to show this report as far as it had been brought up to date, and would take much trouble to make things perfectly

clear. This report requires that every detail shall be separately worked out by itself, showing every expenditure and what proportion it is to the gross expenditure, and how much it amounts to per kilowatt-hour." We cannot make sense of the above conglomeration of tenses, but certainly the Board of Trade does not require every item worked out per kilowatt-hour, or to show its proportion of the gross expenditure. Someone must have been pulling Mr. D'Oyly's leg when he was over here. We are also told: "The increase of business in some cases being 50 per cent. per annum for three years in succession is a very serious matter for the borough engineer who laid out the plans on a basis of the demand for 20 years, especially as the companies have been financed and the sinking fund has been arranged on that basis. A company which sells—as Birmingham did—in 1895 496,000 kilowatt-hours, in 1896 756,000 kilowatt-hours, and in 1897 1,133,000 kilowatt-hours, is quite puzzling, as besides having to settle with the stockholders, there is the Board of City Councilmen and the Government Board of Trade inspector." There is also the proof reader and the editor—which is still more puzzling.

Conductivity of Glass.—At the Royal Society recently, Prof. Andrew Gray and Prof. J. J. Dobbie contributed a paper on the connection between the electrical properties and the chemical composition of different kinds of glass. Experiments have lately been made with the object of determining the circumstances which affect the conductivity and specific inductive capacity of glass, and as Prof. Gray and Dr. Hopkinson had previously found that potash and soda lime glasses have a higher conductivity than flint glasses, some glasses richer in lead oxide than any formerly available—and in some cases practically free from soda—were made for the purpose of the test. The object in providing such special glasses was to discover whether diminution in the amount of soda and increase of lead oxide would still further diminish the conductivity. The experiments of the authors were of a thoroughly comprehensive character, the measurements made with extreme care, and the specimens of glass tested in every case carefully analysed. The anticipation that conductivity would be decreased by an increase of lead oxide and a diminution of soda in the glass was fully borne out. The specific resistance of the lead potash glass was for one certainly above $18,000 \times 10^{10}$ ohms at 100deg. C., for another above $35,000 \times 10^{10}$ ohms at all temperatures up to 135deg. C. The specific resistance of barium glass was also very high, and, what was remarkable in this glass, there was hardly any trace of dielectric polarisation. It was also found that the almost complete replacement of the potash in a lead glass by soda diminishes the specific resistance. It is intended to pursue the experiments on the electrical and mechanical properties of the barium glass, and glasses of other composition, and for this purpose special glasses of as nearly as possible prescribed compositions are being made.

Institution of Mechanical Engineers.—Mr. S. W. Johnson delivered his presidential address to this institution last week, and consisted of a most valuable dissertation on railway progress. Special reference was made to the Midland Railway, as Mr. Johnson has been intimately connected with that line for the past 25 years. We pass over the most interesting facts and figures given on the progress made in the art of constructing steam locomotives as outside of sphere at present, but in the future electricity will have a fair share at least of the work. To quote the president's own words, "the progress of railway engineering in the past having been so great, our thoughts naturally turn to the future; and, although prophecy is proverbially risky, he could not help thinking t
signs of the times point to electricity as likely to
most important agent in the hands of future
mechanical engineers." As regards electricity in sig
Mr. Johnson recorded his appreciation of the
rendered in the following terms: "So restricte
become the conditions under which it is considere
able to indulge in high speeds, that, wherever th
traffic is heavy, additional lines have had to be lai
so that the express trains and other passenger servi
not be interfered with, and that the absolute block
may be enforced. A runaway train or inattentive
must then pass at least two sets of distant and home
before a collision is possible. The electric telegraph
the important and necessary means of working an
lating the enormous traffic, which is passed with sa
and regularity on our railways at high speeds. W
aid the absolute block system has been made nearly
and renders the running nearly absolutely safe. W
such mechanical and electrical appliances, the presen
could not possibly be worked."

A High-Tension Storage Battery.— A
peculiar storage battery is now in use for su
current for electric lighting purposes in Sonderton,
The battery consists of a number of lead plates lai
each other, with the active material between them
plates are rectangular sheets of lead about $\frac{1}{16}$in
made into the shape of a shallow pan with the edges
over to form a lip all round the pan. In the tray is sprea
layer of red led saturated with sulphuric acid; on this is
a layer of about $\frac{1}{8}$in. of powdered charcoal, also
with sulphuric acid. Above this is put a sheet of a
cloth, on which is placed a layer of litharge to the
of $\frac{1}{8}$in. On this is placed the next plate, and so on t
the pile. When enough plates are put on, the w
squeezed up tightly in a clamping frame, and the
between the projecting lips sealed by means of a
rope dipped in beeswax. The pile is then charge
taking about 10 days, a long charge being necessary t
the litharge to change the spongy lead and the acid
through the asbestos cloth. The battery is then ready
but its behaviour is much better after having been in
some time. The advantages claimed for this cell a
the active material cannot come away from the pla
the action on this material is absolutely uniform at al
of the plates. Terminals are practically done away
it only being necessary to have three, one at each en
and one at the middle. The battery is said to be
odourless, and may be placed anywhere without
ventilation being required and without fear of co
other metal work, but this to us seems very doubtful
life of the cell cannot yet be ascertained with cer
but some of the experimental batteries which have b
use for five years are said to show no change wh
These batteries are especially suitable to portable wo
many are now in use for carriage-lighting purposes.
are 30 ampere-hour eight-volt piles, and there are als
larger 60 ampere-hour 30-volt sets for isolated plant
in cases of 14 plates, which weigh, complete, 180lb.
inventor of this battery is Prof. N. Edgerton.

Automatic Telephones.—We inspected this
the system of automatic telephones being introdu
the Direct Telephonic Exchange Syndicate, Limited.
syndicate has fitted up temporarily some rooms in
chester House with instruments and switchboard a
ments designed on the American new automatic ex
system. The devices used are exceedingly ingenio
the manufacturing details allow of low first cost
obtained. The details of the system are diffic

e in words, and we hope to receive drawings for .tion shortly. The subscriber's instrument is fitted wheel on the front, which wheel is numbered up Opposite each number is a recess for the finger. calling another subscriber, say No. 841, the finger ırted in the 8 and the wheel turned round to ›p and let go. It then transmits a series of eight to the station, and controls the automatic switch- ı far as the hundreds are concerned. The operation ı repeated for the 4 and then for the 1. If the ber is not engaged you can then ring him up, and the operation your own bell rings. Should he be d, the failure of your bell to ring acquaints you of ct. The hanging up of the telephone brings all the ıck to zero. The system requires metallic returns, so that a definite number of movements of the wheel e made. Thus in a small exchange 111 is the lowest e number for a subscriber, then the possible number › to 1,110, as the 10 in the hundreds goes as one of signals, just as 9 would do. As regards the size apparatus, the automatic gear for 150 subscribers can ced on a board 9½ft. long by 6ft. high by 1ft. deep. rstem has been in use in several places in America uccess. The advantages claimed are as follows: The age work is done by the subscriber, who is not dent on the switch-girl; absolute secrecy of con- ion is ensured, and it is impossible for a discon- n to occur except at the option of those talking; ıous service without a night staff at the station. l to these, economy of working is said to be effected, f this figures of large exchanges are not to hand. reliability of the apparatus is, after all, the crucial and the present gear appears to us to be the most al in this respect of any we have yet seen.

namo Details. — Our contemporary *L'Industrie que* has in its recent numbers given full details of the orks of the Compagnie Parisienne de l'Air Comprimé Quai de Jemmapes. We referred to the station recently "Notes" and again in an article on the electric light- Paris. We still think, however, that the following ı of some large direct-current dynamos are worthy of . The machines were made by the Société Alsacienne, lfort, and have the field magnets fixed and placed a revolving armature. The commutator, *per se*, is away with, and the brushes rest on the external :tors. It follows from this that the armatures are ne-wound. The following are the mechanical and cal details: Output, 750 kw.—*i.e.*, 500 volts and amperes at 70 revolutions per minute, or, if desired, amperes at 600 volts. The armature has an internal ter of 11ft. 2½in., and an external diameter of 6in. The circumferential speed is 2,750ft. per s. The length of the armature is 1ft. 7¾in., the ection of the iron core 110 square inches, and the number of armature-turns 2,268. The armature is, er, parallel wound, so that with the 12 poles there ly 125 amperes in each wire. The resistance of the ure at 104deg. F. is ·006 ohm. The losses of in the armature at 500 volts are as follows: was 13·5 kw.; hysteresis, 6·8 kw.; Foucault ts, 1·0 kw., or, in all, 21·5 k.w. At 600 volts the was only 19 kw., as the drop in the copper ras more than the increase in the hysteresis. The ing details apply to the field-magnet system: ı of iron in cores, 325 square inches; in yokes, uare inches; length of core, 17¾in.; area of polar s, 560 square inches; air gap, 1·57in.; exciting t, 25 amperes; resistance of field circuit, 24 ohms; lost in excitation, 1,500. With this loss added to the above, the total losses at 500 volts come out at 22·3 kw., giving an electrical efficiency of 97 per cent., while at 600 volts an electrical efficiency of 97·2 per cent. There are 12 sets of brushes to collect the current. The dynamo is direct coupled to a vertical compound steam-engine, and we notice that a heavy flywheel is coupled to the other end of the crankshaft. This detail we strongly object to, as a short-circuit would put great strains on the various parts of the shaft. The steam test gave a consumption of 17·6lb of water per electrical horse-power hour, or 24lb. per kilowatt-hour.

Accumulator Traction.—We take the following from Mr. Carl Hering's digest of a paper by Hauswald appearing in the *Elektrotechnische Zeitschrift.* This paper, read before the German Electrical Society, consists mainly of a description and a discussion of the Pollak system in use at Frankfort-on-Maine; it includes also some general deductions concerning traction accumulators. In these accumulators the active material is first changed by means of a chemical method into extremely fine porous metallic lead, and after that it is formed; the construction is the same for the positive as for the negative plates; the normal capacity of certain cells may be taken as one kilowatt-hour per 100 kgr. (whether plates or complete batteries is not stated) at a three-hour discharge; the price of 100 kgr. is about £10 to £12. The results of the author's investigations led him to two laws, the first that a given plate will stand higher current strength only when the discharge is a fraction of the normal capacity; also that the higher the efficiency at a given discharge the greater will be the life. The requirements for a traction battery are then enumerated; the weight of an average car alone is six tons, the mean load one ton, and the speed nine miles per hour, with a mean daily run of 78 miles. Tests made with one of the Pollak cars gave 33 watt-hours per ton-kilometre; and the author concludes that for a well-designed system 30 to 40 watt-hours per ton-kilometre may be used as a basis for accumulator traction, or on long, level stretches 20 watt-hours. By using roller bearings a further saving of 10 per cent. of the total energy was obtained. The cost and weight of the battery, as well as other considerations, are against the system of supplying energy for a day's run; but the author favours the system of rapid charging at frequent intervals, thus only partially discharging the accumulators, which is accompanied by a high efficiency. The current from the central station will in that case be small, the life of the batteries great, and there will be considerable reserve energy in the batteries. The results obtained by the use of this system have been very satisfactory. At Frankfort the charging is quite automatic. The length of the line is about one mile. The weight of the car, with batteries, but no passengers, is eight tons; it will carry 42 passengers, and has one 15-h.p. motor. Its speed is nine miles per hour. There are 84 cells in the batteries. The charging is at constant potential, which is so chosen that the batteries can never gas. The current consumption per car kilometre, including the loss in the battery and leads, was 400 watt-hours per car kilometre, the efficiency of the batteries being 85 per cent. Every week the separate cells are tested, and are charged up to 2·5 volts. The charging current may be quite great, and per kilometre run the charging time is 1·5 to 2 minutes. This system of partial charges cannot be used for long stretches, and for this the mixed trolley and accumulator system is considered best, but in this great care must be taken to get the proper relation between the distances run by the accumulators and by the overhead line. The regulation of the charging should be automatic, and great care should be taken that the batteries do not gas.

THE ABERYSTWYTH ELECTRICITY WORKS.

The town of Aberystwyth is pleasantly situated in the centre of Cardigan Bay, and on a fine day the view from the front comprises the whole of the shores of the bay, from Bardsey Isle on the north to Strumble Head on the south. The shore-line in the immediate vicinity is most picturesque, as can be gathered from the photograph below. The hill seen on the opposite side of the bay is called the Constitution Hill, and is laid out as pleasure grounds. The view from it of the Aberystwyth Castle, the University, and the second bay beyond is worth the journey from London to see. In fact, the town authorities have adopted for some years a progressive policy, and have taken every possible advantage of the natural attractions of the place. Thus the front is broad, well paved, and the best lighted proportionate to its size of any sea-front we know of. Of the historical reminiscences of Aberystwyth we will not say much, but must recall the fact that the old castle, now in ruins, has been the seat of many a fierce battle. When the castle was not being besieged it was generally used as a centre of attack on other places, until Cromwell dismantled it in the Civil Wars. The small harbour is used a little for local trading, and more for an anchorage for pleasure yachts frequenting Cardigan Bay. The great industry of the place is the entertainment of the visitors who come annually to this model health resort, and after them the University College, with its 500 students, tends to keep the town busy; in fact, it is not desolate in winter, as so many of our West Coast seaside towns are.

FIG. 1.—View of Aberystwyth from the Cambria Hotel, showing the Arc Lamps on the front.

The history of the electric light undertaking starts with the provisional order obtained by the Corporation in 1892. This, after some debate, was transferred to the Bourne and Grant Electricity Company in 1893, who promptly took steps to put it in force. The Corporation at that date, when electric undertakings had not proved their profit-earning capabilities, were perhaps not unwise to transfer their risks as they did. At any rate, they supported the company by lighting up the front most thoroughly by arc lamps. In fact, they decided to call in professional advice as to how many arcs should be used along the length of the front, and as to the suitability of the lamp-posts and lanterns selected Mr. A. H. Preece reported to them that their proposed arrangements would be most satisfactory. Mr. Grant was the engineer responsible for the design of the works, and he chose the alternate-current system. The character of the town as regards compactness leads us to criticise this decision, and wit[h] doubt a three-wire direct-current system would [have] been much cheaper to maintain. Mr. Grant adopted the Brush system of arc lighting, w[hich] necessitated two distinct sets of machinery in the sta[tion]. This gentleman died some years ago, and the deve[lop]ment has since been in the hands of Mr. G. C. M[...] the managing director of the Bourne and Grant Electri[city] Company, and Mr. E. E. Putland, the engineer-in-cha[rge]. Under this management the undertaking has gone ahea[d by] leaps and bounds, and now has connected more ele[ctric] lamps per head of population than most of the town[s in] England.

The works are situated in Mill-street, on a plot of [free]hold ground which as yet is only half built over. [The] land there falls away rapidly to the river, so that a [...] retaining wall was built on the roadside, and a lean-to [...] used to cover the building, as shown in Fig. 2. F[ig. ...] shows the general plan of the building. The ground [floor] of the station is some 5ft. below the roadway, so th[at a] good drop is provided for taking in coal. A plat[form] supported on pillars runs the full length of the buil[ding], and on this, at the broad end of the site, two small h[ouses]

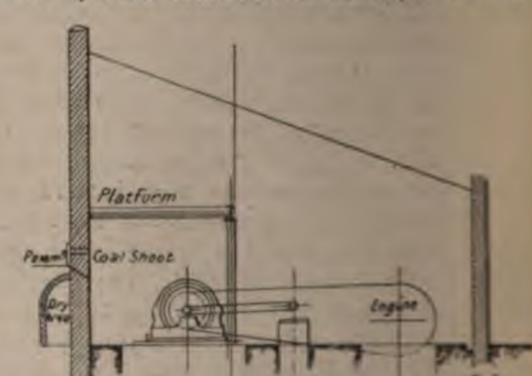


FIG. 2.—Elevation of the Electricity Works.

have been erected for the staff. The wall next to the r[oad]way has no opening in it except at these houses, and [this] wall has been found to act as a good screen for sound[; in] fact, the alternators can hardly be heard from the st[reet]. The extension of the site is at the end of the pre[sent] building, marked "stores," and the width of ground avail[able] continues to increase. On the river side of the buildin[g is] a steam laundry, and beyond that comes the river bed[, so] that it will not be a difficult matter to get water for [con]densing purposes.

GENERATING STATION.

two boilers at present fixed are of theDavey-Paxman nic type, each capable of giving about 80 h.p. at the s. They are 11ft. long and 6ft. 3in. diameter, and t a pressure of 140lb. per square inch. They are fitted leldrum blowers so that they can be forced at times vy load. The chimney used is built up of wrought-ngs of 3ft. 6in. inside diameter, and the total height e chimney is about 60ft. This does not show very h, and the buildings hide the greater portion of it. The rs are fired with a mixture of coke and anthracite, and is found cheaper than using the South Wales steam coal. ngle line of 6in. steam-pipe connects the boilers with the nes. The engines seen in the plan (Fig. 3) and in the general r of the station (Fig. 4) are of Browett-Lindley's make.

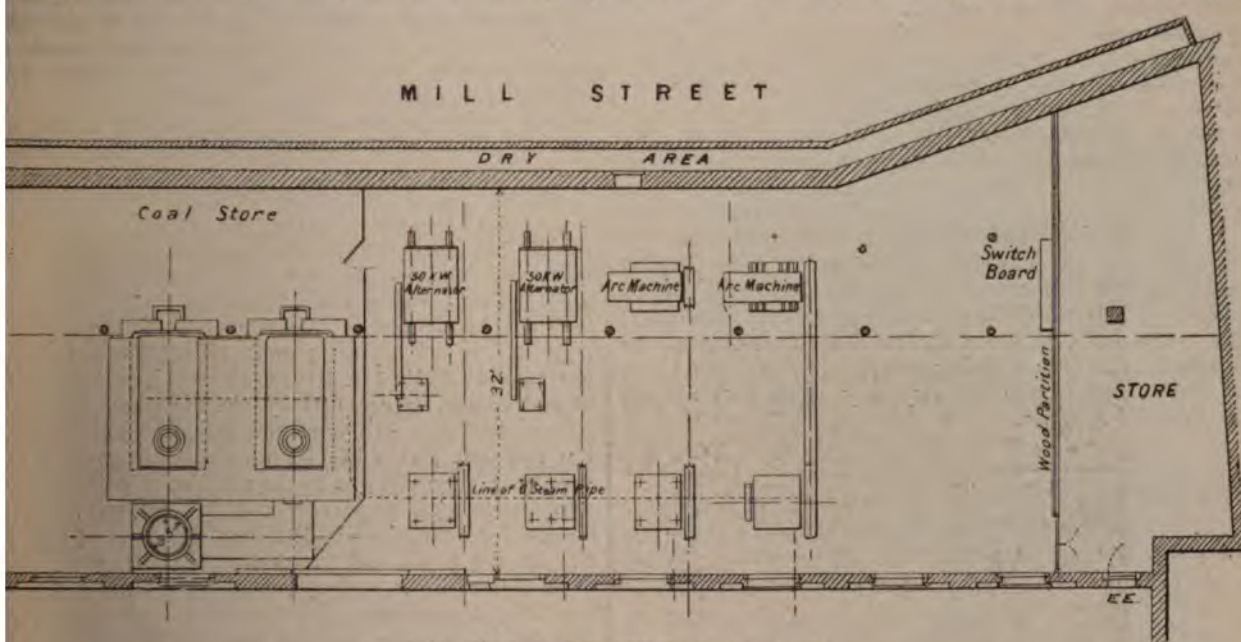


FIG. 3.—Plan of the Electric Light Station, Aberystwyth.

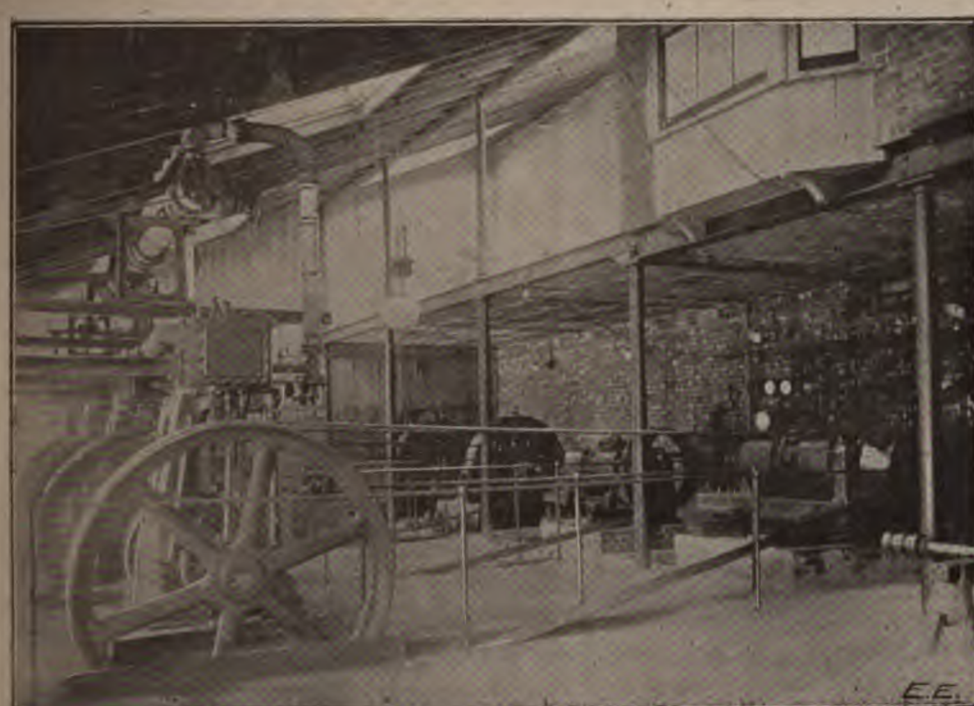


FIG. 4.—General View of the Engine-room.

first three are each of 75 h.p., and run at a speed of revolutions, while the smaller one, used only for arc ing, is capable of giving 50 h.p., and its speed is varied ut the number of lamps burning. All the engines f the compound vertical type, with shaft flywheel rnors, which have given satisfaction. The first two es drive two 50-kw. alternators, made by Messrs. Johnson and Phillips, of Charlton. Rope gearing is used between the engines and alternators, and is also employed for driving the first Brush arc lighting dynamo, but the next engine uses a belt drive.

The construction of these alternators has been fully described before in our columns, but these two machines are of special interest, being the first of the new type introduced by Mr. Gisbert Kapp in 1894. The magnet system consists of two claw-shaped castings, embracing the exciting coil, the field revolving inside the fixed armature, which is built up of wedge-shaped sections, each containing its own coil. The firm usually supply spare coils, which can be easily inserted if one in use should be damaged, but at Aberystwyth these spare coils have not yet been called into service. The voltage employed on the high-tension side is 2,000, and this is transformed down to 100 in the consumer's house, or in one case in a transforming sub-station which supplies a length of low-tension cable. These two machines work well in parallel, but are mostly used on separate circuits for safety. In fact, Mr. Putland has devised all the extensions made in his *régime* so that a total breakdown is

statement of units generated, sold, etc., shows the
ng for the year 1897:

	B.T.U.
y sold for public lamps	21,431
private consumers	24,602
al units sold	46,033
y used on works	1,173

number of public arc lamps used varies from 22 in
nter to 28 in the summer. The maximum load on
ernate-current side was 74 kw.

TES ON ACCUMULATOR CONSTRUCTION.

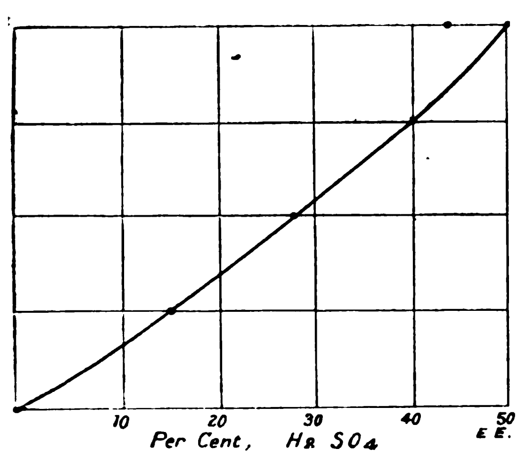
BY DESMOND G. FITZ-GERALD.

[*Copyright.*]

CVII.

ay be expedient to give a few examples of the tion of the foregoing formula for the weight of lyte in an accumulator.

lem 1.—What should be the weight of electrolyte in umulator to yield 180 ampere-hours, the initial gravity of the acid being 1,206 and the final 1,106? ing to Otto's table of the strength of sulphuric acid erent densities at the temperature of 15deg. C. F.), the percentages of H_2SO_4 corresponding to the pecific gravities are 28 (N) and 15 (n).



Density Curve, Based on Otto's Table.

values given in Otto's table, and indicated by the curve with sufficient accuracy for most practical es, are those which have been usually adopted by ts in this country. They differ appreciably—but not ntly to affect results from a practical point of view— ose given in Kolb's table of densities, at the same ature, which is generally made use of on the ent and in America.

pting the above values for N and n, we have (CIV.)

$$A = 180 \times \cdot 129 = 23 \cdot 22 \text{oz.}$$

t (CVI.) $aq = 23 \cdot 22 \times \cdot 1837 = 4 \cdot 26\text{oz.}$

n, $$Aq = \frac{72 \times 23 \cdot 22}{28} = 59 \cdot 7\text{oz.},$$

e total weight of electrolyte will be:

$$6 \cdot 835 + \frac{63 \cdot 96}{\frac{2{,}322}{15} - 82 \cdot 92} \times 82 \cdot 92 = 160\text{oz. nearly, or 10lb.}$$

(*Answer.*)

this case we start with acid somewhat (weaker than possessing the maximum conductivity), generating normal conditions an E.M.F. of 2·05 volts (*vide* under CV.), and we end with acid having only about cent. of the initial conductivity, and corresponding, normal conditions, to an E.M.F. of 1·93 volts. We , therefore, expect a very level curve of discharge, lly at high rates. On the other hand, we have little from local action and sulphatation, unless the cell idle for a considerable period when in the discharged ion.

Problem 2.—What will be the volume, in cubic inches, of 10lb. of acid of the required specific gravity?

10lb. = 1 gallon of water = 277·3 cubic inches, roughly,

and the required volume will be this divided by the specific gravity of the acid in terms of water as unity, or

$$\frac{277 \cdot 3}{1 \cdot 206} = 230 \text{ cubic inches.}$$

The volume of this acid required per ampere-hour is therefore $\frac{230}{180} = 1 \cdot 28$ cubic inches.

CVIII.

Problem 3.—The capacity being 180 ampere-hours, as before, what will be the weight of electrolyte when the initial percentage of H_2SO_4 is 35, and that of the residual acid 20? Give accurately, according to the data of Kolb, the initial and final specific gravities of the electrolyte.

The capacity being the same as in the foregoing case, the weight of H_2SO_4 actually consumed or decomposed in the discharge will still be:

$$A = 180 \times \cdot 129 = 23 \cdot 22\text{oz.}$$

And the weight of water liberated from this acid will still be:

$$aq = 23 \cdot 22 \times \cdot 1837 = 4 \cdot 26\text{oz.}$$

But in consequence of the greater strength of the acid, the weight of water to be added to the given weight of H_2SO_4 to produce acid of this percentage strength will be considerably less than in the former case.

$$Aq = \frac{65 \times 23 \cdot 22}{35} = 43 \cdot 1\text{oz.}$$

And the total weight of the electrolyte will be:

$$W = 70 \cdot 58 + \frac{47 \cdot 36}{\frac{2{,}322}{20} - 66 \cdot 32} \times 66 \cdot 32 = 133 \cdot 4\text{oz.} = 8\text{lb. } 5\tfrac{1}{2}\text{oz.}$$

(*Answer.*)

The weight of the electrolyte has in this case been diminished by about 17 per cent.

In regard to the latter portion of the problem, the specific gravity (δ) corresponding to the percentage $N = a = 35$ of H_2SO_4 is not given in Kolb's table. The next lower specific gravity (d) in the table is 1·263; and the next higher specific gravity (D) is 1·274. As will be seen from Diagram II., showing a small portion of the density curve based on Kolbe's table, these densities (or specific gravities) correspond respectively to the percentages of H_2SO_4 $a = 34 \cdot 7$ and $A = 36$.

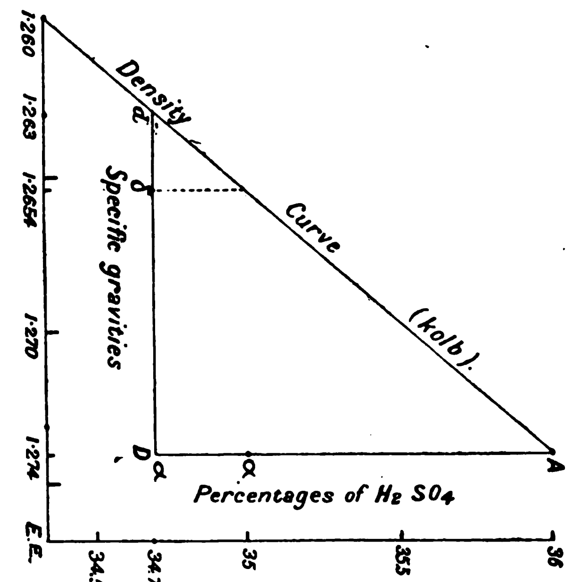


DIAGRAM II.

The curve being thus represented, it is seen by inspection that the specific gravity (δ) corresponding to the percentage $a = 35$, or to the ordinate at δ, is between 1·265 and 1·266, and that it is apparently below rather than above the mean of these two values—viz., 1·2655.

By similar triangles, we perceive that

$$\delta - d : D - d :: a - a : A - a;$$

or

$$A - a : a - a :: D - d : \delta - d.$$

Whence

$$\delta - d = \frac{(D - d)\,(a - a)}{A - a};$$

and

$$\delta = d + \frac{(D - d)\,(a - a)}{A - a}.$$

Thus, in the present case, the initial specific gravity is

$$\delta = 1{\cdot}263 + \frac{(1{\cdot}274 - 1{\cdot}263) \times (35 - 34{\cdot}7)}{36 - 34{\cdot}7} = 1{\cdot}2655. \quad (\textit{Answer.})$$

In similar manner, we do not find in the table the specific gravity (δ_1) corresponding to the percentage ($a_1 = n = 20$) of H_2SO_4 in the residual electrolyte. But the next lower value in the table is $d_1 = 1{\cdot}142$, corresponding to the percentage $a_1 = 19{\cdot}6$ of H_2SO_4, and the next higher value is $D_1 = 1{\cdot}152$, corresponding to the percentage $A = 20{\cdot}8$. Then the final specific gravity of the electrolyte will be:

$$\delta_1 = 1{\cdot}142 + \frac{(1{\cdot}152 - 1{\cdot}42) \times (20 - 19{\cdot}6)}{20{\cdot}8 - 19{\cdot}6} = 1{\cdot}1453. \quad (\textit{Answer.})$$

The volume of 1oz. of water being taken as 1·73 cubic inches, the initial volume of the electrolyte will be

$$\frac{133{\cdot}4}{\delta} \times 1{\cdot}733 = 182{\cdot}7 \text{ cubic inches.}$$

And in this case the volume of electrolyte corresponding to one ampere-hour is

$$\frac{182{\cdot}7}{180} = 1{\cdot}015 \text{ cubic inches.}$$

Or one cubic inch of the electrolyte corresponds to

$$\frac{180}{182{\cdot}7} = {\cdot}985 \text{ ampere-hour.}$$

And a layer of electrolyte having the thickness l inch on one square inch of peroxide (or spongy lead) surface corresponds to

$$\frac{l}{1{\cdot}015} \text{ ampere-hour.}$$

CIX.

Problem 4.—With a view to flattening the curve of discharge, the enquiry is made whether the weight of electrolyte would be greatly increased if the final percentage (n) of H_2SO_4 in the electrolyte were increased from 20 to 25, the remaining data being as in the previous case?

The equations for the total weight of electrolyte will be the same as in the previous case, with the exception only of the value n.

$$W = 70{\cdot}58 + \frac{47{\cdot}36}{\frac{2{,}322}{25} - 66{\cdot}32} \times 66{\cdot}32 = 188{\cdot}58\text{oz.}$$

$$= 11\text{lb. } 12\text{oz.} \quad (\textit{Answer.})$$

The increase in the weight of electrolyte is very considerable, being 3lb. 6½oz., or over 41 per cent. of the original weight.

The volume of the acid will be

$$\frac{188{\cdot}58}{\delta} \times 1{\cdot}733 = 258 \text{ cubic inches.}$$

And the volume corresponding to one ampere-hour is

$$\frac{258}{180} = 1{\cdot}43 \text{ cubic inches.}$$

SELECT COMMITTEE ON ELECTRICAL ENERGY.

Generating Stations and Supply.

SECOND DAY.

Mr. Frank King.—Mr. King's evidence was in effect to show the great difficulty which electrical companies had in acquiring the necessary ground upon which to erect
their works, and especially when the area required b
to a number of people. He pointed out that in th
ticular case a station replaced a quantity of cotta
perty with low chimneys, an old mechanical en
shop, as well as business premises; that there w
less nuisance arising from their chimneys, 100ft. an
high, than from a large number of smaller chimne
high. He pointed out that delays in obtaining p
were very costly to the companies, and instanced l
specific case, in which a very small area, for whic
was asked, could not be obtained because the owner
to make a condition that certain property adjoin
which he asked £29,000, should also be adopted. H
that the nuisances arising from a central station wer
from vibration or smoke and steam, but although t
had a good many complaints at Chelsea on account o
tion during their earlier working, and had actually
account to change the whole plant twice over, th
by adopting a Willans three-crank engine, given the
approach to freedom from vibration that he thoug
commercially possible, at any rate during his tim
investigation of the matter of vibration had not be
fined to officers of his own company, but they had
in such experts as Sir Frederick Bramwell, Prof.
and Prof. Milne. They used the best Welsh sm
coal, and had never received any complaint on acc
smoke. With regard to steam, although during t
of a temporary installation, when the wind was blo
a certain direction, there had been some conde
which fell in the shape of moisture or rain. Si
chimney had been complete, having a height of
there had been no sign of any condensed moisture i

Mr. Sidney Morse.—At the end of Mr. Kin
dence, a few questions were put to Mr. John
Courtenay, the effect being to obtain his opinion th
authorities and companies should have compulsory p
Then Mr. Morse gave instances of Acts authorisin
pulsory purchase summarised in his answer to Questi
He said: "Before the alteration of the standing o
which the Lord Chairman referred in 1893, for the
of 1894, certain Acts were passed authorising elect
ways, including the power to erect a generating s
and there was a common form of clause adopted in
dozen cases, which I will hand in to this effect: 'S
to the provisions of this Act the company may ma
maintain in the lines, and according to the levels
on the deposited plans and sections the railways and
works hereinafter described, with all necessary and
stations, platforms, approaches, and passages, su
and so on, 'generating plant depôts, and may ent
use the lands for these purposes.' That was the f
clause in the following Acts: the Central London R
Act of 1891; the Central London Railway Act of
Section 4; the Great Northern and City Railway
1892, Section 5; the City and South London Railwa
Section 4; the Baker-street and Waterloo Railwa
1893, Section 5; the Charing Cross, Euston, and
stead Railway Act, 1893, Section 5; the Edi
Street Tramways Act of 1893, Section 17."
Section 32 of the Central London Railway Ac
tains a clause giving "roving power": "The compa
take, by agreement, for the extraordinary purpose
tioned in the Railways Clauses Consolidation Act
any quantity of land not exceeding in the whole
acres, but nothing in this Act shall exonerate the co
from any action, indictment, or other proceedi
nuisance in the event of any nuisance being cau
them upon any land taken under the powers o
section." In 1893 Standing Order 5 was altered
consequence of that alteration after that date it
necessary that the notice should define, and it did
the limits of a generating station, and the Ports
Streets Tramways Act, 1896, Section 7, is in this
'Powers to construct generating stations, etc. F
purpose of working any tramways under the various
of this Act by means of mechanical powers, gen
stations, and all necessary engines, dynamos, accum
and other apparatus, works, and appliances for the p
tion of electricity may be constructed, erected, and
upon, and within, but not beyond, the limits of th

er specified—that is to say (a) the depôt of the , known as 40, Broad-street, Portsmouth, and other ntioned.' That was followed in a great many cases." ness could see no distinction between a station ng for power and one generating for light. difficulties were pointed out where companies in accordance with Stock Exchange rules could corporated without having its constitution changed, ere would be difficulties in becoming incorporated compulsory powers. Injustice arises where powers compulsory in that an injunction can be obtained s in a case cited, may cause the station to stop , where with the powers wanted the damage would n small.

lbert Gay mentioned that a slight difficulty had Islington because of a want of compulsory powers, ally he favoured compulsory powers.

vidence after this concerned the second point of s, the having a place for a generating station outside .

Eustace James Anthony Balfour, of the es and Pall Mall Company, gave evidence to the at he did not believe it would be possible to obtain site within the district; that, not being near a or canal, they had to cart 200 tons of coal per rough the streets, as well as remove the ashes. It e less of a nuisance to have a station outside the and have powers to lay mains. The trunk mains e laid down for good and all, and having once mains in, there would be no occasion to again p the streets. The capacity of existing stations be quickly exhausted. Roughly speaking, the in the demand was continuous, and was about cent. annually, so that the supply had to be about every five years. He would not object a rent to the authority on account of the mains. ndon Electric Supply Corporation had a station tford, and the Strand Company also supplied istance, and supplied various other authorities, and nted compulsory powers to purchase a site for a station and powers to lay mains in order to supply mpanies or authorities wholesale from a central

. **Alexander Kennedy** stated that the new com- d not propose to have an area of supply, but to uthorised undertakers only, particularly the West- and the St. James and Pall Mall Companies. He that about two years would see the latter company the limit of its capacity; the Westminster Company e a little longer. Their statutory price was 8d.; re selling at 6d., or, taking it all round, at $5\frac{1}{2}$d. ar, because of the lower price, the public had ving to the extent of £39,000. Their mains were o in that respect authorities through whose districts sed would benefit. The reason why a station was outside the district was thus stated: "I should ay here, it will be present to the committee that npanies, being companies with statutory powers, rked very hard to carry out those powers; they ilt stations in the only places where they might em; they have carried out their work there and erything they could to carry it out without annoy- anybody; and, in fact, have succeeded in doing is only because they find themselves at the end of sources in the matter of land (and not at the end statutory obligations) that they feel the necessity gly of going somewhere else." In his own district d been no friction as regarded the streets between pany and the authorities. Even had they com- powers as regards sites within the district, they ly get them at enormous cost within these special . If the supply stations were at a distance a higher would have to be used, but not higher than was London, where one company had been running 12 ith about 10,000 volts, a specially high pressure, accident had ever happened to outsiders. They d to use 2,000 volts.

Sidney Dobson, engineer to the St. James's said their annual increase was 20 per cent. past two years, and he thought the present resources would take them through two more winters. The coal consumption last year was 8,000 tons. By going outside to the proposed station $2\frac{1}{4}$ miles of mains would have to be laid. He did not quite agree that the company having a main down the street and a number of customers on it necessarily had a virtual monopoly.

Mr. Sidney Morse, recalled, gave further information as to compulsory powers granted to other limited companies; also as to competing companies and authorities in London.

THIRD DAY.

The third day's evidence passed on to the fourth question, with regard to a company which is seeking to supply, not in bulk but in detail, over a large area.

Mr. James Swinburne testified that there was no engineering difficulty in supplying from a distance; the difficulties were only those relating to capital and created by public bodies or legal points. The station would be as near the coal supply as possible, and would distribute under extra high pressure by underground wires to low-pressure network systems. Such stations are common abroad. "In Switzerland from Zufikon to Bremgarton there is a current of 1,300 h.p. and 5,000 volts going to Zurich and elsewhere. At La Goule there is one of 1,500 h.p. and 4,000 volts. Then at Val de Travers there is an extended system which is very much the same sort of thing which is proposed now in England, except that in the Swiss system it is done with water. It feeds Chaux-du-Fonds, which is an industrial town, and some small villages. They have about 10,000 volts, and the smaller of the stations has nearly 1,000 h.p. now, and there is a larger station, but I do not know what it does; evidently it is a large concern and it is growing. Then the Rheinfelden, one of the rapids on the Rhine, have 20 generators, giving altogether 16,000 h.p. I saw some of the generators the other day in Berlin, where they are being made. They are driven by large water powers, and the cost there is a fifth of a penny per unit, with a tax in addition of from £2. 12s. to £8 for each kilowatt a year—that is to say, from £2 to £6 for each horse-power; a large amount of that power is to be used for making gas and that sort of thing, but a good deal of it has to be distributed over distances. Then at Geneva there are 3,000 volts in four miles, with 12,000 h.p. Then the works at Oerlikon, where they make flour-mill machinery, they have 1,000 h.p. and as much as 13,000 volts. In Germany there are 10,000 volts sent from Eichdorf to Grunberg, a distance of 15 miles water power with steam power in addition, and that is overhead system though it is in Germany. Then there are about 600 h.p. or more, sending 5,000 volts from Lauffen to Heilbronn. In Germany there is another undertaking. I have just come back from Germany, and I saw there machines that are being built for central distribution from colliery districts without water power; precisely the same sort of thing, as far as I believe, that is going forward in England now. Unfortunately, when I was at the works where they were making those things, I did not know of this committee, and I did not take full particulars, but if your lordship would like particulars I could write to the makers and find out exactly about it. In Italy, of course, there is the well-known Tivoli, which sends to Rome about 2,000 h.p. In the United States there are two concerns. At Niagara there is one, the Niagara Falls Hydraulic Power and Manufacturing Company. It is difficult to find out exactly what it is doing; it is doing, I think, 6,000 h.p. for the aluminium works, 2,000 h.p. for the paper works, and 2,000 h.p. is ordered, I think, by people who are working an alkaline process there; there may be other things. Then the Niagara Falls Power Company, which is also on the American side, has 10 turbines of 5,000 h.p. each. I am not quite sure where they are all working, but they are being put in. I think Buffalo has the right of getting 10,000 h.p. by June this year, and is to get, if it wants it, an additional 10,000 h.p. every year until it has made up to 40,000 h.p. Whether it will take it all I do not know, but I understand that is the contract. The price I have here marked down is £7. 4s. per horse-

power per year, but this morning I got another list of prices at Niagara, and those prices range from ·64 of a cent per unit to 2 cents per unit—that is to say, it will come to about a farthing per horse-power up to about a penny per horse-power. Then there is an additional charge which goes by the year, I suppose, to cover capital cost. Then there are various other water powers in the United States and Canada; there is one at Fresnó, and they have 11,000 volts, and 15,000 h.p.; one at Folsom with 5,000 h.p.; one at Portland with 10,000 h.p. Then there is the Chambly Rapids (I do not know whether it is Chambly in the United States, or Chambly in Switzerland), where they have 12,000 volts and 2,500 h.p. Then there is the Lachime Rapids, with 14,000 h.p. sent over six miles. Those are all water powers. Then there is an undertaking with 40,000 h.p. at the Lake of the Woods in Canada, and then there are other places in Canada of which I know."

INSTITUTION OF ELECTRICAL ENGINEERS, April 28

Before the reading of Mr. Parshall's paper on "Earth Returns for Electric Tramways," and those by Major Cardew and Mr. Trotter, the **President** said that they would no doubt remember that three meetings ago he had informed them of a testimonial to be presented to Mr. Gramme. The testimonial was duly presented at the banquet, and Mr. Gramme had desired that his thanks should be conveyed to the members of the Institution. The medals commemorating the event would soon be in the hands of the secretary.

Earth Returns for Electric Tramways.

BY H. F. PARSHALL, MEMBER.

(Concluded from page 501.)

In a system that I have recently designed to carry some 250 cars, I propose to employ several earth generators feeding in from several points in the system. Pairs of test wires are run back to the station from various points, one of the test wires being connected to the track return, and the other to adjacent earth plates. The earth generators in the station will be adjusted from time to time, according to the difference of potential between the earth plates and the earth return. As far as possible the adjustments will be made so that the two are kept generally over the system at the same voltage. Whatever difference of potential there is between the two will be such that the earth return is, in general, positive to the neighbouring water or other pipes, since in this case whatever electrolysis takes place will be in the track return itself.

STEEL RAILS.

The percentages of carbon, manganese, etc., in steel rails have varied considerably at different times; and there are, even now, wide variations in the practice of different companies, and in different countries. It may be said that English rails some years back would commonly contain the following:

Carbon	0·25 to 0·35
Manganese	0·8 „ 1·0
Silicon	0·05
Phosphorus	0·06
Sulphur	0·06

Of late years the percentage of carbon has increased. One large railway company specifies:

Carbon	0·4 to 0·5
Manganese	0·95 „ 0·85
Silicon	0·10 „ 0·06
Phosphorus	0·10 „ 0 08
Sulphur	0·08

In American practice the carbon runs still higher, as will be seen from the following:

Carbon	0·45 to 0·55
Manganese	0·8 „ 1·0
Silicon	0·10 „ 0·15
Phosphorus	0·06
Sulphur	0·06

In France yet higher percentages of carbon have been tried, running up to nearly 1 per cent.

Carbon.	Manganese.	Silicon.	Phosphorus.	Sulphur.	Resistance compared with copper 20deg. C.	Resistance of one mile one square inch sectional area at 20deg. C.
0·378	0·550	0·181	0·040	0 041	10·8	0·468
0·446	0 568	0·188	0·046	0·044	11·1	0·482
0·536	0·592	0·201	0·051	0·059	11·3	0·490
0·568	0·608	0·204	0 053	0 061	11·4	0 495
0·588	0·632	0·214	0·656	0·065	11·5	0·499
0·610	0·650	0·220	0·062	0·071	12·9	0·560

The results are shown in the preceding table—tri sample sections of steel rail of varying compositions furnished for testing purposes.

Eight 76lb. track rails, tested in place after 2½ gave the following results:

Test No.	Resistance compared with copper 20° C.	Resistan 1 sq. in area
1	11·3	
2	10·3	
3	10·1	
4	10·7	
5	9·65	
6	10·07	
7	10·25	
8	10·50	
Average	10·4	

Two old 65lb. rails, much worn, tested in place:

Test No.	Resistance compared with copper 20° C.	Resistanc 1 sq. in. area a
1	11·7	
2	12·3	
Average	12·0	

High values would be expected owing to the weari rail, which is not allowed for in the calculations. 90lb. rails, tested in place:

Test No.	Resistance compared with copper 20° C.	Resistanc 1 sq. in. area a
1	10·6	0
2	10·4	0
Average	10·5	0

A 66½lb. rail not laid—

	10·0	.0

BONDS.

The current flows across the joints partly through plates and partly through the bonds. The resistan fishplates is a variable quantity, but all tests on rai have shown that they contribute considerably to the co of the joint. For the bonds themselves the following been made: (1) conductivity tests on bond copper; ance due to contacts; (3) resistance due to current "g from other sections of rail to enter the bond terminal.

1. For *Conductivity* the Chicago bonds in the diffe have shown practically 100 per cent. of the conductivit copper. A flexible Crown bond showed only 93 per ductivity. The Columbia bonds in the cases trie about 90 per cent. conductivity.

2. *Resistance due to Contacts.*—Measured from the difference between two points very close together, o bond terminal, the other on the steel. Experiment sh following results:

—	Test.	Resistance per bond (two terminals).	Resistance of 176 joints, or per mile with 30ft. rails.	
		Ohms.	Ohms.	
Chicago bonds ⅞in. terminals in ½in. web; 1·37 square inch contact area.	1	0·00000197	0·000347	Bond and clean.
„ „ „	2	0·00000215	0·000379	„
„ „ „	3	0·0000025	0·000440	Bond not hole f reamed,
„ „ „	4	0·0000080	0·00141	Bonding s vised.
Crown bonds ⅞in. terminals in 7/16in. web; 1·2 square inch contact area.	5	0·0000080 0·0000028		„
Total		0·0000108	0·00190	
Crown flexible bond ⅝in. terminals in 7/16in. web; 1·2 square inch contact area.	6	0 0000422 0·0000518		Bonding s vised; bo wards f have bee rusty hol
Total		0·0000940	0·0165	
Columbia bond In ⅞in. hole in ½in. web; 1·37 square inch contact area.	10	0·0000072	0·00127	Hole clea untouche
„ „ „	12	0·0000095	0·00167	„
„ „ „	13	0·0000077	0·00136	Hole four bond unt

Tests 4, 5, and 6 show that want of care in bonding

increase in contact resistance. From the tests made said generally that bonds properly applied—that is, ds in bright reamed holes, put in with a proper fit ft driven square—have practically negligible contact . Experiments showed that at at least 100 amperes e inch the drop in the contact surface was inappreipared with that in the bond and in the rail. The found true with bonds—samples of which are exhiat have been in use for over two years, when the ensity has been limited as stated. Experiments on have been carried out to a considerable extent, since n frequently stated that the contact resistance is a eciable factor, and that it can be greatly lessened by iting the surfaces. This will not be the case except re is carelessness in putting the bonds in place.

ering.—The current may be supposed to flow uniformly he rail at all parts a foot or so from the ends or from At a bond, however, it has to gather, and it is scarcely pected that, say, 16in. of rail terminating at a bond ow the same resistance as 16in. in the middle of the ts on a bar of steel 3in. by ½in. showed "gathering" bond terminals added resistance equivalent to a total in. of the bars. Tests on an 83lb. rail showed "gathertance equivalent to 3·4in. of rail at each contact, or a 8in. per joint.

JOINTS.

iductance of the joints depends, as stated, on both l fishplates. The first have been discussed already. d have a very appreciable effect, even with rails that in use for some time. The following table shows the a number of tests made partly in the laboratory and track in use :

oratory tests.	Additional resistance due to joint. Ohms.	Inches of rail.	Resistance of 176 joints per mile, or with 36ft. rails.
; six tests; no ihplates uncleaned fully tight	0 0000095 to 0·000081	10 to 87	0·0017 to 0·0143
.... -	0·000039	34	0·0068
) ; 30in. bond only ed)	0 000101	109	0·0178
with one 30in. 000 bond, plates tened*	0·0000024	3	0 00041
fishplate removed...	0·000106	114	0·0187
on rails in use.			
one 30in. 0000 bond and fishplate	0·0000307 to 0·0000622	32 to 65	0·0054 to 0·011
made without distrack, average......	0·000043	45	0·0076
s above (track 2½ l) ; four tests	0·0000275 to 0·0000843	28 to 80	0·0048 to 0·0148
....	0·000046	48	0·0081
n. 0000 Chicago y (calculated)	0 000103	114	0·0181
rail ; one 30in. icago bond, fisht tight..............	0·000069	57	0 0121
th fishplates re...........................	0·000090	74	0·0158
fishplates replaced tightened	0·0000473	39	0·0083
; two 32in. 000 bonds and plastic shplate†	0 0000081	10	0·0143
	0·0000040	5	0·0071
....	0 0000060	7½	0 0105

ond has too great contact resistance (see contact test Fishplate added to conductivity.

we values show that the contacts had not deteriorated y in the 2½ years of use. Some of the rails were very the fishplates, which were not fully tight, showed tches of metal at places of contact with rail. On plate and rebonding the joint was equivalent to 39in. A second rail tested without fishplate showed also no ion of the bonding. Some 66½lb. rail laid on another tly bonded showed joint resistances equivalent to 9½in. four different cases.

he table, it seems safe to take the resistance through as equivalent to some extra 50in. of rail, and to take ance as in parallel with the copper or plastic bonds addition. Curves can then be constructed for any

PLASTIC BONDS.—One and a-half inch hole in the cork receptacle between fishplate and rail filled with plastic material.

—	Increased resistance due to joint.	Inches of rail.	Increased resistance of 176 joints, or per mile, with 30ft. rails.
	Ohms.		
83lb. rail bonded to one plate only ; both plates separated by paper from rail..........................	0·0000213	24	0·00375
Ditto, but bonded to both fishplates ; plates not very tight	0·0000126	14	0·00222
Ditto ; plates a little tighter	0·0000123	14	0 00217
Ditto ; plates very tight ; brown paper still between plates and rails	0·0000117	13	0·00206
Ditto ; brown paper removed ; plates tightened very hard up ...	0·0000083	9	0·00146

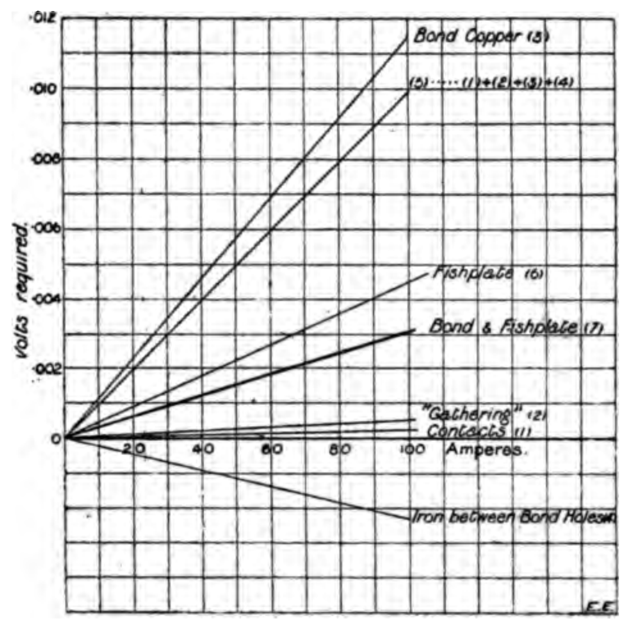


FIG. 2.—Volts required by various elements of joint in 80lb. rail bonded with 1½in. plastic bond to one fishplate only.

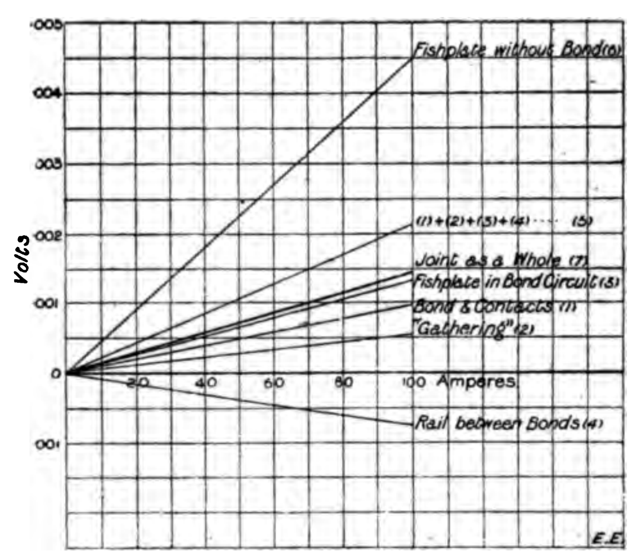


FIG. 3.—Volts required by various elements of joint in 80lb. rail bonded with a single 30in. 0000 copper bond, with ⅞in. terminal in $\frac{7}{16}$in. web.

particular system of bonding similar to those of Fig. 3, which gives P.D. for the various elements of a joint of 80lb. rail bonded with a single 0000 B. & S. copper bond 30in. long with ⅞in. terminals. The contact and gathering resistances are added to the bond copper resistance, and the resistance of the iron between the bond holes deducted. This gives curve No. 5. The resistance so found is taken as in parallel with the fishplates' resistance and curve (7) calculated for the whole joint. The volts so found must be multiplied by the number of joints per mile, and added to the volts required to drive the current through a mile of jointless rail.

Apparatus Employed in Testing.

All resistances were found by measuring the potential difference between two points on the rails when a constant current of 30—150 amperes was passed through the latter. A standard resistance of 0·0000398 was placed in the same circuit, and the fall of the potential across this compared with that across the two points on the rail. The places at which current was led in and out of the rail were always at some distance from the points between which the potential difference was taken. Where measurements were made upon the actual track, current was supplied from an accumulator placed upon a car brought up to the spot. Current was led from this to a point in the middle of the rail to be tested, and was led out some 5ft. or 6ft. on the other side of a rail joint. The fall of potential was then measured between two points inside those by which the current was led into the rail, and also between two points on the same rail outside the places at which current was led into it. The standard resistance was included in the circuit, and comparisons taken with this at each stage. From these two measurements the resistance of the rail could be calculated as long as no cross-bonds occurred upon the part of the track actually under test. To measure the resistance of the joints, a joint was included between the two points of which the potential difference was taken, and this compared with the potential difference between two points at a similar distance apart on the continuous rail. It was found extremely important in some cases to reverse the current both in the rail and the potentiometer, since with the small potential difference measured thermo-electric effects were very liable to disturb the results. In certain experiments a current was passed into the rails at one end of the track and taken out at the other. The current in the rails at intermediate points could be measured by taking the difference of potential between two points on the same metals which had been tested for resistance as above. This had, of course, to be done for all four lines of the double track. The volts used to drive current through the whole length of track were measured by making use of the test wires. The potentiometer was employed for this purpose also, and the results may be taken as correct, within the limits of correctness of calibration of the instrument itself, which was supplied by Elliott Bros.

Discussion.

Mr. D. Gadsby, who opened the discussion, said that he noticed in Mr. Parshall's paper that he referred to the electrolytic action on lead-sheathed cables. He had had a good deal to do with these lately, and could quite endorse Mr. Parshall's remarks, some of the holes found being as large as a shilling. He thought that the method of cast-welding rail joints would be adopted on all electric tramways during the next few years. He thought it a great mistake to try and introduce the electric weld. With regard to the varying resilience at different points of the rails referred to by the author, he thought that the author must have been thinking of the American tracks. He thought a great deal of energy was used in the joints. He had designed a joint in which the head was separate from the body of the rail, and fastened with an eye-shaped joint of iron. The two halves would be arranged to break joint, and would allow of the worn parts being removed without very great difficulty. He would like to ask if the rails from which the results had been taken had been laid in the ordinary way, or if special means had been taken to produce good results? As to separate feeders on tramway circuits, this was no doubt advised a long while ago, and he did not suppose that Major Cardew would recommed them now. In a tramway of about three miles in length the whole leakage from the rails was about 10 per cent. of the total current. A great deal of this was caused from having the station 200 or 300 yards from the rails and the cable which conveyed the power being insufficient to carry the current back again. A drop of four or five volts between the station and the rails was the result.

Mr. Murphy said he would confirm what Mr. Gadsby said about the joints. The Falk system would, no doubt, be the one universally adopted. He agreed with the author that the welded joints had not enough conductivity. He had had some experience of joints with separate heads, such as Mr. Gadsby described, and had not found them to work well. These papers were very useful to those who, like himself, were connected with the finance and working of tramways.

Mr. A. W. Heaviside said that in 1890 he was aware of a leaking in the electric light wires of which he was in charge. In order to find it he made a large triangle of copper, which he carried across his shoulder. Within this circuit and connected with it he carried a telephone. By the noise in the telephone he was able to ascertain the presence of any large water or gas pipes in the streets near which the electric conductors ran. This, he thought, was strong evidence of the leakage from electric tramways into pipes, etc.

Mr. A. J. Lawson said that Mr. Gadsby had evidently referred to the Dover tramways, but had not considered the effects of pipes in the subsoil on tramways. A large water-pipe followed the track almost all the way, and the soil was impregnated with salt water. It was the people associated with Mr. Gadsby who brought the cable referred to back from the tramway rails. The losses he thought also differed greatly according to the different subsoils through which it passed.

Prof. Perry had sent a communication which he des
Ayrton to read. There was, he said, very much useful
tion in Mr. Parshall's paper. It was important to know
bonds did not decrease in conductivity with time. He wis
the members if there should not be a rule that all electric
conductors should be insulated? He was not one of
said that an enterprise should be stopped because
interfere with somebody else, but he thought that if tram
ductors were laid within a radius of 1½ miles or two mi
observatory, the magnetic instruments could not be relied
all calculations would be upset. If Kew Observatory, for
were interfered with, the loss would be irreparable. H
also ask them to consider the danger of uninsulated
wires. In the long run he thought that, by the length
of the cables, double insulation would pay the tram
panies, as well as benefiting other people.

Prof. Ayrton then said that Prof. Perry's views on thi
agreed with his own. He did not think that scientific col
observatories should have their instruments interfered
electric tramways. All the papers had aimed at getti
rails down to an electric zero, but why should there be an
all? The insulating of the electric returns would save
trouble of trying to get this, and would by no means inter
the running of the trams. Some underground railway c
had lately inserted in their Bills clauses to the effect that,
system of electric traction they used, all the electric co
should be insulated to the satisfaction of the Science
Department and the City and Guilds Institute. It was
sure fact that it was for their own benefit as well as th
Science and Art Department. He would ask them to
heads together and see if they could not have a successfu
of insulating return conductors for electric tramways.

Prof. S. P. Thompson said that there was no doubt o
effects of electric conductors on the delicate instru
observatories. The whole of the readings of the Toronto Ob
had lately been rendered valueless by the proximity of a
tramway. They certainly ought not to allow anything
affect the instruments near Kew Observatory. As to not
them near science colleges, he thought they were very
them. He wished they would run one down City-roa
would be a means of teaching the students the effects of
earth currents, etc., and of showing them how to wo
adverse circumstances. As regards the bonding of pipes
he said there was only one place where this could be
advantage. The damage was done where the current left
not where it entered it. The return conductor should
bonded to water or gas pipes close to the station. In th
might be possible to prevent the current leaving the pip
by a metal conductor. In the results shown the resistanc
be the same at all the terminals, and he thought that w
that one of the joints was a bad one that he had obtained
results. The resistance of the conductor was almost a
and he was astonished to learn that the resistance of a wel
joint equalled that of 39in. of rail. The tests taken
from as near the ends of the rail as possible. He thank
Cardew for his clear account of the negative booste
of working. After all, the Board of Trade rules were
in disguise, as they raised the standard and quality of
and materials and caused improvements to be made.

Mr. C. H. Wordingham said that he thought the than
Institution were due to the author for this very usef
Personally he had at first thought that it would be imp
comply with the Board of Trade rules. He thought they w
to adopt the overhead trolley system, but now they were i
better condition than formerly, owing to trying to work sp
rules. They had not found so much difficulty as antic
complying with them. The observatory question wa
important one, and he thought that tramway compani
try to minimise as much as possible the effects of the earth
from their lines. He should like to ask whether it woul
better to punch the holes in the bonds instead of drilling

A telegram was then read from **Mr. Wood,** enginee
Bristol tramways, in which he testified to the success w
attended the return booster system.

Mr. J. W. Swan said he was glad that these papers h
forth an observation on the question of insulating bot
tramway wires. As long as the common practice of using
as an earth return was indulged in, the numerous earth
would affect the instruments in scientific observatories an
the calculations of no value. The papers by Major Ca
Mr. Trotter were of immense value. Mr. Parshall had
p. 2 of his paper that corrosion occured on those pipes w
parallel to the electric conductor, and this showed that t
position for pipes near it was a parallel.

Mr. H. F. Parshall, in reply, said, in answer to Prof.
question as to the diagrams, that all the tests there sh
from his own tests. When Prof. Thompson spoke abou
effect he thought he had found out that twice one are tw
these effects were well known.

Major P. Cardew, in replying, said that of course th
was written a long time ago, and, instead of return feeder
booster would be used. In answer to Prof. Thompson's re
was rather difficult to lay any specified distance for tra
go near observatories. If the electric tramway cam
1½ miles of an observatory and then went straight awa
in a direct line, he did not think it would affect the ob
much. The corrosion was not entirely got over if th
sufficient difference of potential in the rails as to allow
out at any other part.

MEETING, MAY 5.

ght's meeting of the Institution the following were es balloted for.

- Robert Thorburn Turnbull, Wellington, New

—David Armitage, 31, Shrubland-grove, Hackney, d Reade Braid, 21, Esmond-road, Bedford Park, W.; ovan, The Arcade, Reading; Thomas Hesketh, 63, d, Folkestone; Edward Benjamin Hibberdine, 15, k-terrace, N.W.

-John Robert Craig, Carmel, Mathoura road, Toorak, Australia; Kenneth T. Mackinlay, 125, Ashley- W.; Alexander Pope, 2, Thorburn-square, S.E.; nard Roberts, Murchison, Victoria, Australia.

LIGHT RAILWAYS.

ay, Tramway, and Electric Lighting Committee of the Council state in their report that they have settled e sent to the Light Railway Commissioners respecting dley and District Light Railways Order, 1898, and n that it would be advisable for the Corporation to truct and work the line from Netherton to Cradley

ion of tramways was again discussed by the Ripon on Thursday week on a report of the Finance and poses Committee. There had been an interview with listrict superintendent of the North-Eastern Railway eds, and also correspondence with Mr. Roden and to better railway facilities, from which it appeared the number of tickets collected and issued at Ripon 251,609; the number of excursion trains being 62. also been received from Mr. T. S. Mason (Lord Ripon's g that in 1896 the number of visitors to Fountains),448, and in 1897 33,940. Mr. Williamson said that seemed favourably disposed to giving better train ticularly with regard to the extension to Ripon of f the Bradford-to-Harrogate trains. With respect to port between the city and the station, the committee ral schemes before them, and proposed to visit Blackham to inspect the gas and electric trams, but that verruled as being premature. The action of the as confirmed.

meeting of the Lindsay County Council the Clerk r) reported that he attended the public enquiries into on for orders authorising the construction of light Waltham to Saltfleetby, and from Haxey to the arshland line, in the Isle of Axholme, and that the s had decided to recommend the making of orders plications. Mr. Scorer added, with reference to the between Waltham and Saltfleetby, that there was a ade as to running the line on the west side of the road ney and Humberstone, and to that proposal serious s taken on the ground that the frontagers' rights siderably interfered with. He was desired to formuwhich would obviate the difficulty, and this he fors Commissioners. In consequence of that and other ns the promoters were now disposed to carry the line o buy land from the owners adjoining the road so as s line from the side of the road altogether. All objecould be raised on account of the interference with the erefore be obviated. The Council gave their consent ion.

of the Skye District Committee of the County Council shire was held last week at Portree to consider and a motion regarding the levying of an assessment on rict for the promotion of the light railway proposed cted from Uig to Isleornsay. After some discussion motion was carried: "That the County Council of requested to approve of the intention of the Fifth trict Committee to make application to the Light missioners for an order authorising an advance of l sum as can be raised by rate, not exceeding 6d. ed on the valuation of Skye, to the Hebridean Light pany to aid in the construction of the light railways Skye defined on the plans lodged or to be lodged by pany." It was agreed to submit to the Light Railways rs a motion for the deviation of the proposed railway aes instead of going by Sligichan.

ng of the Light Railways Committee of the Stafford- Council in June last an application was submitted oters of the Leek, Cauldon Low, and Hartington ays for a grant by the County Council towards the of Section No. 4—Waterhouses to Hulme End. The which was signed by Mr. Charles Bill, M.P. (on Leek Light Railways Committee), stated that the lway would leave the North Staffordshire line at Junction, about two miles from Leek Station, and erhouses, up the valley of the Hamps and Manifold me End, about 1½ miles from Hartington. The line aterhouses would be of the normal 4ft. 8½in. gauge, h Staffordshire Railway had agreed to assist the underastructing the line so far at their own expense. From to Hulme End, about 7½ miles, the line would be of a e, and it was for the construction of this portion of the line, or Railway No. 4, that a grant was asked for from the County Council. It was explained that the application was based on the section of the Light Railways Act which allowed a county council, if authorised by an order under the Act, to advance to a light railway company any amount authorised by the order. By the draft order lodged with the Light Railway Commissioners, a power was given to the County Council to contribute towards the construction of the railway a sum not exceeding £10,000. Subsequently an application was made to the Treasury for a grant towards the scheme, and the Treasury are now prepared to contribute one-third of the cost of constructing No. 4 railway, such contribution not to exceed £10,000, and to be granted subject to the County Council's contributing £10,000. The application having been considered by the Light Railways Committee of the County Council, they appointed a subcommittee to cause enquiry to be made in the locality respecting the proposals, and to report thereon. The sub-committee held a public enquiry at the Temperance Hall, Leek, on Friday last. The chairman (the Earl of Dartmouth), in closing the enquiry, said the committee were very well satisfied with what they had heard. Though the committee could not hope to draw up a report that would be favourable to all parties, he trusted that in the end the result of this enquiry would be favourable to the majority and of benefit to the district. At a special meeting of the Leek Urban District Council a resolution in favour of a rate for the Leek, Waterhouses, and Hartington Light Railway in the event of a deficiency arising and as a guarantee to the County Council for the proposed loan of £10,000 was passed.

At a meeting of the Parliamentary Committee of the Leeds Corporation on the 3rd inst. the following resolution was agreed to: "That having regard to the proposal of Bradford to include the districts between Leeds and Bradford within their city, and to the fact, as stated at the recent conference with the Bradford Corporation, that they had leased their tramways to a company for a term of which five years have yet to run, and also to the fact that several miles of the projected tramway within the city of Leeds have yet to be constructed, and that, in fact, power to lay the greater length of this line have yet to be obtained, it will not be opportune to hold the conference suggested by the promoters of the light railway until the questions of incorporation have been settled, and the additional tramways, the laying of which will be proceeded with as quickly as possible, have been completed."

FORTHCOMING EVENTS.

FRIDAY, MAY 6.

Royal Institution.—Albemarle-street, at 9 p.m., "Living Crystals," by Edward A. Minchin.

Iron and Steel Institute.—At 10.30 a.m., at the Institution of Civil Engineers, general meeting for discussion of the papers listed in previous issues.

Institution of Junior Engineers.—At 8 p.m., at the Westminster Palace Hotel, "Evaporative Condensers and Independent Air-Pumps for same," by Mr. Harry Fraser.

MONDAY, MAY 9.

Society of Arts.—At 8 p.m., second of a series of four Cantor lectures on "The Electric Locomotive," by Prof. Carus Wilson.

Northern Society.—At Palatine Hotel, Manchester, at 8 p.m. "Electric Elevators," by Mr. W. C. C. Hawtayne.

TUESDAY, MAY 10.

Rontgen Society.—At 11, Chandos-street, at 8 p.m., "Notes on a New Induction Coil" (with demonstration), by Mr. A. Apps, M.I.E.E.; and "Some Notes on Contact Breakers," by Dr. J. Macintyre.

Institution of Junior Engineers.—At 7 p.m., visit to Messrs. Brim's Oxygen Works, Horseferry-road, Westminster, to inspect Dr. W. Hampson's self-intensive refrigerator for gases.

WEDNESDAY, MAY 11.

Society of Arts.—At 8 p.m., "Water Gas and its Applications," by Prof. Vivian B. Lewes.

Royal Society.—Annual conversazione, Burlington House, at 9.

THURSDAY, MAY 12.

Institution of Electrical Engineers.—At Society of Arts, at 8 p.m., the conclusion of discussion on Mr. Andrews's paper, if not finished yesterday; and new papers on "The Registration of Small Currents used for Electric Lighting and other Purposes," by A. H. Gibbings; and on "A Magnetic Balance for Workshop Test of Permeability," by Prof. J. A. Ewing, F.R.S.

Royal Institution, Albemarle-street.—At 3 p.m., the Right Hon. Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S., on "Heat." First lecture of three.

FRIDAY, MAY 13.

Royal Institution, Albemarle-street.—At 9 p.m., "Recent Experiments on Certain of the Chemical Elements in Relation to Heat," by Prof. W. A. Tilden, D.Sc., F.R.S.

Physical Society.—At Burlington House, at 5 p.m., "Galvanometers" (Part II.), by Prof. W. E. Ayrton and Mr. T. Mather.

Electro-Harmonic.—At 28, Victoria-street, at 4.30 p.m., annual general meeting.

told them that some carping busybodies in the West of London had pretended to believe that the Zürich incident had rung the death-knell of the trolley system of electric tramways traction. "Forgive them, monsieur," one said; "they know not what they do. But is it not funny? We inaugurated another electric tramway in Zürich only last week!"—Yours, etc., J. CLIFTON ROBINSON.

Zürich, April 28, 1898.

SOLENOIDS.

SIR,—I am desirous of making three solenoids of the following sizes and powers, and should be very glad of any information regarding the size of iron cores and the number of ampere-turns necessary. One solenoid is required to lift ¼lb. weight 2in. high, with a voltage varying from 95 to 120; another solenoid is required to lift ¼lb. 2in. high, with a current varying from 100 to 800 amperes; and the third is required to lift 20lb. 4in. high, with a current varying from 100 to 800 amperes. If any electrician could give me the desired information (if only approximately) I would be greatly obliged.—Yours, etc.,

Manchester, May 4, 1898. W. H. B.

THE DISTRIBUTION OF ELECTRICAL ENERGY IN PARIS.

BY J. LAFFARGUE.

(Continued from page 523.)

Amongst other generating stations in the interior of Paris there are the works at the Rue de Bondy, those at the Rue d'Alexandrie, those at the Quai de la Loire, and those at the Abattoirs. In the works at the Rue de Bondy there are four Belleville boilers, giving 3,300lb. of steam per hour; three Belleville boilers, giving 4,800lb. of steam per hour; two vertical Weyher and Richemond triple-expansion engines; one horizontal Farcot steam-engine, of 600 h.p.; two Laval turbines, each of 300 h.p. The different steam-engines respectively actuate two Desroziers dynamos, of 97·5 kw. at 130 volts; one Desroziers, of 400 kw. at 130 volts; and two sets of two Gramme machines, of 100 kw. at 120 volts. A battery of 75 accumulators of the Société des Métaux, having a capacity of 2,000 ampere-hours, allows of a discharge of 500 amperes. The works at the Rue d'Alexandrie contain four Belleville boilers, yielding 3,300lb. of steam per hour; two boilers of the same manufacturer, yielding 4,400lb. of steam per hour; five vertical triple-expansion Weyher and Richemond engines, of which four directly actuate a Desroziers dynamo, of 97·5 kw. at 130 volts, at 160 revolutions per minute; and one works by belting a similar dynamo, at 260 revolutions per minute; and a Laval turbine of 300 h.p., working two Desroziers dynamos. The works contain also a battery of 70 accumulators, of a capacity of 2,000 ampere-hours. In the La Villette station there are two Belleville boilers, two vertical steam-engines similar to the above-mentioned of 150 h.p., two Desroziers dynamos of 97·5 kw., and a battery of accumulators of 70 cells yielding 1,400 ampere-hours. The station at the Abattoirs, having machinery of 200 kw. capacity, is specially used to supply electrical energy within the Abattoirs.

The stations of which we have just spoken—those of the Rue de Bondy, of the Rue d'Alexandrie, of the Faubourg St.-Denis, of the Boulevard Barbès, and of the Quai de la Loire—are all connected in parallel for the supply of a distributing network of two conductors. From each of the works proceed a certain number of feeders which are connected at various points with the distributing network. The generating machines of the rotary transformers, or the apparatus in connection with the transformers for diphased currents, receiving the current after transformation, are connected in parallel with the 'bus bars. The distribution is everywhere effected by means of naked copper conductors supported by porcelain insulators within concrete subways.

The Société d'Eclairage et de Force has plant at its works of 4,110 kw. capacity, of which 3,820 is from machines and 290 from accumulators. At the end of 1896 the number of arc lamps for which current was supplied amounted to 3,257, and the number of incandescent lamps was 60,594. The total length of mains extended to 51 km. The total distribution of energy for the year was 1,584,890 kilowatt-hours; the average price was 6d. per unit. The total power used for lighting amounted to 2,450 kw. The motors for various purposes numbered 134, absorbing a total power of 331 kw.; and the motors for working lifts were eight in number, absorbing a total power of 37 kw. The total power installed for the supply of motors was thus 368 kw. This company possesses in Paris, as we have seen, works of but limited capability and extent. These works were initially established in 1888 and 1889, when it was a question of lighting by electricity the Renaissance, the Ambigu, and the other neighbouring theatres. They were afterwards utilised when the concession for distributing electricity was granted in 1889. At that period it was necessary to carry out promptly the electric lighting of the boulevards. At weak points of the sector it was considered sufficient to put up rotary transformers, worked by means of the power transmitted by continuous currents from the St.-Ouen works.

The Société d'Eclairage et de Force has now commenced to adopt another system. It has undertaken the transmission of energy by diphased currents, using the alternators of Hutin and Leblanc, and the special transformers of the same makers. The electrical energy supplied to the Nord and La Chapelle Railways is thus transmitted. We have seen that a similar trial of this mode of transmission has been made at the central station of the Rue du Faubourg Saint-Denis.

La Compagnie d'Air Comprimé et d'Electricité.—At the outset this Parisian company had at their disposal two works—one established at the Boulevard Richard Lenoir and the other Rue Saint-Fargeau. These two stations were supplied with a certain number of 500-volt dynamos connected in series, giving 1,500 volts, and two series were coupled for the supply at 3,000 volts of a network comprising 20 sub-stations with accumulators distributed within Paris. Each sub-station then constituted a special centre for secondary distribution. Only three of these sub-stations are now in existence, and these are still supplied from the works at the Boulevard Richard Lenoir (1,000 kw.) and from those at Saint-Fargeau (1,300 kw.). But these sub-stations are shortly to disappear, and to be replaced by the system of distribution now to be described. It should be mentioned that the high-tension circuit is still connected to a sub-station at present utilised—the St.-Roch sub-station, where it supplies 12 rotary transformers of 80 kw. and four of 40 kw. at 120 volts. There are also two reserve stations, with motors working by compressed air at the Bourse du Commerce and at the Rue des Jeûneurs.

The distribution is at the present time effected in Paris by means of a network of five wires connected at various points to sub-feeders proceeding from the two sub-stations at the Rue St.-Roch and at the Rue Mauconseil. These two sub-stations are themselves supplied each by means of three feeders of 1,000 square millimetres section from the large central station at the Quai Jemmapes (Fig. 5). This station is established on the banks of the Saint-Martin Canal. In front are the offices, and to the left, passing from the ground floor to the second storey, are to be found a repairing shop, a testing-room, and the accumulator-room. The works, properly speaking, consist of an extensive longitudinal wing, which will be of the maximum length of 240ft. when all the machines are installed. The width is 45ft. On the ground floor is the engine-room, which is 36ft. in height. At present it contains five Corliss steam-engines, of the vertical compound type, of 1,200 h.p., constructed by the Société Alsacienne de Constructions Mécaniques at Belfort. These machines, furnished at one side with an enormous flywheel of 31 tons, and with a small auxiliary steam-engine for starting, actuate directly, by means of a star wheel of 39 arms, a dynamo, with external collector and 12 internal fixed poles, giving 750 kw. at 500 volts, with 70 revolutions per minute. Two other similar machines are shortly to be installed. The guaranteed consumption of steam is 15lb. per brake horse-power hour.

The switchboard is fixed at the end of the room, upon a

platform at the height of the first floor. Each machine is provided with a panel, to which are attached the measuring and regulating apparatus. All the instructions are given by means of optical signals, made with incandescent lamps of different colours placed near the machines, and

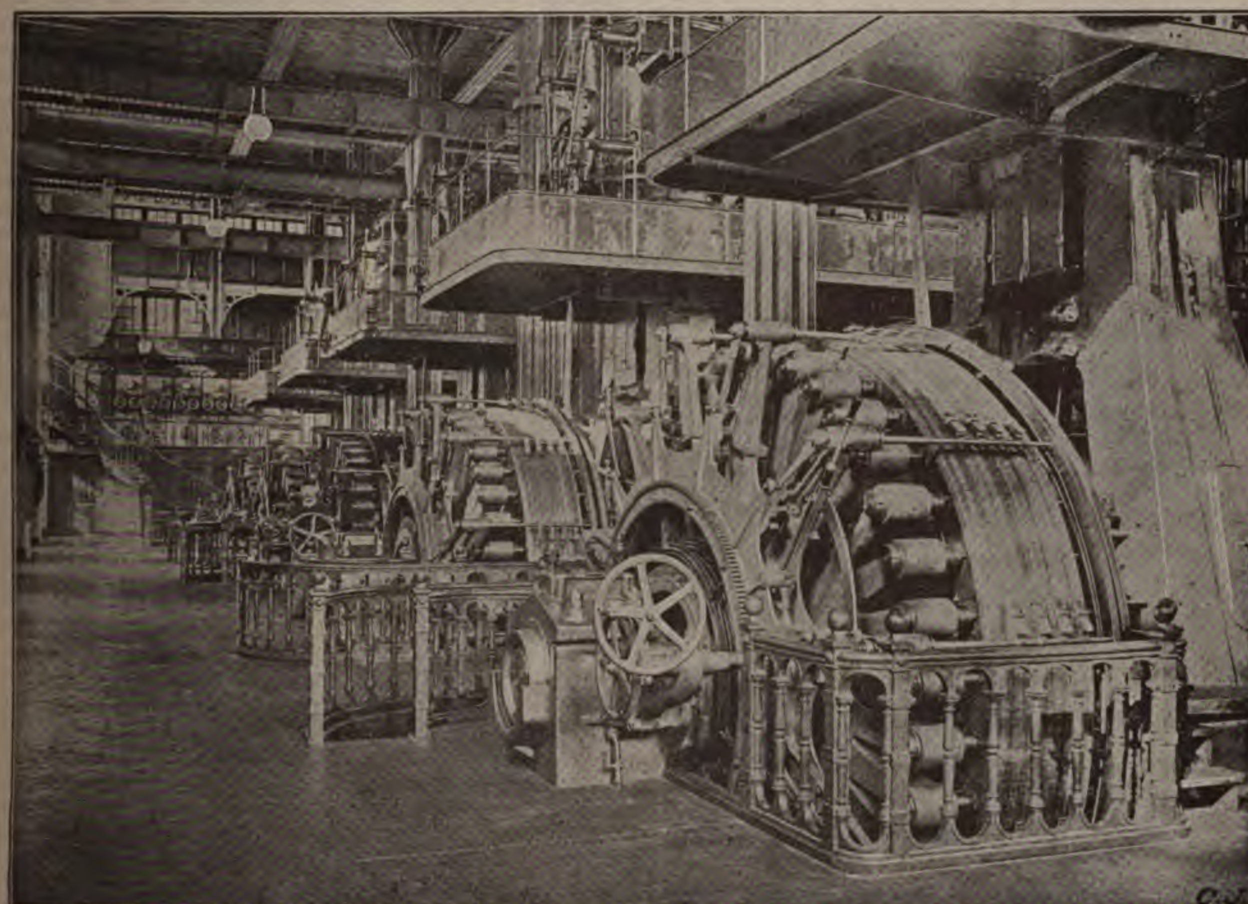


FIG. 5.—Engine-Room at the Quai Jemmapes Station (Parisian Compressed Air Company).

which are lighted or extinguished by the electrician-in-chief according to the switchboard requirements. All the dynamos are connected in parallel, and the switchboard is connected by means of two 'bus bars with the board to

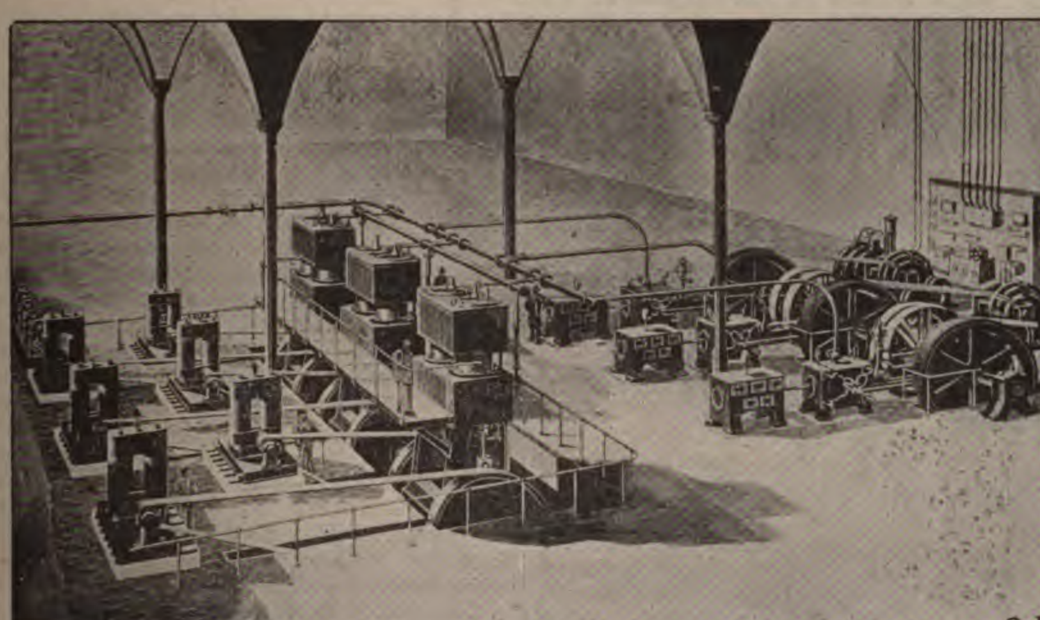


FIG. 6.—Electricity Works at Halles Centrales.

which the feeder terminals are attached. On this board are arranged switches, which allow of the current being transmitted to the feeders either directly or through an adjustable resistance, according to the requirements of the service. On the first floor, above the machine-room, are at the present time installed 20 multitubular Belleville boilers, having a fire-grate surface of 100 square feet, giving, at a pressure of 170lb. per square inch, about 6,600lb. of steam per hour. The 20 boilers are distributed in five sets of four each, each set having its own chimney flue and water-tank. The coal is located in the false roofs above the boiler-room, and is supplied in front of each boiler through hoppers arranged for this purpose.

Parallel with the first building just described is a second building of less importance, having in the basement a gallery from which proceed the cables, and on the ground floor stores and a shop for mechanical repairs. When the works are completed, this last building will be located in the middle; and, on the other side, there will be a building similar to the first-mentioned, and, like it, comprising an engine-room, with 10 engines of 1,200 h.p., and a boiler-room.

The distribution is wholly carried out by means of lead-covered armoured cables, manufactured by the Société Alsacienne de Constructions Mécaniques, of Belfort; they are laid directly in the earth, with a metallic trellis above them to give warning of their proximity. Three feeders, 1,000 square millimetres in section, proceed to the Saint-Roch sub-station, and three others, of the same sectional area, to the sub-station in the Rue Mauconseil.

The Saint-Roch sub-station contains two batteries of 280 Tudor accumulators, yielding 2,000 ampere-hours with a current of 600 amperes; and one battery of 280 cells by the Société des Métaux, yielding 880 ampere-hours with a current of 300 amperes. These accumulators are charged from 12 Thury rotary transformers of 80 kw., and from four of 40 kw. The primary conductors of these transformers are supplied from the high-tension circuit of the Richard Lenoir and Saint-Fargeau works. The secondary circuits are coupled in parallel with the feeders at 500 volts from Jemmapes for the supply of the sub-feeders belonging to the five-wire distribution. The sub-station at the Rue Mauconseil contains four batteries of 280 accumulators from the Société pour le Travail de Métaux, having a capacity of 2,200 ampere-hours with the maximum current of 300 amperes. The starting point of the two stations is at the sub-feeders, with five wires supplying a network of distribution.

The total power at present at the disposal of the Cie. Parisienne de l'Air Comprimé is 3,600 kw. at the Quai Jemmapes works, and 2,325 at the Richard Lenoir and Saint-Fargeau works. At the end of the year 1896 the company had 1,504 subscribers, utilising 1,713 arc lamps and 64,353 incandescent lamps. The motors for various applications were 90, having a total power of 350 kw.; there were in addition 44 electric lifts, absorbing a total power of 130 kw. As we have just seen, this company has completely transformed its system of distribution, and has definitely adopted that with five wires. The two old works are still in existence as well as a few sub-stations, but these are shortly to disappear. In any case, the new central station at the Quai Jemmapes constitutes a really magnificent works which is very well conducted.

The Municipal Works at the Halles Centrales.—The municipal works for the Central Markets were installed in 1889 in the basements belonging to the latter for the purpose of providing electric lighting for the Halles, and also to carry out some tentative distribution outside (Fig. 6). The works contain in the boiler-room six Belleville boilers giving 3,300lb. of steam per hour at the pressure of 210lb. per square inch. In the machine-room there are three vertical Weyher and Richemond triple-expansion engines of 150 h.p. at 160 revolutions per minute. These actuate by belting six Edison bipolar dynamos, yielding 40 kw. at 120 volts at the speed of 600 revolutions per minute. The cables from the machines are first connected to a special switchboard for coupling, and then to a switchboard for the feeders. Two of these supply the lighting to the Halles Centrales, consisting of 245 arc lamps of five and ten amperes and 743 incandescence lamps. The other feeders supply the distributing network established in some of the neighbouring streets to meet the requirements of a few subscribers and those of public lighting, notably that of the square of the Tour St.-Jacques and that of the Boulevard Sebastopol, which has recently been lighted from the Rue de Rivoli to the Rue Etienne-Marcel. The distribution is effected by means of insulated cables carried by lateral insulators within concrete subways, and also by means of lead-covered and armoured cables laid directly in the ground. A trial of distribution by alternating currents has also been made. The installation comprises within the works three horizontal Lecouteux and Garnier engines, of 170 h.p., of the Corliss type, with tandem condenser. The speed is 180 revolutions per minute. Each of these machines actuates by means of belting a Ferranti alternator of 110 kw. at 2,400 volts, working at 530 revolutions per minute. A special countershaft has been installed which allows two steam-engines each to actuate during the day two Desroziers dynamos of 42 kw. at 170 volts for the purpose of charging two batteries of 72 accumulators of the Société des Métaux having the capacity of 2,000 ampere-hours. *(To be continued.)*

QUESTIONS AND ANSWERS.

Under this heading we insert questions and an of a practical character relating to central-station tramway work, or construction work; and for each able question offer *one shilling*, and for the best tion of any question we offer *ten shillings.* We give *five shillings* for every other answer we print. answers to any question should be sent within 10 after the question has appeared, and should be writt one side of the paper only. We would call the att of those sending in answers to the fact that the ne of any sketches sent in is considered when markin relative values of these answers. Questions may b at any time.

QUESTIONS.

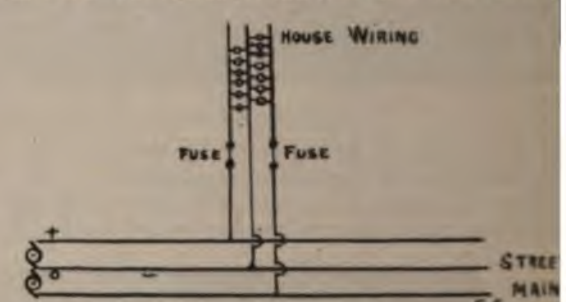
60. What are the relative advantages and disadvantages electric and steam driven boiler feed pump respect Give figures ?—W. W. A.

61. Give details of a test for efficiency and steam consu of any one dynamo or alternator coupled to a engine, selecting a test on which you were pers engaged ?—P. T.

ANSWERS.

Question No. 55.—Large buildings are sometimes wired three mains taken directly from the three mains supply circuit, each house main having its separate If the fuse of the middle house main goes, there is of lamps being burned up if the two sides of the wire supply in the house be unequally loaded. H this danger be best avoided ?

Best Answer to No. 55 (*awarded* 10*s.*).—The only and reliable method of dealing with the problem abolish the fuse on the middle wire altogether. By this, certain safety, at least, is secured against the bu out of the lamps, no matter how unevenly loaded the circuits are. The reason for this is evident from the dia



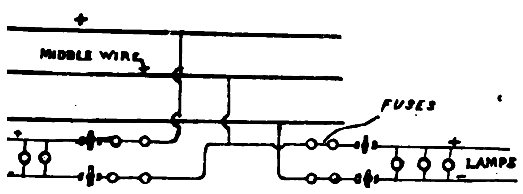
for it will be seen that so long as the middle wire o house service has connection with the middle wire o house wiring, then the pressure between the consu middle wire and either of the two outside wires can exceed that between the neutral and one of the out the street mains, which is, say, 100 volts. The fus the two outer mains are, of course, of sufficient si carry the load on each side of the system respectively in all cases are generally arranged to carry as near possible equal loads. Now, if there were an abn current on one side of the system, the fuse in the main belonging to that side would be blown, thus cu off the supply on that side, whilst the opposite side w be unaffected.

Turning to the original method, with a fuse in middle wire (which fuse would be made the weake would be blown first, and the lamps on the other si the system would receive an increased pressure, wit possibility of being burnt out or blackened. From above considerations it will be seen that by having no in the middle wire, the danger of lamps being burnt o avoided, and that should a short-circuit occur on one it is cut off without disturbing the other, but it mu taken into account that when one side is cut off the m wire has then to carry the full current required b other side, and accordingly should be of sufficient car capacity.—S. J. M.

Answer to No. 55 (*awarded* 5*s.*).—In order to see the lamps can get burned up when the middle fuse suppose there are 10 lamps on between two of the

amps on between the other two; then if there is a of 200 volts between the two outers, there will be s across the 10 lamps and only 20 volts across the hence the 10 will have their filaments burned up. oads on the two sides were fairly equal when the :use went, then the supply would continue prac- naltered. It is only dangerous to the lamps when s are very unequal. The question naturally arises it is necessary to have a fuse on the middle main If the potential of the middle main of the service rere zero or nearly zero, of course there would be for a fuse, but as in practice it is often 50 volts or ove "earth," it is necessary to have one. A bad the centre main is the only cause that would make blow, and although such an event is, comparatively , rare as compared with ordinary short-circuits the mains, yet it would never do to run the risk merely for the saving of the cost of a few Again, as the middle fuse very rarely blows, the to secure the safety of the lamps must be a very .d simple one. Electromagnetic cut-outs to prevent age between the mains ever rising 20 per cent. e normal voltage would be effective, and might be onsidering if for any reason "earths" were often g on the middle main. In ordinary cases, however, ıary trade custom of putting a thicker fuse on the han on the outers is to be preferred. This practice uzzling at first to the theoretical electrician, as he ys been accustomed to consider that the middle r of a three-wire system should have a less section ıer of the outers, and hence, carrying less current, ave a smaller fuse. In order to avoid having lamps ıut it is best to make the middle fuse $1\frac{1}{2}$ times larger than the outer. This rule obtains official in Germany, as the following extract from the wiring rules shows: "In installations on the three- tem the fuses of the middle wire must be $1\frac{1}{2}$ times of the fuses of the outer wires."—J. C. R.

r to No. 55 (*awarded* 5s.).—Where the supply is on e-wire system, it is usual, when wiring large s, to divide the middle wire into two branches, ing its separate fuse and leading off with one of r wires, say the positive, to one floor or section of ling, the other going with the negative wire to section. As shown in sketch, there will be in all



n fuses and switches. Any fuse blowing will only e lamps on its own side, and it can be safely by opening the switch connected with it. Fuses be put in for each lamp or group of lamps, but it s better to divide the middle conductor, as the ıre that some of the lamps will be burnt up before go, not to speak of the trouble of replacing the fuses.—J. K.

No. 56.—Give your reasons for and against the ice of taking pupils in central electric light stations.

Answer to No. 56 (*awarded* 10s.).—The question of ıpils in a central station must be looked at from ts of view—viz., that of the employer and that of —and we will take the case of the employer first, ider the advantages or otherwise of taking pupils. st place, there is the premium, which may be quite ration in a small station. This is taken as revenue companies or corporations, but the usual way is to hief engineer a smaller salary and allow him the of taking pupils. Then there is a saving in wages, t pupil can be put to do testing, etc., in place of a nan; and thirdly, a pupil should make a useful neer when his time is up, as he will know the horoughly, and having learnt all his practical re he can be kept on at a small salary, as he would probably find it difficult to obtain a post elsewhere. The disadvantages of having pupils in a central station are that they cannot be depended upon; they come in at all hours, stay away without leave, and they always want to leave a job before they have learnt to do it properly, besides which they generally spoil a good deal of gear with experiments, and they take up the men's time by asking questions and getting in the way.

Looking at the matter from the pupil's point of view, we find that he has plenty of time to study thoroughly the practical part of electric lighting, and that after he has served his time he is almost certain to be made a shift engineer if he has shown ordinary ability and stuck to his work, as he will be well up in the running of that particular station, and therefore of more use than an outsider. But for all this, to send a boy to a central station as a pupil is certainly not the way to make a good electrical engineer of him, as electric lighting is, after all, only a branch of mechanical engineering; a good general engineering works is the proper place in which to train a lad to be an engineer. There he can go through the different shops, learn how to handle tools and how to deal with different metals, and also the best way to erect or repair machinery, and after he has been four or five years in the shops and two or three years in the drawing office he should (if he wishes to become an electrical engineer) go for a year's course to some good technical school, where he will be taught the theory of electricity and also the use of instruments and how to test mains for insulation, etc. He will then find it an easy matter to get a post as a shift engineer at some central station, as engineers are often taken on who know nothing whatever about electric lighting, as long as they have had good mechanical experience, as this is what the Board of Trade is most particular about. An engineer trained in this way will have a very good chance of getting charge of a station after a few years of shift work, whereas a man who has had all his practical training in a central station is generally looked upon as a mere electrician, and unless he is very smart can only command a small salary. There is not enough engineering in an ordinary station to enable a lad to learn the practical part of mechanics; he will perhaps get a smattering of fitting by assisting in repairs, but will have no opportunity of learning anything about turning, patternmaking, or moulding, and will probably get little or no drawing to do, so that at the end of his pupilage, unless he has made exceptional use of his opportunities, he will be only qualified to take a place as a switchman or wireman, as many a pupil has found to his cost: and even if he really is qualified to take charge of a station it will probably be a difficult matter for him to get a post, as people generally want a man who has been through the shops and had drawing-office experience as well.

Of course, these remarks will not apply to a lad who has got a real talent for engineering, as the way such a lad is trained will make very little difference to his future prospects. At the worst it will only delay him for a year or two, but this talent is only possessed by about one engineer in ten. The majority have to be content to plod steadily along without making any mark in the world, and consequently the way they are trained for their profession is of vital importance; and their parents or guardians should be most careful to let them have as good a training as possible. I would advise anyone who wishes to make his son an electrical engineer *not* to send him as a premium pupil to a central station, but to a works where electrical machinery is made. After he has been through the shops and drawing office there he will probably be sent out to superintend the erection of machinery at new stations, and if he does this well he will very likely have the post of chief engineer offered to him by the electric lighting company or corporation to whom a new station belongs. This is how a very large number of engineers now in charge of central stations, or holding good positions in the electrical world, have obtained their posts.—R. S.

Answer to No. 56 (*awarded* 5s.).—In answering this question, I do not propose to distinguish between the two cases where the central-station authorities (whether a company or a corporation) or the central-station engineer himself

benefit by the premium paid. In some few cases these premiums are allowed to go into the pockets of the central station engineer, though one can only conclude that this is taken into account in fixing the salary of the engineer. The obvious advantage in a premium pupil is the income derived from his annual premium, together with a small saving of from £25 to £50 per annum in the way of salary, which would have to be paid for the work done by the pupil. The disadvantages are, however, equally obvious, and it is at once apparent that one cannot get the same useful work out of a pupil, who has paid to learn what he can and to use the time as much to his own advantage as possible, that one can get out of a paid servant, even if their experience and abilities are equal. In the first place, it is always difficult to rely on a premium pupil for keeping punctual hours; then he will consider himself entitled to days "off" or to somewhat lengthy holidays; and, finally, he is apt to turn up his nose at jobs which do not suit him, and over which he does not consider that he will be learning sufficient. It may be argued that I have given the premium pupil a very bad character, but I think that some of these points are always present—to a greater or less degree—in all pupils that have paid to learn, thus making them "unreliable." There is no doubt but that useful work can be got out of a premium pupil in the way of testing meters, plant, or cables, though they cannot be of much use in the way of running the station itself, or in taking a shift, as it is always risky to entrust expensive machinery to inexperienced men.

The central-station work premium pupils are not of so great an advantage as they are with manufacturing firms. The premium pupil, often a gentleman's son holding a good position in some part of the country, is useful sometimes in filling vacancies as a representative, and is able to be of use to his firm by means of his influence. This point does, however, not tell in his favour when a central station is in question. It is difficult to believe that it can be satisfactory to any supply company to take premium pupils, as far as getting the work done cheaply goes, and I am strongly in favour of paying the pupil a small weekly wage (without a premium), and then being able to rely upon him. The only case in my opinion where a premium pupil should be taken is where an engineer, possibly well up in other subjects, wishes to acquire an insight into central-station work. He can then arrange to be coached by the central-station engineer for a period of six to twelve months, as the case may be, in this work; and as the trouble falls entirely upon the central-station engineer, it would appear to be only fair that he should receive the premium, and look upon the pupil as a private matter. That pupils should go to a central station for periods of two to three years with a view of becoming trained engineers, in some cases straight from college and without any previous shop experience, and should pay a premium for so doing, is waste of time and money to themselves and of little advantage to the central-station authorities.—E. T. F.

Answer to No. 56 (*awarded* 5s.).—In answering this question it is presumed that the querist meant it to be looked at from both points of view—namely, from the standpoint of the engineer and also that of the pupil. Looked at in the former light, the practice has much to recommend it. In small stations, if adopted, both the management and wages' costs can be very much reduced, as probably a good pupil who has had both a college training and has also been in a workshop is quite capable of fulfilling the duties that ordinarily would devolve upon an assistant. In this is included all the testing work in connection with the mains, plant, and general apparatus of a central station; also drawing and clerical work, which from its technical nature could not be performed by an ordinary clerk, work which pupils from their early theoretical training are eminently fitted to perform, and which if not done by them would require the services of a well-paid assistant. If a requisite number of pupils are employed, the services of switchboard attendants can be dispensed with, as in the early stages of a station probably a pupil would perform the duties as well and even better than a paid attendant, because he would have a good theoretical knowledge to help him, whereas the paid man of the type usually obtained (for the wage ordinarily offered) would not have had a very efficient trainin
larger stations, of course, these lines could not be follo
the letter, as the responsibilities in connection with the
of a switchboard attendant, for instance, are too grea
assumed by a young pupil knowing comparatively l
the routine of a central station; but if, say, the engi
charge of each shift has a pupil placed under him, in
of time the latter will become quite fitted to take th
neer's place in the event of his absence. By this
a suitable number of men would always be at hand
into the shoes of the assistants and junior assistants
latter gradually leave, and thus the necessity of brin
perfect stranger into the station would be avoided
although he might be thoroughly competent, it wou
some months to initiate into the ways of the place
salary of the engineer is very suitably supplemente
the premiums of the pupils. Here it might be well t
out the unfairness of the assistant engineer receiv
portion of this, since it is upon him that the greater
the work of teaching the pupils devolves. And,
the system is a legitimate and very suitable met
filling up the ranks of central-station engineers, a
selecting them from any source in the same haphazar
as has prevailed in the past.

Now, viewing the practice from the pupil's point of
It gives him an introduction into a profession
undoubtedly is becoming more and more distinct fro
other branches of engineering, and the routine of
can only be learnt by being actually on its staff. E
an opportunity of learning in a comparatively shor
all the work in the different departments of a
station, which it would take a paid official years
Unfortunately this course is not always consi
pursued, and very often the whole of a pupil's tim
services are utilised on switchboard work or some
comparatively menial job, the manipulation of whic
a very short time he gets thoroughly familiar wit
which very often entails his working at hours which
age are both prejudicial to his health and must nece
debar him from getting an insight into work which
its very nature, can only go on in the daytime—that
outside work and the managerial portion of the eng
duties. If, on the other hand, a pupil gets with a
neer who takes an interest in him, and who gras
fact that the more pains he takes with him the more
he will ultimately be to himself, then probably both
will benefit very materially, and the pupil will get
which he could not possibly obtain by any other me
F. S. B.

MUNICIPAL ELECTRICAL ASSOCIATION

The following is the official report of the meeting
association held at the Westminster Palace Hotel, S.
Monday, April 25, to consider and report upon the
having the attention of a Joint Committee of the two H
Parliament:

The PRESIDENT, in opening the meeting, expressed
that the notice sent out had been so short, but the cla
consideration were so important that it was absolutely ne
the matter should have immediate attention. He the
upon Alderman Higginbottom, of Manchester, who had
a very considerable amount of time to the subject to
sidered, and who would be able to give them, he was
very clear explanation of the effect of the clauses.

Alderman HIGGINBOTTOM then carefully explained the
to the association, and explained the course which ha
taken by Manchester, Glasgow, Nottingham, Sheffie
several other Corporations who were represented by
before the Joint Committee.

The PRESIDENT then said he would put the clauses
one to the meeting, and would ask them to consider t
separately.

Clause 1.—"Whether, notwithstanding the provis
Section 12 (1) of the Electric Lighting Act, 1882, power
be given in any case for acquiring land compulsorily for
ing stations; and, if so, under what conditions as
liability for nuisance, notices to surrounding owners, an
wise."—Resolved, that powers for acquiring land comp
were desirable, and that such powers should not be
with special conditions as respects liability for nuisance e
as provided for in the Railway Acts.

ɛ 2.—"Whether compulsory powers of acquiring land erating stations, if proper to be given in any case, should n where the proposed site is not within the area of "—Resolved, that compulsory powers of acquiring land erating stations should not be given without the consent he local authorities affected.

ɛ 3.—"Whether, in case of a generating station, how- quired, not being situate within the area of supply, power be given for the breaking up of streets between the ing station and the boundary of the area of supply."— d, that compulsory powers for opening up streets the generating station and the boundary of the area ly should not be given without the consent of all the thorities affected.

ɛ 4.—"Whether powers should be given in any case for ply of electrical energy over an area, including districts erous local authorities, involving plant of exceptional ons and high voltage; and if such powers may properly n, whether any and what conditions should be imposed: respect to system and plant, and to the construction ation of generating stations in view of the powers of e conferred upon local authorities by Sections 2 and 3 Electric Lighting Act, 1888; (b) with respect to the s of the promoters to other undertakers and to local ties within parts of the area."—Resolved, that no powers be given for the supply of electrical energy over an area g districts of numerous local authorities without the of the local authorities affected, and that no special ns are required, as the Board of Trade have all powers ry.

ɛ 5.—"Under what conditions (if any) ought powers to erred upon promoters seeking to supply electrical energy r undertakers and not directly to consumers."—Resolved, wers should be conferred upon promoters to supply l energy to other undertakers by agreement.

s further resolved that a witness be appointed to appear the Joint Committee to represent the views of this ion as expressed at this meeting, such witness to be l by the council.

Gibbings, the president of the association, was appointed council to represent the views expressed at the meeting.

T. PANCRAS ELECTRICITY ACCOUNTS.

following is the report of Mr. Albert E. Pycraft, lerk to the St. Pancras Vestry, on the working of ctricity and public lighting department during the ear. The revenue account, general balance-sheet, atement of electricity generated, sold, etc., are also led:

g the year a sum of £9,485 was received from the London Council, making a total amount of £162,485 received up to , 1897. Since that date a further sum of £22,425 has been d. The total expenditure on account of capital amounts to 0. 18s. 4d. The expenditure during the year was £28,457. . Against this a sum of £4,046. 18s., in respect of the land rred to the dust destructor works, and other credits, have ceived, thus reducing the amount for which an additional required to £23,555. 7s. 11d. The gross revenue for the ounts to £33 347. 19s. 11d., being an increase over the year £6,258. 3s. 6d.; the not profit amounts to £6,517. 19s. 9d.; after writing off the deficit of £800. 12s. 7d. brought from aves a net profit to carry forward of £5,717. 7s. 2d. The g table shows succinctly the progress since the commence- f the electricity undertaking:

Regent's Park Station.

No. of con-sumers	Current sold to consumers (not including public street-lighting). 3d. per unit. £	s.	d.	5d. and 6d. per unit. £	s.	d.	Lamps, etc. applied for. Incan-des-cent. 16 c.p.	Arc.	Mo-tors.
172	—			8,167	7	8	9,990	82	11
238	384	11	6	9,161	6	0	12,851	110	19
349	1,236	13	9	10,819	15	9	15,532	129	22
447	2,142	9	6	12,682	6	0	19,195	139	37
530	2,490	12	9	16,064	4	5	21,511	151	44
615	3,226	6	9	19,878	9	5	23,988	187	65
King's-road Station.									
142	458	2	0	3,366	4	3	4,912	36	3
193	855	3	3	5,342	2	0	8,262	69	13

GENERAL BALANCE-SHEET.

Liabilities.	£	s.	d.
account—amount received as per account	162,485	0	0
loan from bankers	47,711	18	10
creditors	3,667	2	0
due under contracts	7,565	0	0
accrued on loans	1,640	6	9
ue account	5,717	7	2
	£228,786	14	9

Assets.	£	s.	d.
Capital account—amount expended for works	210,690	18	4
Stores in hand at Dec. 31, 1897: coal, £203. 15s. 2d.; oil, waste, etc., £139. 19s. 5d.; carbons, £34. 8s.; general, £4 623 11s.	5,001	13	7
Debtors for current supplied to Dec. 31, 1897, £12,552. 0s. 3d.; less deposit account, £140. 10s.	12,411	10	3
Sundry debtors	545	0	1
Sundry items (in suspense)	89	7	0
Cash in hand	48	5	6
	£228,786	14	9

REVENUE ACCOUNT.

Dr.	£	s.	d.	£	s.	d.
To Generation of Electricity.						
Coal or other fuel, including carriage, etc.	£5,321	13	10			
Oil, waste, water, and engine-room stores	593	0	6			
Proportion of salaries of engineers	440	0	0			
Wages at generating stations	2,696	19	3			
Sundry petty expenses	88	5	7			
Repairs and maintenance: buildings, £267. 3s. 8d; engines, boilers, etc., £899. 6s. 2d.; dynamos, exciters, accumulators, etc., £342. 19s. 3d; other machinery, instruments, and tools, £134. 12s. 8d.; less received for old materials, £5. 10s. 7d.	1,638	11	2			
				10,778	10	4
To Distribution of Electricity.						
Proportion of salaries of engineers, etc.	351	2	5			
Wages of outdoor staff	490	14	7			
Repairs, maintenance, and renewals of mains of all classes, including materials and labour	3,271	2	10			
Repairs, maintenance, and renewals of meters, switches, fuses, and other apparatus on consumers' premises	238	2	3			
Water, etc., at sub-stations	10	17	5			
Repairs of apparatus at sub-stations	5	12	6			
				4,367	12	0
Public Lamps.						
Carbons and attending	446	0	10			
Repairs	104	5	8			
				550	6	6
Licenses and wayleaves				25	13	6
To Rents, Rates, and Taxes.						
Rents payable	111	1	2			
Rates and taxes	470	5	2			
				581	6	4
To Management Expenses.						
Salaries—engineer's department and clerical staff	971	11	2			
Stationery and printing	279	16	3			
General establishment charges	300	15	9			
				1,552	3	2
Law and parliamentary charges				17	4	8
To Special Charges.						
Insurances, etc.	189	9	3			
Expenses testing meters	2	15	0			
Expenses obtaining loans	65	8	0			
Cost of commemorative tablet, disallowed by London County Council	136	15	0			
Expenses of rewinding consumers' motors	79	17	6			
				474	4	9
Total expenditure				18 347	1	3
Balance carried to net revenue account				15 000	18	8
				£33,347	19	11

Cr.	£	s.	d.
Sale of current per meter at 6d. per B.T.U.	24,320	14	0
Ditto at 5d.	899	17	5
Ditto at 3d.	4,081	10	0
	29,302	1	5
Public lighting	3,704	8	4
Work done on consumers' premises	6	0	0
Special chargeable works	46	14	3
Fees for testing installations	5	10	0
Rents receivable	24	7	3
Proportion of office expenses chargeable to the lighting (gas) department	258	18	8
	£33,347	19	11

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC., DURING 1897.

Regent's Park Station.

Quantity generated (in Board of Trade units)		1,404,806
Quantity sold: Public lamps	177 812	1,231,894
Quantity sold: Private consumers (by meter)	1,054,082	
Quantity used on works, etc.		50,388
Total quantity accounted for		1,282,282
Quantity not accounted for		140,211
Number of public lamps		97
Total maximum supply demanded (amperes)		16,800

King's-road Station.

Quantity generated (in Board of Trade units)	442,376
Quantity sold (to private consumers by meter)	288,460
Quantity used on works, etc.	65,120
Total quantity accounted for	353,580
Quantity not accounted for	71,079
Total maximum supply demanded (amperes)	5,070

HUDDERSFIELD ELECTRIC LIGHTING ACCOUNTS, 1897.

REVENUE ACCOUNT.

Dr. Generation of Electricity.		£ s. d.
Coal and other fuel	£900 12 2	
Oil, waste, water, and engine-room stores	104 12 7	
Wages at generating station	873 18 9	
Repairs and maintenance: buildings, £48. 17s. 2d.; engines and boilers, £218. 17s. 10d.; machinery, instruments, tools, etc., £232. 1s. 11d.	499 16 11	
		2,379 0 5
Distribution of Electricity.		
Wages	73 1 8	
Repairs—Mains and services	183 2 3	
Transformers, meters, and other apparatus	73 14 8	
		329 18 7
Attending and repairs to public lamps		75 2 4
Rents, Rates, and Taxes.		
Rents	63 6 7	
Rates and taxes	248 2 0	
		311 8 7
Salaries and Management.		
Borough fund, proportion of salaries	120 0 0	
A. B. Mountain, electrical engineer	341 13 4	
Percy Dunn, outside assistant	104 0 0	
J. A. Swift, clerk	78 15 0	
Deputation expenses	71 1 9	
Stationery, printing, and advertising	88 15 4	
General establishment charges	187 7 10	
Insurances, etc.	9 9 0	
		1,001 2 3
		4,096 12 2
Balance carried to net revenue account		4,963 19 11
		£9,060 12 1

Cr.	£ s. d.
Sale of current per meter at 6d. per B.T.U.	7,879 16 5
Ditto at 2½d. per B.T.U.	66 15 3
Sale under contracts	152 0 0
Public lighting	434 18 1
	8,533 9 9
Rental of meters and other apparatus, £458. 7s. 5d.; sale and repairs of lamps, etc., £68. 14s. 11d.	527 2 4
	£9,060 12 1

BALANCE-SHEET.

Liabilities.		£ s. d.
Capital account—amount raised by loans		69,000 0 0
Sundry creditors—on open accounts, £4,015. 5s. 5d.; discounts (estimated), £287. 1s. 8d.	£4,302 7 1	
Reserve for bad debts	35 3 11	
Depreciation account—balance transferred	1,618 9 1	
		5,956 0 1
		£74,956 0 1

Assets.		£ s. d.
Capital account—amount expended for works		69,414 14 2
Stores on hand Dec. 31, 1897: fuel, £41. 7s. 6d.; oil, waste, etc., £14. 2s.; general stores, £177. 11s. 6d.	233 1 0	
Sundry debtors for current supplied, half-year to Dec. 31, 1897, £5,154; and for fittings, services, etc., £136. 3s. 5d.	5,290 3 5	
Cash in engineer's hands	18 1 6	
		5,541 5 11
		£74,956 0 1

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			632,046
Quantity sold	Public lamps	43,309	438,848
	By contract	15,733	
	Private consumers by meter	379,806	
Quantity used on works			17,407
Total quantity accounted for			456,255
Quantity not accounted for			175,791
Number of public lamps	Arc		22
	Incandescent		54
Total maximum supply demanded in B.T. units			636

WORCESTER ELECTRIC LIGHTING ACCOUN

The accounts of the electricity department o Worcester Corporation for the year ended Dec. 31, have just been published, from which we extract the re account, general balance-sheet, and statement of elect generated, sold, etc. An abstract of Mr. E. T. Ru Murray's report to the Electricity Committee on the of the department during the year is also appended:

REVENUE ACCOUNT.

Dr. Generation of Electricity.	£
Coal	£1,327
Oil, waste, and engine-room stores	144
Wages at generating station	957
Repairs to buildings, plant, and machinery	613
Distribution of Electricity.	
Wages of linesmen, fitters and labourers	51
Repairs, maintenance, and renewal of mains	1
Repairs and maintenance of transformers, meters, etc.	1
Repairs, maintenance of apparatus at distributing stations	5
Attending and maintenance of public lamps	341
Rents, Rates, and Taxes.	
Rents	37
Rates and taxes	49
Management Expenses.	
Salaries—engineers' department	361
Stationery and printing	57
General establishment charges	47
Special Charges.	
Insurances	18
Lamps	79
	4,096
Balance carried to net revenue account	2,195
	£6,291

Cr.	£
Sale of current per meter at 1½d., 2d., 2½d., 3d., 5d., and 6d. per Board of Trade unit, £4,804. 11s. 5d.; less discounts, £121. 18s. 3d.	4,682
Public lighting	1,285
Rental of meters and other apparatus on consumers' premises	192
Carbons	3
Rent of water-mill at Powick	50
Rent of cottages	29
Old casks, iron, and firebars	7
Contribution towards cost of removing lamp opposite Lloyd's Bank	10
In settlement of the Council's claim for accident to boilers	50
	£6,291

GENERAL BALANCE SHEET.

Liabilities.	£
Capital account—amount received	62,569
Sundry creditors	1,741
Sinking fund account	4,270
Treasurer	6,912
	£75,492

Assets.	
Capital account—amount expended for works	67,293
Stores on hand Dec. 31, 1897: coal, £55. 5s.; oils, waste, and engine-room stores, £152. 6s. 2d.; carbons, £84. 6s. 3d.	291
Sundry debtors for current supplied to Dec. 31, 1897	1,718
Public lamps	325
Other debtors	118
Sinking fund account	4,270
Net revenue account—balance, being deficiency on revenue account	1,474
	£75,492

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			[illegible]
Quantity sold	Public lamps	83,700	[illegible]
	Private consumers by meter	325,130	
Quantity used in works			
Total quantity accounted for			[illegible]
Quantity not accounted for			[illegible]
Number of public arc lamps			
Number of public incandescent lamps			
Total maximum supply demanded (kilowatts)			

MR. RUTHVEN-MURRAY'S REPORT.

In submitting the following report on the progress made the third year's running of the electricity works, I have f the precedent set in my former reports by appending an a of the accounts, which is printed this year so that a comp may be made with the results obtained in the two preceding Additional tables are also added containing information wh prove of interest. During the past year, as usual, the pl been maintained in thorough order, all necessary repairs

id for out of revenue. The item of £613. 6s. 9d. for 's to buildings, plant, and machinery," appearing under "To Generation of Electricity," includes the sum of £50 irs to the boilers, and as this was recovered from the nsurance Company, I have entirely neglected it in my , since it has no place among the costs. In March, 1895, ent occurred to one of the turbines at the works. The of the Council's liability to pay the cost of repair mitted to Mr. W. H. Preece, who, at the end of last warded the contractors their claim of £295 15s. 3d. h this item legitimately belongs to the 1895 accounts, vertheless included, but in drawing comparison between ts of 1897 and 1896, it must be omitted in order n the true cost figures. The actual cost of repairs and ance for the year was £267. 11s. 6d., or ·149d. per unit igure comparing very favourably with that of other works, ch includes for the first time the wages of a permanent with the increased output it became necessary to keep rder to maintain the plant in the highest state of efficiency. orks' cost per unit sold for the past year was 1·55d. against ner year's 1·53d., an increase of ·02d., or, including the repairs previously referred to, 1·70d., an increase of ·17d. . The total cost per unit was 1·91d., excluding turbine comparing with 2·26d., a decrease of ·35d. per unit, or g the 1895 repair bill 2·06d., against 2·11d., a decrease of Both works' and total costs compare most favourably with taining in other high-tension stations.

greater consumption of fuel during last year is mainly ble for the higher works' cost, and it at first sight appears ical that while so many more units were generated by ower, the coal account should have increased. The follow- e explanation: By reason of an increased private day load lic lighting load, extending daily over many hours, it was to use more water power when the supply was plentiful, ecessitated more steaming on low loads when the limits of er power were exceeded, or when no water could be l. During the fall of the year, when the flow of water was nally small, the percentage of steaming hours and steam- ed units became very high. Owing to the engineers' strike stoppage of work, we were unable to get any of the exten- nt which was ordered last year. The day-load engine, as more than ever required, has only just been delivered. ent upon the increase of the mean load and the small flow , the steaming hours increased from the previous years cent. to 45 per cent. of the total, and the cost of coal steam unit generated from 1·06d. to 1·32d. With the ll engine at work, I look forward with confidence to a n in this figure for the present year. As the works have ken to the water, fuel has also to follow, and at a moderate the extra cost for increased railway dues and cartage on 2 tons of coal used was £127, which should of course be d from the revenue derived from the water power. It so be noted that the above sum represents 6 per £2,100. The increase in units sold last year amounts per cent., of which increase 50·9 per cent. was supplied ic lamps and private day load, the private lighting owing an increase of 23 per cent. over last year's, per cent. of the total increase. The waterworks motors ·22 per cent. fewer units than in the previous year. the price obtained for public lamps and motor units is low the average derived from private lighting, and because pplies take during the greater part of the year all the at can be generated by water, it follows that the revenue r-generated units averages less that for steam-generated nce the greater proportion of the private lighting is done n power. I estimate the value of the revenue derived from er power during 1897 at £1,880.

g last year 50 additional consumers were connected to the with 2,754 additional lamps (32 watt 8 c.p.) Doubtless ration in tariff deterred some people from coming on who d to wait and see how it worked, whilst, as we were absolutely without spare plant, we were compelled to as few additional lamps as possible. Free wiring did not ce for the same reason; but the company with whom we agreement have now commenced work in the city, and ope, be kept very busy as soon as the public know that emises will be fitted up completely for electric light free itial cost. The average price obtained per unit sold is gainst the previous 3·06d. The waterworks units were irst quarter in 1896 supplied at 1d., this explains the small 15d. per unit. Public lamps returned 2·12d., against 2·8d., se of nearly ¾d. per unit; and I should like to call special o this, as showing at how much less cost compared with eased light the streets are being lighted.

ugh the private consumer's consumption has increased out roportion to the extra lamps wired, the average price has not yet fallen. I hope to see this average price , as it will prove that the proportion of consumers who the higher rate, and on whom we are losing money, is g smaller. As the principle of the new system of charge been generally understood, and as it has been stated that charge is too low, I would again point out that the of the average price obtained is not proof that we are g under cost, as has been urged, since whether a profit or ade depends entirely on the length of time the supply is he number of units consumed per maximum lamp demanded. s sold at 6d. cost 8d. and upwards, whilst those sold at under ¾d. I am strongly in favour of an alteration in such alteration must be to charge the short-hour user re nearer the cost of the supply, so that the loss incurred on such shall not be borne by the profitable consumer, as is now the case.

The gross profit on the year's working of £2,195 represents nearly 3½ per cent. on the average amount of capital employed throughout the year, and is more than sufficient to pay interest on loans. The net deficiency, after setting aside for sinking fund, is £1,474. 10s., representing an average loss of ·82d. per unit sold, as against 1·16d. last year.

Under the heading of "Units accounted for" the Board of Trade requires a statement of units generated neither sold nor used in the works; but though so designated it is not difficult to analyse where these go. The whole of these units perform work in the system either by magnetising iron in transformers (the machines used for converting energy at a higher pressure to a lower one or *vice versâ*) or meters, so as to increase the sensitiveness in registering a very small proportion of their full load current, or in overcoming the resistance to the transmission of energy in the mains or other conductors. Transforming losses are inherent to any high-pressure system, are continuous while the converters are on circuit, and alter very little with variation of load. Similarly in meters the "shunt" losses continue throughout both day and night. The losses in the high and low tension mains and transformer windings only occur when current is flowing, and vary directly with the increase. In a high-tension system main losses are usually lower than in a low-tension one, although the latter has no transformation losses, which in our case represent an average equivalent to 14 e.h.p. continuously. Having been asked to explain where the lost energy went, I have endeavoured to do so as simply as possible. To avoid the transformation losses increasing to a higher percentage than at present is a problem which I see no great difficulty in solving, when, by reason of the tramways being operated electrically, and an increased demand for lighting, more plant is required, which will, of course, be laid down in the city in order to avoid the expense inseparable from taking coal so far to the works.

The extensions are now progressing satisfactorily. The new boilers are erected, as also the steam-pipes, but the large steam alternator will not be ready to leave the builders' works for some weeks yet.

UNITS GENERATED BY STEAM AND WATER POWER, WITH PERCENTAGES FOR 1897.

Month.	Total units.	Steam.	Water.	Steam. Per cent.	Water. Per cent.
January	63,323	26,940	36,383	42·5	57·5
February	51,494	25,234	26,260	49·1	50·9
March	47,056	22,013	25,043	46·8	53·2
April	44,394	5,261	39,133	11·9	88·1
May	37,894	3,663	34,231	9·7	90·3
June	30,805	7,855	22,950	25·5	74·5
July	29,900	21,138	8,762	70·4	29·6
August	30,866	25,129	5,737	81·4	18 6
September	39,564	32 629	6,935	82 5	17·5
October	52,440	42,897	9,543	81·8	18·2
November	62,352	48,163	14,189	77·3	22·7
December	69 187	37,688	31,499	54·5	45·5

ABERDEEN ELECTRIC LIGHTING ACCOUNTS.

The electric lighting accounts of the city of Aberdeen for the past year have just been published by the Corporation. We give herewith the revenue account, balance-sheet, and statement of electricity generated, sold, etc.:

BALANCE-SHEET.

Liabilities.	£	s.	d.
Capital account—amount borrowed on mortgage	44,068	0	0
Amount of temporary loans	1,000	0	0
Sinking fund—balance unapplied	17	18	6
Reserve fund	428	14	8
Amount due to sundry creditors	831	9	10
Amount deposited in security for current	52	0	0
Balance due to bank	3,273	13	5
	£49,671	16	5

Assets.	£	s.	d.
Capital account—amount expended on works, £48,423. 4s. 5d.; less depreciation written off, £2,864. 12s. 8d.	45,558	11	9
Sundry debtors for current supplied to Dec. 31, 1897, outstanding, £3,171. 15s. 8d.; ditto for service lines, etc., £90. 11s. 9d.	3,262	7	5
Stores on hand at Dec. 31: coal, £6. 6s.; oils, waste, etc., £40. 12s. 1d.; engine spares, cable, etc., £550. 16s 2d.	597	14	3
Reserve fund invested	253	3	0
	£49,671	16	5

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		317,552
Quantity sold — Public lamps	15,310	287,072
Quantity sold — Private consumers, by meter	271,762	
Quantity used in works		6,524
Total quantity accounted for		293 596
Quantity not accounted for		23,956
Percentage		7·54
Number of public lamps		22
Price of electricity per Board of Trade unit		5d., 6d., 3d.

Dr. Revenue and Expenditure Account.	£	s.	d.
Fuel	451	4	10
Oil, waste, water, and engine-room stores	145	19	11
Wages at generating station	554	4	11
Repairs on buildings	64	8	1
Repairs on plant	286	2	4
Main and service repairs	147	3	8
Meter repairs	10	4	11
Rents and feu-duty	58	6	4
Taxes	343	18	3
Management	82	18	0
Salaries	223	15	0
General establishment charges	96	19	6
Stationery and printing	100	8	0
Insurance	19	11	12
Inspector's wages	5	14	6
Bad debts	5	12	5
Balance carried to net revenue account	3,111	0	7
	£5,707	12	5
Cr.	£	s.	d.
Sale of current per meter	5,373	9	11
Public lighting	256	11	3
Rental of meters	77	11	3
	£5,707	12	5

COMPANIES' MEETINGS AND REPORTS.

CITY OF BIRMINGHAM TRAMWAYS COMPANY, LIMITED.

The annual general meeting of the City of Birmingham Tramways Company. Limited, was held last week at the Grand Hotel, Birmingham, Mr. James Ross presiding.

The **Chairman**, in the course of a lengthy speech, said: The statement of the Company's accounts had been submitted to you, and it is pleasing to have to record that our financial results are so satisfactory, in spite of the fact that our endeavours to improve the system, in accordance with the agreement we had with the city, have hitherto been frustrated by the Committee of Public Works and the Council. What we had proposed to construct was an electric system with the overhead wire, and eight miles of the electric conduit system in the central parts of the city. What the committee and Council agreed to give us was an overhead system with probably not more than 10 miles of conduit, and with this we were satisfied. In consequence of this resolution the Company had been reconstructed, for the purpose of working the tramways on new leases for 21 years and for the substitution of an improved motive power. Subsequently the Council insisted upon the wires being laid underground. After giving details of the correspondence between the Council and the Company, he said that in preference to entering upon what would undoubtedly be a long and costly lawsuit with the Corporation, they had better exercise patience and rely rather upon the exercise of a just and fair desire to give effect to the previous resolution of Council of July, 1896, in the spirit in which it was passed and in which they accepted it.

A resolution confirming the latter course of action was approved by the meeting.

The *Birmingham Daily Post* says: "The members of the City Council have naturally been greatly exercised by the statements made by Mr. Ross, chairman of the City of Birmingham Tramways Company, at the annual meeting on Friday last, and the subject was a good deal canvassed by them in the lobbies of the Council House before and after yesterday's meeting of the Council. Members of the Public Works Committee, questioned by our representative, denied very explicitly their knowledge of any permission, verbal or otherwise, being given to the directors of the tramway company to proceed with the provision of plant for the installation of overhead electric traction upon the Sparkbrook and Small Heath routes. Members of the committee were also emphatic in their contention that nothing had been done committing the Council to the approval of the overhead system. The chairman of the committee (Sir James Smith) was rather less communicative. He, however, thought it desirable to call together his colleagues upon the Public Works Committee at the close of the Council meeting, and they were closeted for an hour or more in the city surveyor's office. The Lord Mayor was amongst those present, and the town clerk also attended the meeting. At the close of the meeting, Sir James Smith informed our representative that there was 'nothing to communicate.' Asked as to the question of the alleged 'verbal permission' to the tramway company, Sir James said he could give us no information. We understand, however, that the subject mentioned was the principal topic of the hour's discussion, and that denials were made all round of anything which could be interpreted in the sense indicated. The town clerk was instructed to write to Mr. Ross asking him for specific information as to the person and occasion on which the permission was given. The desirability of making an early report to the Council on the whole question of the tramway negotiations was generally recognised, and the committee will probably meet in a few days to receive Mr. Ross's reply and agree upon their report. Councillor Bisseker, referring to the course of the negotiations, says: 'Many times the Company were asked for their plans and suggestions, but for months nothing could be obtained in writing. Interviews were held, at which various methods were talked over, and on one occasion it was suggested that two routes should be fitted out for the committee to see, one overhead and one partial conduit and overhead combined, b
committee could not accept this until the actual recommend
of the Company were placed in writing before the comm
The Company said they would order the material for such r
I remember distinctly that they were told they would do so on
on their own responsibility, until the motive power had
decided upon by the committee.'"

EASTERN EXTENSION, AUSTRALASIA, AND CHI TELEGRAPH COMPANY, LIMITED.

The report of the directors for the half-year ended De
1897, states that the gross receipts, including Government
sidies, amounted to £275,142, against £325,405 in the pr
year. The decrease is accounted for by the reductions of tari
the falling off of Australasian traffic. The expenses, incl
£30,956 for repairs to cables, absorb £102,844, against £10
leaving a balance of £172,297. After deducting income
interest on debentures, debenture stock, and contributi
sinking fund, etc., the net profit for the half-pear is £135,13
with the sum brought forward shows an available balan
£169,944. A dividend of 1¼ per cent. is now proposed, pa
on the 12th prox., making, with the interim dividends al
paid, a total dividend of 5 per cent. A bonus of 4s. per sha
2 per cent., is also proposed, making a total distribution of
cent. for the year 1897. The balance of £57,444 has been
ferred to the general reserve fund.

WEST COAST OF AMERICA TELEGRAPH COMPA LIMITED.

The report for the year 1897 states that the gross incom
£25,773. Owing to depressed state of the trade, and the ni
industry especially, the traffic receipts were small, but the in
of the Company was sufficient to provide for the working exp
(£19,476) and the interest on the 4 per cent. debentures, leavi
balance of £297 to be carried forward.

OSWESTRY ELECTRIC LIGHTING AND POWER COMP LIMITED.

The annual report of the directors for the year ending De
1897, states that the net profit amounts to the sum of £134. 4s.
out of which it is proposed to place £15 to a reserve fund, a
pay a dividend at the rate of 2½ per cent. upon the paid-up ca
leaving a balance of £2. 8s. 8½d. to be carried to next acc
The directors report that the demand for current is st
increasing, while the percentage of the cost of generatio
distribution of electricity upon the receipts from customers i
than last year. The directors retiring by rotation are M
Wynne Corrie and Mr. E. Bremner Smith, who are eligib
offer themselves for re-election. The auditors, Messrs. Wi
and Nicholson, also retire, and are eligible for re-election.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Namur.—Tenders are invited for the construction of an s
to the central station. Specifications, etc., are to be ob
from W. Weens, rue Leopold No. 5, at 5d. Tenders by May

West Ham.—The Council invite tenders for electr
standards, etc., required for their public buildings situa
the county borough of West Ham. Full particulars app
our advertising columns. Tenders by May 10.

Madras.—The Secretary of State for India in Council ann
that the time allowed for the receipt of tenders by the
Engineer for Irrigation, Madras, for the utilisation of
power of the Periyar Lake has been extended from Oct. 31,
to July 1, 1898.

Colwyn Bay.—The Urban District Council invite tend
connection with the lighting of their new promenade by elect
for steam engine and boiler (or gas-engine), dynamo, switch
cables, etc. Tenders by May 9.

Madrid.—Tenders are invited for the construction and w
of an electric cable between Cadiz and Havana, vid Teneri
the island of Visques. The deposit required is 150,000 p
Specifications, etc., are to be obtained from, and tenders ad
to, the Colonial Office, Madrid, by May 16.

St. Helens (Lancs.).—The Health Committee invite tend
the erection of destructor shed, new pail shed, electric
engine-house, chimney, weigh-house, offices, etc. Plans, etc
be obtained on and after May 6 on application to Mr. Ge
Broom, M.I.C.E., the borough engineer, on payment of
which will be returned on receipt of bona fide tender. T
by May 25.

London, E.C.—Tenders are invited by the Great
Railway Company for the supply of stores, including, among
articles, telegraph materials and indiarubber. Forms of
may be had on application to the Secretary's Office, Liv
street terminus, E.C., and patterns may be seen
Company's Stores, Stratford, between 10 a.m. and 4 p.m
May 5 to 7, and from May 9 to 11 inclusive. Tenders
Secretary by May 12.

Newcastle.—The report of the special committee appointed to consider the desirability of the Corporation undertaking the provision of the electric lighting recommends negotiation with the Newcastle and District Electric Lighting Company, Limited, and with the Newcastle Electric Supply Company, Limited, for the purpose of ascertaining upon what terms the two companies would sell their undertakings to the Corporation. The report will be considered at a future meeting.

Dissolution of Partnership.—The partnership between Messrs. Frederick Charles Geary and John Hall, trading as electrical engineers at Swadlincote, under the style or firm of Hall, Geary, and Co., and at 164, Corporation-street, Birmingham, as the Birmingham Electrical Accessories Company, has been dissolved by mutual consent. We are informed that all debts due to and owing by the late firm will be received and paid by Mr. John Hall, and the business carried on under the same name as heretofore.

Bideford.—The Town Council do not seem very satisfied with their gas bill. During a recent discussion a councillor said he was glad that the contract with the gas company had nearly concluded. Another suggested that it was highly desirable that there should be some competition in the lighting of the town. Why did not the Council introduce the electric light? Exeter and Taunton Corporations had profited by the electric light. Unless competition was introduced the town would not be treated as it expected to be.

Electric Lighting Provisional Orders—A memorandum just issued by the Board of Trade shows that the 22 local authorities which it is proposed to empower to undertake electric lighting within the areas under their control are the Corporations of Hereford, the Airdrie Burghs, Brechin, Hamilton, Rothesay, Ossett, Rotherham, Batley, Lewes, Chichester, and Doncaster, the King's Norton Rural District Council, and the Urban District Councils of Dartford, East Ham, Ilfracombe, Rawmarsh, Hornsey, Ilford, Leigh-on-Sea, Barnes, Hove (Altrincham), and Leatherhead.

Rotherham.—The Clerk has reported to the Town Council that he has received the electric lighting provisional order from the Board of Trade, which now only requires the formal assent of Parliament; further, that the mayor and himself had attended a meeting of representatives of public bodies affected by the proposed Bill of the General Power Distributing Company at Nottingham, and that it was decided that a joint opposition should be made against such Bill by counsel and witnesses, and that a committee of representatives from six towns (including Rotherham) had been appointed with power to deal with such opposition.

Bristol. — The directors of the tramways company have submitted to the sub-committee of the Sanitary Authority the list of new fares to be charged when the tramways are extended and equipped for electric traction. The fares range from ½d. to 3d., and worked out on the exact lengths of each route represent for ordinary passengers ·75d. per mile, and by workmen's cars ·32d. per mile. The Town Council have agreed that the tramways company be asked to consent to include in the proposed agreement any new lines which the Council might consider necessary to construct within the next five years in the present term of purchase.

Eccles.—An additional length of main is to be laid to the entrance of Bindloss-avenue. The electrical engineer's report states that everything is progressing satisfactorily at the engine builders' works, and there is every prospect that the engines will be ready for delivery on the date specified in the contract. Messrs. Johnson and Phillips are making the dynamos, which will also be ready on the specified date. Referring to complaints about the quality of the bricks supplied at the generating station, the architects had informed the engineer (Mr. S. V. Clirehurgh) that the materials in use are of the kind contemplated in the specification, and such as not to give ground for any complaint.

St. George's, Hanover-square.—At a meeting of the Vestry held yesterday it was proposed that an arrangement be entered into with the Westminster Electric Supply Corporation, Limited, by which the charges to the parish for electric current for lighting purposes should be made in one account at 6d. per unit for the first 4,000 units, and 4d. per unit used in excess of 4,000 units each year. The Works Committee reported that they had received a noticed a notice from the Westminster Electric Supply Corporation, Limited, of the corporation's intention to lay distributing mains in Woodstock-street and Blenheim-street, as per plan submitted, and have instructed the surveyor to have the mains referred to laid in the footway where possible.

Liverpool.—At the City Council on the 4th inst., Sir Arthur Forwood moved the acceptance of the tender of Messrs. Willans and Robinson for two compound engines and dynamos at the price of £6,530 each, and one triple-expansion engine and dynamo at the price of £6 939 subject to a deduction of 2½ per cent. upon the respective amounts. Sir Arthur explained that these engines were to supply electrical power both for tramway and electric lighting purposes. It was contended that the acceptance of this tender would commit the Council to a policy which would ultimately involve an expenditure of £112 000, and that the engines recommended to be supplied were of the wrong unit of power. Upon the motion being lost, Sir Arthur Forwood resigned his seat both on the committee and on the Council.

Salford.—The Highways Committee of the Town Council have passed a resolution declaring it to be essential that a clause be inserted in the new lease of the tramways to the Manchester Carriage and Tramways Company enabling the Corporation to relay the tramways for electrical traction during the renewed term of three years. The committee are prepared to arrange equitable *terms, "or in case* of inability to agree, to refer the question of
compensation to be paid to the company for any mater
ance to an arbitrator appointed by the Board of Tra
the event of the company accepting this proposal the
will not insist upon a clause enabling the Corporation
similar powers to those contained in Section 43 of the
Act, 1870, unless the company desire it in their own in

Edinburgh.—The Electric Lighting Committee of
Council met on the 29th ult., and adjusted their
estimates for the ensuing year, 1898-99. The expendi
mated at £49,250, and the revenue at £51,250, leaving
£2,000 to be carried to the credit of the rates, afte
£6,000 for the reserve fund. For the current year—1
expenditure was estimated at £33,390, and the revenue
leaving a surplus of £2,065 to be carried to the credit o
after providing for £4,000 to be contributed to the re
The capital expenditure for tramways, general im
and dwelling-house improvements, is put down in th
for 1898-1899 at £492,400, the greater part of which
the conversion of the tramways, erection of power-ho

Shoreham.—At the last meeting of the Urban Cou
was read from the Local Government Board with refe
borrowing of £6,000 for purposes of electric lighting of
stating that the Board would require plans and detaile
of the cost of all works and financial particulars, and
the approval of the Board of Trade had been obta
system proposed to be adopted, and the Board were un
they would be willing to grant their sanction to the lo
particulars they asked for had been supplied, and the
had been investigated by one of their inspectors
enquiry. It was agreed that before anything could b
opinion of an expert should be obtained, and that
should remain in abeyance until they were prepared to g
information.

Newington.—At the last meeting of the Vestry, Mr
on behalf of the Electric Light Committee, moved that
of Mr. C. Gray Hill, Coventry, be accepted for the er
electric light station at a cost of £12,790. Mr. Davis,
and others commented severely on the fact that a station
estimated to cost £5,000 was now to cost nearly £1
Edwards explained that the station proposed would
times the working power of the original design. T
long and heated discussion, in the course of which
question of electric lighting was discussed. Mr. Da
the matter deferred until after the elections; but eve
tender of Mr Sharpington was accepted, several mem
that the slight difference in the cost did not justify th
bringing country workmen into London.

Fulham.—The Vestry have adopted the report of the
Electric Lighting, and Dust Destructor Committee.
stated that a sub-committee had been appointed to vi
worth Bridge-road by St. Matthew's Church and repo
application for additional lighting. The following
proposals were submitted: (1) That the Vestry carry
visional order, and at once proceed to take steps for the
a suitable electric lighting station, dust destructor, and
on the Town Mead site at an estimated cost of £56,0
the solicitor be instructed to forthwith enter into negot
the Electrical Development and Finance Corporation
of their offer to carry out the scheme for the erection of
lighting station, dust destructor, and disinfector a
£55,260. The first proposal has been adopted.

Monmouth.—At the Town Council on Tuesday
Mayor (Councillor W. Honeyfield) resigned the chair
the Drainage and Electric Light Committee Mr. Ho
that when he took up the combined scheme for dr
electric light six years ago his action, particularly on
question, clashed with a numerous and influential p
town; he therefore did not get the support and co-op
might under other circumstances be reasonably exp
cost of extras which the engineer (Mr. Lailey) had
£500, has now reached £6,000. A resolution was pa
future before commencing any extra work the enginee
Council with a description and the probable cost; a
engineer tender a monthly account of the work done,
foreman of the works supply a weekly statement of ex

Bradford.—Exceptional expedition has been shown
of electricity cables in the heart of the town. Betwe
on Saturday night and six o'clock on Sunday night
feeding mains (a length of 330 yards being complet
1,980 yards of cable) for the Great Horton section of th
were laid under the tramlines in Valley-road, Canal-ro
square, and along Market-street to the tower entr
exchange. Thence they are to be taken by Tyrrel-str
to avoid the wood paving in front of the town hall.
were laid by the staff of the electricity department
poration. Four large mains were put down with a se
of 1 6 square inch of copper, together with a telepho
the tram service, and a "pilot wire" for recording the
different parts of the route. These cables are quite se
the lighting mains. There are at the Valley-road
Siemens dynamos for 500 volts current, 600 h.p., dire
two Willans engines.

Appointments Vacant.—The Metropolitan Asylum
about to appoint an engineer to the Board, who will
to devote his whole time to the duties of his offi
must be thoroughly competent to advise upon and
the various engineering, machinery, drainage, and
(including gas, electric lighting, and water supplies).

£600 per annum, with travelling expenses, office accommodation, and the necessary clerical assistance. Fuller particulars the appointment may be obtained from Mr. T. Duncombe ann, clerk, Chief Offices, Norfolk House, Norfolk-street, W.C.— general assistant is required in the city engineer's office at orwich; one having experience of mechanical and electrical engineering, and desirous of increasing his knowledge of municipal work, referred. The salary is £100 per annum. Applications, stating ge and experience, and accompanied by copies only of not ore than three testimonials, enclosed in envelopes, endorsed General Assistant," must be sent to Mr. Arthur E. Collins, .M.I C.E., city engineer, Guildhall, Norwich, by May 9.

Blackpool.—At the meeting of the Blackpool Town Council on e 3rd inst. the Chairman of the Electric Lighting and Tramways ommittee pointed out that on and after May 7 until further otice, the tram fare would be increased to 2d. each journey. The mmittee, he said, recognised the fact that the 1d. fare was not ly popular but remunerative, and it was solely due to the heavy penses that they felt bound to put up the fare during the season. he experiment of only increasing the fare during four days at aster had answered, inasmuch as the takings amounted to £217 ld more than they were in the corresponding month of last year. e number of passengers carried being 61,000. The committee ged the Council to put in hand the widening of the promenade once, so that they could have the double line of trams, and ith the advent of the overhead system they would then have the st tram system in the country. Alderman Buckeley urged the cessity of providing waiting-rooms, remarking that if the trams ere under the management of a private company the Council ould have compelled them to have waiting-room accommodation.

Bath.—Upon the motion of the adoption of a report from the lectric Light Committee at the last Council meeting the following iscussion took place, which we cull from *Keene's Bath Journal*: "Mr. Titley said if, as Alderman Taylor said, the sum of something ke £26,000 paid to the company on the acquirement of the lectric light undertaking had, as he understood from his remarks, en thrown away, how was it in his account presented before the uncil last month he only wrote off £600 towards the sinking nd? If he had found out, as he presumed he had done, that he depreciation amounted to nearly the whole of the amount paid the company, why did he not write it off? Alderman Taylor id it was true, in this case as in all others, 'sufficient unto the y is the evil thereof,' and he did not think it necessary to make y explanation on the point. Mr. Titley: What is the amount ghly of the commission and expenses paid to Mr. Hammond up date? Alderman Ricketts: Hear, hear. Alderman Taylor: I ink that is a matter of which we should have had notice. Mr. tley gave notice that he would ask this question at the next eting. The committee's minutes were passed without dissent."

Stafford.—The Town Council will, at its May meeting, discuss recommendation by a committee to pay Mr. Bell £250 as muneration for the extra services rendered by him in connection th the obtaining of the provisional order for the electric lighting stallation, for preparing the necessary designs, drawings, and ecifications, and also for acting as resident engineer during the nstruction of the works. The committee's report, which has en adopted, states that in the electricity department the consumption during the past 12 months had been 52,231 Board of ade units, as compared with 39,606 units last year, an increase f 12,625 units, or nearly 32 per cent. A special sub-committee pointed to consider the question of extending the cables up the ewport-road into Rowley-park reported that out of 130 circulars ued 56 persons replied that they did not require the light, six y were prepared to take it, and 68 did not reply. The extension of the cable at present, therefore, could not be recommended. e Chairman added that the capacity of the electric light mains now being tested almost to the full, and a report of the ager on the advisableness of doubling the present capacity been referred to Dr. Hopkinson for his opinion.

Fort William.—The *Oban Times* says: "Perhaps the town of t William may be said to be the first real instance where the ric light has entirely taken the place of gas to such an extent the manufacture of the latter has ceased. Fort William had t was understood to be the oldest gasworks in Scotland, and tly after the opening of the West Highland Railway it was chased from the owners by Mr. H. Mayberry, Glasgow, who plied for and obtained parliamentary powers, as the result of enquiry held by Colonel Yorke, of the Board of Trade, to me the lighting authority of the town and district, and to a new gasworks within a limited period. A site had been red, but in the interval an electric light company was formed, Mr. Yorke, electrician, Stirling, as manager, who from the power close by has succeeded in introducing a first-class . The railway stations are now lit up with the electric light, the West Highland Railway Company have now agreed to over the gasworks properties, which bound their line of rails the immediate vicinity of the station. This company and Mr. berry, as the owner of the properties, have agreed to refer the s that should be paid to Sheriff Lees, advocate, Edinburgh."

he Spiral Globe, Limited.—According to a prospectus in her column, this Company is about to issue 50,000 £1 shares. parent Company has been formed to purchase various British, gn, and Colonial patents of Messrs. Dunlap and Quain for r spiral glass cover for electric incandescent lamps, and to lop the business. The invention is of an exceptionally simple ater, and consists essentially in the employment of a spiral rod having lens-like qualities, and of about ⅛in. in diameter, y coiled round the bulb of an electric incandescent lamp. ngst its advantages it is stated that the spiral glass cover acts both as a concentrator and diffuser of the light rays. As the results of tests from Faraday House the following figures are given: Candle-power at 100 volts ordinary lamp, pointing towards photometer screen, 10·1 c.p.; spiral incandescent lamp (half covered across vertical axis), 17·0 c.p. The same lamps were reversed in position; 1·1 c.p., as against 10·8 c.p. The lamp half covered with wires laid parallel to axis, and the lamp being pointed upwards, with covered part towards the screen, the figures are: 15·3 c.p. to 22·8 c.p., while, when the lamp is wholly covered by the spiral, 23·1 c.p. is stated as the result of the test. As the expense of covering an incandescent lamp is very small, and greater efficiency of the lamp must mean a smaller consumption of current, a saving should be effected by the use of these lamps. The expense of covering an incandescent lamp with the glass spiral is very small. The spiral glass cover, being an addition to and not a substitute for the electric lamp, will not compete with the electric lamp industry, but, on the contrary, by reducing the cost of electric lighting ought to increase the sale of all kinds of electric incandescent lamps.

Wormit.—Meetings have been held to consider the advisability of installing the electric light. The area to be embraced in an application for a provisional order includes the land lying between the west boundary of Wormit estate and the burgh boundary of Newport at Woodhaven on the east. The cost of the whole scheme would be very much the same whether the generating plant was erected on the east or on the west. A suitable engine of the best make to work up to 70 i.h.p., with dynamo coupled direct, is proposed at a cost of £670; a steel boiler, probably of local make, working at 150lb. pressure, at £330; accumulators, sufficient to supply current from 11 p.m. till daylight next morning, at £300; switchboard, feeders, underground mains, and all wiring to meters in dwellings, at £1,200; buildings, including chimney, at £250; and provisional order and other legal charges would cost £250, making a total of £3,000. The capital charges on this sum at 3½ per cent., is £105; coal, £50; oil, stores, etc., £15; ground rent and taxes, £20; allowing 5 per cent. for uphold of accumulators, £15; and engineer and fireman, £130—in all an annual charge of £335. The engine power, as stated, would be sufficient for 700 16 c.p. lamps; if twice that number of lamps were fitted in dwelling houses, never more than 50 per cent. of the lamps erected would be in use at one time. One hundred and forty houses with 10 lights at an average of £4 for each house, would give a revenue of £560; £30 might be derived from public lighting. Deducting the charges for interest, coal, wages, etc., as stated, at £335, this would leave a margin of £265. It is proposed to charge at the rate of 5d. per Board of Trade unit. A rate of 5½d. would be equivalent to the present cost of Newport gas. Several householders stated that the cost of oil lighting in their dwellings amounted to from £3. 10s. to £4 per annum, exclusive of breakages and the prime cost of lamps.

Adamson's Light for Photography.—This method of artificially lighting a studio by a number of incandescent lights (introduced by Adamson Bros., of Eldon-street, E.C.) presents certain advantages, such as softness, brilliancy, and steadiness as compared with the arc light. As with the latter, there is no longer any necessity for building studios on house-tops, as a front shop, or even a basement, may now be utilised provided a cable can be laid from a neighbouring electric station or main. This system is economical in working to the highest degree. It is claimed that about one-twelfth to one-eighth of a penny is the cost of each exposure. It is silent, gives soft, pure, brilliant, white light, and it is a known quantity. Its intensity and actinic quality are at at all times equal, so that the correct exposure of the plate can be ascertained with perfect accuracy and repeated with equal results as often as desired. The exposure required is very short, from one second upwards according to the lens used, and the apparatus is always ready when once installed. There are various installations both portable and pendant, consisting of a reflector (with set of Adamson's special photographic lamps), conducting arms and distributing pivots, light steel girder beam and counterweight, patent electric swivel, length of steel rail for attachment to roof of studio, one single-pole main switch, one single-pole branch switch, special graduating resistance, and all necessary flexible cables connected. The stand or portable form of apparatus is a smaller form of the above, and is mounted on a stand instead of an overhead rail. This installation is capable of covering an 8ft. by 8ft. background with an equal illumination, and is so designed that, in addition to its value in the studio, it may be easily detached and taken out to balls and evening parties, or for "at home" photography. It can be put into a cab, and a few minutes serve to mount it for work. Around the inside of the reflector 36 or more 32-c.p. lamps are arranged in a circle. Four of these are kept constantly burning for focussing, while the rest are only turned on during the exposure. The light is turned on gradually, thus enabling the operator to gauge its effect.

Cheltenham.—At last Tuesday's quarterly meeting of the Town Council, it was reported that the tests showed the electric supply (low-pressure cables) to have averaged 101·5 volts, and the gas 16·19 candles. The lamp-book showed 18 lamps extinguished and five burning dimly. The electrical engineer reported that the new steam alternator, No. 6, had been started, and had run very satisfactorily for about 10 days on the town mains; the buildings were nearly complete, and he hoped to get the battery of accumulators into place shortly. He recommended that a small part of the extension to the arc lighting mains, included in his estimate of extensions in February, should be carried out, the extensions being from Manchester-street sub-station to the bottom of North-street, where the mains join the Winchcomb-street arc lighting circuits, the cost of which would be about £120, laid complete. In

consequence of two faults on high-pressure cables on Saturday, the 16th, the town supply was interrupted for periods of eight and eighteen minutes respectively, at about 7.20 p.m. and 10.50 p m. The earlier fault was due to breakdown of a rubber-insulated cable forming a service in Landsdown-terrace, and the second fault occurred on one of the two main feeders and at the junction of the St. George's and Gloucester roads. At this place the cable had been several times disturbed by openings made by the gas company, and the highways and waterworks departments, and he thought it likely it had suffered some rough usage. The fault, however, was very much burnt up, and at that time he could give no definite opinion as to the cause of the trouble. Both faults had been repaired, and, except for the temporary cessation of the light generally for the times mentioned, very few customers had been inconvenienced. The estimate of the expenditure on street lighting for the current year was £3,750 for gas, and £2,550 for electric lighting—total, £6,300. The Deputy Mayor, in submitting these proceedings for approval, referred to the rather large addition proposed to the street lamps, and said the tendency was for the expenditure to go up in this matter. Up to the present Cheltenham had not been a well-lighted town, and they must expect additional expenditure on lighting both in the town itself and in the added districts. The minutes were approved. A letter from the enterprising Trans-atlantic Mr. Bickerdike, referred to in our last, was also before before the Council.

South Staffordshire Tramways.—A conference of representatives from local authorities was held in the Town Hall, West Bromwich, on the 3rd inst., with respect to the use of steam on the South Staffordshire Tramways. Colonel Marindin (inspector of the Board of Trade) presided. Mr. Schuster explained that the South Staffordshire Tramways Company were contemplating promoting a Bill—the expense of which would be paid by the British Electric Traction Company—to meet the views of the various local authorities, those of their own company, the British Electric Traction Company, and the Board of Trade. The Bill was to enable them to introduce some improved method of traction agreeable to the local authorities and the Board of Trade, and he suggested that the British Electric Traction Company should confer with those local authorities upon the system to be introduced. Whatever Bill the local authorities favoured, their company would do their best to promote it. There was nothing in their Act to prevent them from taking the electric traction to-morrow, but they had agreed to lease the lines to the British Electric Company, who would aid them in promoting the Bill. What they really wanted was an extension of the steam license until the necessary steps are taken to carry out a new scheme. When they had the power to lease the lines to the British Electric Company they would adopt some method of traction which, he hoped, would be suitable to all concerned. It was intended to re-equip the lines entirely. Mr. Dunn (Mayor of Dudley) mentioned that the license for the trams in the borough of Dudley would expire in four years, and then the Town Council intended to avail themselves of the provisions of the Tramway Act and municipalise them They had already a provisional order for electric lighting. A discussion ensued as to the best mode of traction, and Mr. Sellons said expert evidence showed that the conduit system was impracticable in England. In answer to a question whether the British Electric Traction Company were capable of undertaking such an extensive scheme, Mr. Sellons mentioned that the capital (£500,000) had all been subscribed. Ultimately, Mr. Sellons undertook to supply the local authorities with full particulars of the proposed Bill within a month, and the Mayor of West Bromwich was asked to convene another conference after those had been considered.

Islington.—At a meeting of the Vestry to-day a report will be submitted by the Electric Lighting Committee stating that in consequence of the wages of the labourers having been increased from 6½d. to 7d. per hour in order to conform to the Vestry's resolution that the trades union rates of wages as in practice obtain be paid, the other members of the labouring staff have been placed in a somewhat anomalous position; that according to the schedule of wages of the National Union of Gas Workers and General Labourers, the labourers' rate of pay is stated to be 7d. per hour, whereas by the schedule of the Amalgamated Protective Union of Engine-Drivers, etc., the rate for stoker or boiler attendants is also fixed at 7d. per hour; that it is apparent that either one rate is too high or that the other is too low, as a certain amount of skill is required in stoking a boiler properly, and the stoker is therefore relatively of more value to the department than the labourer, and that other anomalies have also arisen in consequence of the increase in the labourers' wages; submitting for the information of the Vestry a schedule of wages as paid at present and the rates which it suggests should be paid; and recommending that an increase of ½d. per hour to all artisan and labouring staff (labourers and coal trimmers excluded) be approved and paid forthwith. Referring to the salaries of the technical and clerical staff of the electricity department, the committee is of opinion that a proper schedule under various grades, showing the commencing salaries, yearly increments, and maxima is very desirable, and that it would be to the interest of the department that the members of the staff should know what prospective increments of salary they may attain to in the event of their giving satisfaction; and they will recommend that the scale of salaries shown in the following schedule be adopted and put into operation forthwith: "Switch-room attendants and inspectors of meters—commencing salary, 30s. per week; annual increments suggested, 2s. 6d. per week; maximum salary suggested, 40s. Inspectors of mains—commencing salary, 30s. per week; annual increments suggested, 2s. 6d. per week; maximum salary suggested, 40s. Draughtsmen—commencing salary, £134 per annum; increments suggested, £8 per annum; maximum salary sug £150. Clerk—commencing salary, £105 per annum; annual ments suggested, £7. 10s. per annum; maximum salary sug £120. Electricians-in-charge and on mains—commencing 40s. per week; annual increments suggested, 5s. per maximum salary suggested, 60s."

Glasgow.—The Corporation are at present considering a for a great extension of their electrical plant, to enable th supply electric current over the whole municipal area. The expenditure, including what has already been done, is calc at about £551,000. Mr. Chamen's report to the Electricity mittee states, according to the *Dundee Advertiser*, th Waterloo-street station, with its capacity for 3,300 h.p. completely overloaded during the fog last winter, and increase in the number of lamps fixed had been on an aver five years about 30 per cent., this meant, with the erection 100 lamps on the Springburn electric tramway route, a ne for at least 100 h.p. additional. Waterloo-street station being to its utmost capacity, a new site had been purchased a Dundas, where work had already been begun, and arrange had been made for the purchase of another site for a gene station on the south side of the river, near Eglinton-street s At Port Dundas there would be no difficulty in installing 30,000 h.p., and at the southern station another 15,000. The tion of distribution had also to be considered. Waterloo station was at present distributing current at a pressure and 200 volts, but the Board of Trade regulations now per current to be supplied at 250 and 500 volts, which enable current to be carried much further, and saved very largely amount of copper required in the distributing mains and fe the saving being about 50 per cent. The new plant already or for Port Dundas was designed to supply current at the inc pressure, and the plant for the southern station could be sim designed. There would be no difficulty in supplying la points about two miles distant from each of the new gene stations and in further supplying an area of about half radius from such distant feeding points. This area prac included the whole municipality, so that there would b necessity for resorting to high-tension current. The the increased voltage rendered it impossible to work new stations in connection with the same mains, whi present distributed the energy from Waterloo-street, and would be desirable in time to relieve that station of its load. The capital expenditure detailed in the report is £55 made up as follows: capital expenditure at present, £15 capital expenditure proposed in report, £396,000; cost of re of Waterloo-street plant, £50,000. The surest way to arri a low rate of charge for the supply of electric light, con Mr. Chamen, is to make the concern as large as possible, so the sooner the capital expenditure contemplated in the rep reached the better. He therefore recommends (1) that, in ad to the £95,000 to which the Corporation already stand comm a further expenditure of £61,000 be authorised for the Port D station and mains, and (2) that an expenditure of £108,0 authorised for the south side station and mains. The expend would be spread over a period of two years.

Nottingham.—Prof. Robinson, who is at the head of mechanical and electrical engineering department at Univ College, has been interviewed by a representative of the *Notti Express* on the subject of the system of electric traction pro for the new tramway system for Nottingham, and he courte consented to briefly explain its working in simple language. reference to the scheme put forward by the committee o Corporation, the professor said: "To my mind there can b doubt that the overhead system is the best. One of the objec made to it is that the posts running along the centre of the s will be unsightly, but I disagree with that view. We have a exaggerated idea of the ugliness of the overhead trolley sy The cast-iron posts and projecting arms can be made artistic, and in long thoroughfares, and especially those Mansfield-road, where there is an incline, the perspective wi pleasant. These supports will certainly not be so unsightl so dangerous as the present system of overhead telegraph telephone wires. There is another point in favour of over electric traction: the speed can be regulated within a conside range. In America the rate is five or six miles in the town from 10 to 12 miles in the suburbs. Think of the importa from a social point of view, of rapid electric transit from centre of the city to the outlying districts. It will prove a boon to people who now live in crowded streets and who change to healthy homes in the suburbs. In the cable syste speed has to be the same in every part of the line, unles gripper is loosened and slipping along the cable is resorte This would mean that the cable would suffer abrasion and out rapidly. A second argument against the cable system is it interferes with the streets more than the overhead arrange And then, again, you cannot reverse the direction of the although there is this to be said, that a greater number o may be attached to the cable when traffic requires them. rience in America and elsewhere has proved that the el system is more speedy. The overhead electric system is th and allows greater change in speed than the cable system, pointed out in the careful and concise report drawn up b committee of the Corporation. In that the advantage disadvantages of both systems are fairly stated. Most objections to the overhead system I have heard advanced been the outcome, I think, of pure prejudice. It may be the natural conservatism of human nature, or to that inde

ation one has for anything that is old, although super- The overhead trolley system has been adopted largely in , and in a good number of towns in this country and on tinent, with satisfactory results. The working expenses in this and other reports show clearly the superior and economy of the overhead system as compared with e. With regard to the gradients it will be possible to he steepest streets in Nottingham. Ascents can be where the gradient is 1 in 10. Yes, undoubtedly the l system is the best for Nottingham."

ahead.—The special committee appointed by the Birken- wn Council in July last year to consider the question of l tramways for the borough, have, according to the *Courier*, just issued a report, in which they state that e found it impossible to come to any satisfactory arrange- ith the Birkenhead United Tramway, Omnibus, and Company for the surrender of their lease. As to the ramways, the lease of which expires in 1916, the com- id not think it desirable to acquire the interest of that . Both companies had suggested that the existing leases e determined, and that a new lease of all the lines in the should be granted to them or to a new company, who econstruct the existing systems and convert them into electric tramways, but to this proposal the committee ble to assent. Applications had also been received from npanies for acquiring the tramway lines, with a view of g them into electric tramways, but the committee to entertain any of the proposals made to them. Acting owers given them by the Council the committee strongly ended that the existing Birkenhead tramways, or some thereof, should, when the Corporation came into actual n of the property, be reconstructed and relaid as electric s, and that the present system should be in part extended, lines laid. It was not proposed to touch upon the ques- he Wirral tramways, inasmuch as it may be many years e lines revert to the Corporation. As to the best system nical haulage to be adopted in the borough for tramway , the committee had given full and fair considera- the claims of all the well-known systems, and they e to the conclusion that electrical haulage was the best With regard to the exact number in which electrical energy should be applied the committee had considered ntages and disadvantages of the Simplex, conduit, and und systems generally, as well as of the overhead or stem, and were satisfied that the latter was on all grounds suitable for adoption in Birkenhead, and they therefore nd that electrical tramways on the overhead or trolley ould be adopted in the borough. As to the working of ways, the committee suggest that the entire system of s in the borough, including lines, plant, etc., should be ed, provided, and worked by the Corporation as a muni- dertaking, and without the intervention of lessees or In order that the Council may be in a position to com- rk as soon as possible, and in order that no unnecessary y arise in placing electric tramway carriages upon such the Council may determine, the committee recommend cil to approve their report, and to agree to the scheme nbodies the views of the committee. Dealing first with ing routes, it is remarked that that portion of the borough between the central station and the ferry has separate or the up and down traffic respectively. There does ar to be any advantage in having three separate routes retained their retention would necessitate addditional lectric feeder cables, etc. It appears desirable therefore up and down lines should be taken together along the reets, and both lines are now proposed to be laid along street, Canning-street, and the ferry approach. On the se a portion of the present route is taken along Canning- Sandford-street, Taylor-street, and Bridge-street. These are not very suitable for tramways, and it would seem that l of following the present route it would bo preferable to out of the lines laid in Argyle-street direct into Cleveland- which is a more suitable street, and where there is a much population to be served. The existing Claughton and Oxton proposed to be practically abolished, and in its place two outes are substituted. Only the portion of the existing along Conway-street is proposed to be retained as part of w scheme. The following are the routes proposed: Borough- ine—Commencing at Woodside Ferry, and proceeding along rry approach, part of Canning-street, Argyle-street, Borough- to Prenton-road, then along Prenton-road West to the gh boundary. Dock line—Branching out of the Borough- line in Argyle-street at the end of Cleveland- , passing along Cleveland-street, a portion of Corpora- oad, Beaufort-road, to the borough boundary. Higher ere line—Branching out of the Borough-road line at Whet- lane, passing along Whetstone-lane, Church-road, Bebing- ad, to Dacre-hill. An alternative route has been suggested portion of the distance, along Argyle-street South into Whet- lane. Shrewsbury-road and Oxton line—Branching out of rough-road line at Balls-road East, passing along Balls-road Balls-road, Shrewsbury-road, and Shrewsbury-road North ston-road. Park-road North line—Branching out of the gh-road line at Conway-street, passing along Conway-street, oad North, and Upton-road to the end of Shrewsbury-road . (These two lines form a complete loop, and will provide traffic as well as for down traffic to the railway stations ries, for the greater part of Oxton and Claughton, and part enhead adjoining Conway-street. These lines also provide park and football traffic.) Central Claughton line—Branch- ing out of the Park-road North line, passing along Claughton-road, with a loop from Camden-street to Conway-street, Eastbourne-road, part of Grange-road West, Grangemount Grosvenor-road to Blandford-street, and along Blandford street, terminating in Shrewsbury-road. It is proposed that double lines of track should be laid in all places practicable. With regard to the providing and equipping such a system of electrical tramways as that recom- mended, the borough engineer and surveyor advises that the cost of taking up, relaying, and converting such of the lines at present laid as are included in the scheme, and laying new lines in those streets where lines are not at present laid, would amount to about £104,500. To this sum would have to be added the cost of erecting the necessary overhead wires, poles, etc., and the cost of con- structing and furnishing complete an electrical generating station, erecting carriage sheds, providing the necessary tramway cars, and other minor matters which would involve a further expendi- ture of possibly £77,500. The committee point out that if the Council seriously contemplates the providing of electrical tram- ways in the borough, it is very desirable that application be made in the ensuing autumn for the necessary parliamentary sanction to lay the lines in those streets in which tramways are not at present laid.

PROVISIONAL PATENTS, 1898.

APRIL 25.

9466. The compact electric switch. Percy Herbert Brant, 1, Column-villas, Belvidere-road, Shrewsbury.

9475. Improvements in and connected with arc lamps. Frederick Richard Boardman, 17, Leopold-street, Burdett-road, London.

9482. Improvements in apparatus for freeing lighting and extinguishing gas-burners at a distance by means of electricity. Paul Louis Guyenot, 60, Queen Victoria-street, London.

9493. Improvements in or relating to "starting boxes" or combined rheostats and automatic cut-outs for electric motors. Alfred Julius Boult, 111, Hatton-garden, London. (Frank E. Herdman, United States.)

9499. Improved method and apparatus for maintaining the action of vacuum tubes. William Phillips Thompson, 6, Lord-street, Liverpool. (The Voltohm Electricitäts Actien-Gesellschaft, Germany.)

9504. Improvements in operating mechanism for the switches of electric railways. John William Mackenzie, 40, Chancery-lane, London. (Charles William Squires, United States.)

9511. Improvements in rheostats for the graduated control of electrical resistance particularly applicable to the production of theatrical luminous effects. Claude Edouard Clémarçon, 1, Queen Victoria-street, London.

APRIL 26.

9534. Improvements in incandescent electrical devices. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Conrad Hubert, United States.) (Complete specification.)

9548. Improvements in electric arc lamps respecting arc striking arrangement. Peter Spies, 3, Fossdene-road, Charlton, Kent. (Complete specification.)

9581. Improvements in coin-freed or prepayment apparatus for supplying electricity. Alexander George Ionides, 4, South-street, Finsbury, London.

9607. Improved electric arc lamp. Joseph Thiebaut Tschieret, 6, Bream's-buildings, Chancery-lane, London.

9637. Improvements in process for the production of chemical compounds by electrolysis. Joseph William Richards and Charles William Roepper, 24, Southampton-buildings Chancery-lane, London. (Complete specification.)

9638. Process for manufacturing metallic sulphides electrolytically. Joseph William Richards and Charles William Roepper, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

APRIL 27.

9677. Improvements in swing joints or ceiling connections for carrying suspended electric light fittings. Veritys, Limited, and Percy Garniss Ebbutt, Plume Works, Aston, Birmingham.

9692. Improvements in resistance apparatus for regulating electromotors. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Atkien-Gesellschaft, Germany.) (Complete specification.)

9712. Improvements relating to telephones and to circuit arrangements and relays therefor. Oliver Joseph Lodge, 323, High Holborn, London.

9714. Improvements in portable electric batteries and electric lamps. George Frederick Emery, 5, King's Bench-walk, Temple, London.

9723. Improvements in electric current switch-gear. Leonard Andrews, 46, Lincoln's-inn-fields, London.

APRIL 28.

9778. Improvements in plates for electric accumulators. Max Bernstein, proprietor of the firm of Joh. Friedr. Wallmann and Co., 111, Hatton-garden, London. (Complete specification.)

9739. Improved means and apparatus for electrolytically decomposing salts of the alkaline and earthy metals or other substances containing them for the manufacture of caustic bleaching powder, chlorine, or other products contained in them. Frederic Hungerford Bowman and Frederic Edmund Bowman, 17, St. Ann's-square, Manchester.

9779. Relating to improvements in testing and protecting apparatus used in conjunction with telephone, telegraph, or other electrical circuits. Daniel Sinclair and William Aitken, Oxford-court, Cannon-street, London. (Complete specification.)

9789. Improvements in and connected with electroliers and incandescence electric lamp pendants. Hugo Hirst and John Hillery Collings, 73, St. Stephen's-road, Upton Park, London.

9802. An improved system and means for driving newspaper-printing or like machines at variable speeds by electric motors. Walter Angove Clatworthy, William Henry Holmes, Alfred Holmes, John Henry Holmes, Leonard William Holmes, and Ellwood Holmes, 1, Queen Victoria-street, London.

9811. Improvements in and relating to dynamometrical apparatus. Henri Bouron, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

APRIL 29.

9844. Improvements in adjustable shade supports for electric and the like fittings. William Henry Sturge, 12, Cherry-street, Birmingham.

9877. Improvements in electric switches. John George Dixon, 70, Palace-chambers, Westminster, London.

9881. Improvement in means and devices for electrically lighting coin-freed apparatus for displaying pictures. Arnold William Witt and Mervyn Walter Stikeman, 65, Chancery-lane, London. (Complete specification.)

9895. Improvements in apparatus for raising and lowering arc lamps. William James Davy and George Thomas-Davies, 40, Chancery-lane, London.

APRIL 30.

9912. A new and improved chimney for incandescent gas, electric, and oil lights. Mill Altman, 117, Back Church-lane, Commercial-road, London.

9921. An electric brake. Frederick Wise, 24, York-road, Crosby, Liverpool.

9946. Patent electrical spindle for bicycle lamp. John English Preston, Lightburne Villa, Lightburne-avenue, St. Annes-on-the-Sea.

9947. Improvements in and connected with phonographs. Alfred Schoeller, 102, Burdett-road, London.

9960. Improvements in or relating to electric meters. Alfred Julius Boult, 111, Hatton-garden, London. (Eurico Luigi Giuseppe Cauro, Italy.) (Complete specification.)

9983. Improvements in or relating to telephonic apparatus. Raimund Günther, Edler von Kronmysth, jun., 46, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED.

1896.

12390.' Watt or ampere-hour meter. Staveley and others. (Amended specification.)

1897.

9276. Primary batteries. Rowbotham.

10908. Transmission of signals through submarine telegraph cables. Muirhead.

11402. Process of and apparatus for electrically decomposing solid substances. Romme.

11861. Electric accumulators or storage batteries. Lindner.

12056. Dynamometer. Soames.

12089. Apparatus for controlling electric motor-generators at a distance. Siemens Bros. and Co., Limited, and Estler.

12758. Form or construction of pipes for the reception of electric cables. Green and Oates.

12957. Transforming alternating into continuous electric currents or vice versa. Müller and Tudor.

13212. Covers or casings of switches, cut-outs, ceiling roses, and other electrical fittings. Taylor.

13213. Tubes or cases of electric fuses. Taylor.

14341. Machines for making carbons for electrical purposes. Lake. (Dooley.)

15237. Electrical switch apparatus for the points and crossings of electrical railways or tramways with underground conductors. Siemens Bros. and Co., Limited. (Siemens and Halske.)

17812. Electric railway systems. Murphy.

28943. Electric driving gear. Correns, Noah, and Noah.

1898.

5185. Electric railway and tramways on a road contact system. Stendebach.

5806. Manufacture of metal bases for electric incandescence lamps. Lake. (La Compagnie Générale des Lampes à Incandescence.)

TRAFFIC RECEIPTS.

Liverpool Overhead Railway.—The traffic receipts for the week ended May 1 were £1,451, as compared with £1,276 for same week of 1897, being an increase of £175.

Birmingham Tramways.—The traffic receipts for the week ending April 30 were £3,667. 17s. 9d., as compared with £3,44[illegible] 0s. 6d. for same week in 1897 being an increase of £221. 17s. 3d.

Dover Tramways.—The traffic receipts for the week ending April 30 were £130 8s. 10d. The total receipts for the year 1898 are £1,951. 11s. 0d. The mileage open at present is 3 miles.

Bristol Tramways.—The traffic returns for the week ending April 29 were £2,694. 4s. 7d., compared with £2,292. 0s. 3d. for same period of last year, being an increase of £402. 4s. 4d.

South Staffordshire Tramways.—The traffic returns for the week ending April 29 were £579. 7s. 9d., as compared with £550. 14s. 6d. in same week of 1897. The aggregate receipts for the year are £10,083 14s. 7d., as against £10,126. 10s. 0d. in the same period of the previous year.

City and South London Railway.—The returns for the week ended May 1 were £988, compared with £934 for same week of 1897, being an increase of £54. The total receipts for the half year amount to £18,757, compared with £18,546 for the same period last year, being an increase of £211.

Dublin S.D. Tramways.—The traffic receipts for the week ending April 29 were £476. 15s. 8d., as compared with £537. 18s. 7d. in the corresponding week in the previous year, being a decrease of £61. 2s. 11d. The number of passengers carried was 77,851 in 1898 and 81,812 in 1897. The aggregate returns up to date are £7,368. 17s. 1d., as compared with £7,655. 3s. 10d. last year, being a decrease of £286. 6s. 9d. The mileage open is the same as last year—viz., 8 miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	[illegible]	10½-10¾
British Electric Traction, Limited. Ordinary, Nos. 1-30,000	10	[illegible]
—— 6 p.c. Cm. Pf., 30,001-40,000 (iss at £2. 10s. pm., all pd.)	4	[illegible]
Brush Company, Ordinary	2	[illegible]
—— Non. Cum., 6 per cent. Pref.	2	[illegible]
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	[illegible]
Callender's Cable Company, Debentures	100	110-113
—— Ordinary	5	[illegible]
Central London Railway, Ordinary	10	[illegible]
——	6	[illegible]
—— Pref. Half-Shares	1	[illegible]
—— " "	5	[illegible]
Charing Cross and Strand	5	[illegible]
—— 4½ per cent. Cum. Pref.	5	[illegible]
Chelsea Electricity Company	5	[illegible]
—— 4½ per cent. Debentures	100	115-117
City of London, Ordinary	10	26-27
—— Prov. Cert. 90,001-100,000	5	18-19
—— 6 per cent. Cumulative Pref.	10	[illegible]
—— 5 per cent. Debenture Stock	100	[illegible]
City and South London Railway, Consolidated Ordinary	100	[illegible]
—— 4 per cent. Debenture Stock	100	[illegible]
—— 5 per cent. Pref. Shares	10	[illegible]
—— " " " '96	10	[illegible]
County of London and Brush Provincial Co., Ordinary	10	[illegible]
—— " " "	5	[illegible]
—— 6 per cent. Cum. Pref.	10	[illegible]
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	[illegible]
—— 5 per cent. Debentures	—	[illegible]
Crystal Palace District, Ordinary 5 per cent. Stock	100	[illegible]
—— Preference 5 per cent. Stock	100	[illegible]
Edison and Swan United Ordinary	[illegible]	[illegible]
—— 5 per cent. Debentures	5	[illegible]
—— 4 per cent. Deb. Stock, Red.	100	[illegible]
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	2	[illegible]
Electric Construction, Limited	2	[illegible]
—— 7 per cent. Cumulative Pref.	2	[illegible]
—— 4 per cent. Perp. 1st Mort. Deb.	100	[illegible]
Elmore's Copper Depositing	1	[illegible]
Elmore's Wire Company	2	[illegible]
W. T. Henley's Telegraph Works, Ordinary	10	[illegible]
—— 7 per cent. Preference	10	[illegible]
—— 4½ per cent. Debentures	100	[illegible]
House-to-House Company, Ordinary	5	10-11
—— 7 per cent. Preference	5	11-12
India Rubber and Gutta Percha Works	10	[illegible]
—— 4½ per cent. Debentures	100	[illegible]
Kensington and Knightsbridge Ordinary	5	[illegible]
—— 6 per cent. Pref.	5	[illegible]
London Electric Supply, Ordinary	5	[illegible]
Metropolitan Electric Supply, Limited, Ordinary	10	[illegible]
—— 4½ per cent. First Mortgage Debenture Stock	100	[illegible]
National Telephone, Ordinary	5	[illegible]
—— 6 per cent. Cum. First Pref.	10	[illegible]
—— 6 per cent. Cum. Second Pref.	10	[illegible]
—— 5 per cent. Non. Cum. Third Pref.	5	[illegible]
—— 3½ per cent. Deb. Stock, Red.	100	[illegible]
Notting Hill Company	10	[illegible]
Oriental, Limited, £1 shares	1	[illegible]
—— £5 Shares	5	[illegible]
—— £4½ shares	4	[illegible]
Oriental Telephone and Electric Company	1½	[illegible]
Royal Electrical Company of Montreal	—	[illegible]
—— 4½ per cent. First Shares Mortgage Debentures	100	[illegible]
South London Electric Supply, Ordinary	[illegible]	[illegible]
St. James's and Pall Mall, Limited, Ordinary	[illegible]	[illegible]
—— 7 per cent. Pref.	[illegible]	[illegible]
—— 4 per cent. Deb. Stock, Red.	100	[illegible]
Telegraph Construction and Maintenance	12	[illegible]
—— 5 per cent. Bonds	100	[illegible]
Waterloo and City Railway, Ordinary	100	[illegible]
Westminster Electric Supply, Ordinary	5	[illegible]
Yorkshire House-to-House	5	[illegible]

NOTES.

ach Duties.—The new import duty in France on accumulators amounts to about £6. 15s. per ton.

itution of Mechanical Engineers. — The r meetings of this institution are this year to be Derby.

phones for Central Africa.—The order for a te telephone equipment for 50 subscribers, to be d at Umtali, has been placed in England.

British Route.—The Canadian Pacific Railway has work on the construction of a new transcontinental h line between Montreal and Vancouver. It will Vaudreuil and the short line to Ottawa, and thence main line to the coast. When completed, there will ngth of about 2,900 miles of wire.

aklin Institute "Journal."—The May number *Journal* contains several articles of electrical These include the accounts of tests of the nograph on the telegraph lines of the British ment, by A. C. Crehore, Ph.D., and G. O. Squier, and a paper on "The Booster System as applied to Railways," by J. Lester Woodbridge.

nce Abstracts.—The April number of these s has reached us, and we are glad to note that gth of the individual notices is kept short. This is uld be, so long as the abstract gives details as to what information may be gleaned from the original. We ndering how the large number of gentlemen on the ing staff are saved the annoyance of writing out te notices, which are therefore not wanted.

trical Water-Gauge.—Oscar von Miller describes, *Zeitschrift für Elektrotechnik*, an indicator used in the l works at Kamannstadt. This station is worked er power, and the instrument is a simple arrange- which a float is connected with various lamp circuits, are closed according to the rise and fall of the water. ircuit in its turn lights a lamp of a different dis- colour, thus showing at a glance how much water able.

nce and Engineering.—We have received from arles Bright a 24-page pamphlet on science and ring. This deals with the progress made between rs 1837 and 1897, and was originally written as an ction to the Victoria Era Exhibition last year. Mr. has had to condense a vast amount of matter into a pace, and hence every specialist will consider his own nent unduly neglected. Thus we find that electric is treated under the same heading as gas lighting, at the information given is rather historical than l.

k in the Press.—Messrs. Emmott and Co., Limited, preparation an entirely new work by C. N. Pick- Wh.Sc., entitled "The Indicator Handbook: a l Manual for Engineers." In Part I., which will be issued, all the various modern instruments are mpletely described, together with the best methods ying and actuating the indicator. The errors of the r and its connections are fully dealt with, while the ons necessary to secure accurate diagrams and the use and care of the instrument are also treated of derable length.

ness Principles Prevail.—When the war the United States and Spain was only in con- ion, we were informed that the employés of the Electric Company would be paid full wages by pany while they were serving their country in the ganised by Captain Eugene Griffin. Now the following notice posted at Schenectady contradicts this. It says: "If employés of the company are called by the Government for service, it will be the intention and desire of the company to re-employ them at the expiration of their term of Government service if they shall not then be incapacitated for duty."

The Benefits of Competition.—The application of the Barking Council to borrow £15,000 for electric lighting purposes was opposed by the local gas companies, although what *locus standi* they had we do not see. One company promptly offered to reduce their charge per public lamp from £4 to £2. 15s. per annum. When it is remembered that in Barking there are nearly 500 public lamps, it may easy be calculated that a saving of 25s. per lamp per annum will be a "climb down" by the gas company of about £600 per annum. Therefore, in this instance, at least, if the Council's application to borrow for electric lighting should for some unforeseen reason fail, the ratepayers will benefit to the extent of £600 per annum as a result of the competition.

A Sign of the Times.—*Indian Engineering* gives the following paragraph to show how Western innovations are being accepted even by the most religious sects in India. At the last anniversary meeting of the Sri Guru Singh Sabha, Ferozepore, there was an audience of over 3,000 Sikhs from Ferozepore and other Punjab districts, and the president discussed the question of lighting up the Golden Temple, Amritsar, with the electric light, and requested any Sikh opposing the proposal to come forward. Some of the leading members of the community spoke strongly in favour of the proposal. Not a single dissentient voice was heard from the assembly, and the proposition was unanimously carried: "That this meeting has no objection, on religious or other grounds, to electric light being introduced in the Golden Temple, Amritsar, provided the durbar funds have not to bear the present or future expenses of the same." The meeting thanked his Highness of Faridkot for providing funds for the electric light.

Telephones in Guernsey.—Progress with the erection of poles and wires for the States telephone exchange has recently been rapid, and it is expected that the exchange will be opened for business by the last week of the present month or the first week in June. The only element of doubt is some uncertainty as to the delivery of the switchboards. These are being specially made for the Guernsey exchange, and comprise several novel devices designed to save labour, facilitate rapidity in making connections, and reduce the chance of error. When two subscribers are in connection, neither the operators nor other subscribers will be able to hear their conversation. The first circuits completed will be St. Peter-Port, St. Sampson's, and the Câtel, including several subscribers at Cobo. St. Andrew's and St. Martin's will be joined up a month or so later, and switch-rooms at the Vale, at the Forest and St. Peter-in-the-Wood will be opened as soon as the necessary number of subscribers present themselves. When all the circuits are opened there will be between 300 and 400 subscribers, which is a good number for a start.

The Bordeaux Muddle.—The recent decision of the Paris Court, by which the gas company at Bordeaux was ordered to discontinue its supply of electricity, has been reversed by the Conseil d'Etat. The decision on appeal is that the concession of the gas company is to be interpreted to apply to new systems of lighting, and that the present rights of the town authorities over the public ways is limited by this concession. In other words, the town has not power to grant other concessions for the breaking up of the road for electric lighting purposes. The Corporation is charged with all the costs of the present and

previous hearings. A Mr. Charles Sirey, an advocate of the Paris Courts, in criticising the above decision, says that the Bordeaux authorities are still in an awkward position. They cannot allow the Société d'Electricité to continue to lay down plant as they have begun to do, and yet Mr. Sirey says the gas company are still bound by the decision of the Paris Court not to supply electricity. As this decision has been annulled, we fail to follow the gentleman's reasoning; perhaps our failure is due to some intricacy of French law.

Electricity in China.—The United States Consul at Hankow reports that Tschangscha, the capital of the province of Hunan, which up to a short time ago manifested the greatest antipathy to the influences of Western civilisation, and where only two years ago the attempt to erect telegraph posts led to riots, may now boast of an electric lighting supply. An electric company has been formed there, and the business places in the town, as well as the residences of the directors and higher officials and the palace of the governor, are provided with incandescent lights. Moreover, at the gate of the palace an electric arc lamp of 2,000 c.p., called a "moon" by the natives, was installed. According to the advertisements issued by the company an electric light of the first degree, whatever that may mean, for the time from sunset to the second night watch (about 10 o'clock in the evening) costs 500 cash, or about 31 cents; the inferior degrees, 32, 30, 28, and 25 cash; the lowest, therefore, only 1½ cents for the evening. Double prices have to be paid for lights which burn during the whole night. Electric lighting has met with such favour that at the last examination of students even the examination-rooms were lighted electrically. At Hankow also some Chinamen have formed a company for lighting the town with electric light, and the requisite capital is already nearly subscribed.

High Insulation on Arc Circuits.—The United States have much more series arc lighting than we have in England. The following question and answer from *Electrical Engineering* shows to what extent it is carried. Thus X. Y. Z. asks: "What, in your opinion, is the best way to secure high insulation on a high-potential arc circuit? We run about 5,500 volts at the terminals, seldom have any bad single ground, but especially in damp weather the insulation is very low, evidently leakage at the insulators, about 600 on the circuit. I should be pleased to have the experience of others who have overcome the trouble." The editor replies: "You need not worry about general low insulation, as such a condition is normal on an arc lighting line of the usual construction in very damp weather. We think, however, that you ought to get better than 600 ohms insulation resistance, and that the leakage is not all over the insulators, but at least half of it is over the lamp suspensions—perhaps three-fourths. If you can spend some time in fixing up the suspensions and terminals and any loop switches you may have, so that you will be certain the insulation resistance of each of these devices is quite high, you should get a test, under the very worst conditions, of 2,500 to 5,000 ohms, according to the state of the surface of the glass insulators." The editor proceeds to advise certain types of insulators and insulating materials.

Amateur Electricians.—In connection with the electrical exhibition to be opened in New York shortly, a model-making competition for amateurs has been organised. The various classes under which apparatus may be entered are given below, and cash prizes and medals for each class. As far as the cash prizes affects the amateur status of the competitors we are not told: (Class A) working model, or actual machine of a dynamo-electric or electro-dynamic type, made by one or more boys under 21, so far as designing, lathe work, assembling, and finishing is concerned; (Class B) instrument of precision, made by amateur or student, such as galvanometers, resistance bridges, electrometers, etc.; (Class C) practical application of electricity to communication, the assembling and finishing to have been the work of a single exhibitor (telephones, sounders, etc.); (Class D) ingenious application of electrical appliances to domestic, etc., uses by an amateur under 18, none of the parts of the apparatus to be necessarily of home manufacture; (Class E) design or working drawing of an electrical appliance or installation, made within the past 12 months by a student of a recognised chartered institution and bearing the instructor's certificate as to its *bonâ fides*; (Class F) design of instrument made by a teacher below the grade of college professor for illustrating some electrical law. The judges will be Prof. Morris Loeb, Dr. W. E. Geyer, Dr. C. A. Doremus, and Mr. T. C. Martin.

Long-Distance High-Voltage Transmission.—An interesting experiment in high-voltage transmission was recently made at Ogden, Utah, over lines connecting the plant of the Pioneer Electric Company at Ogden with the distributing circuit at Salt Lake City, 36½ miles distant. About 500 h.p. of the Salt Lake City station load was run from Ogden for two days with current at 24,000 volts. The atmospheric conditions were unusually severe—rain, fog, snow, and a severe thunderstorm taking place during the test. It is stated that the motors operated without failure, and the lights burned throughout the whole time without flickering. As a further experiment the Salt Lake ends of the transmission line were connected, thus giving a complete transmission circuit of 73 miles over three No. 1 wires. One thousand horse-power was then transmitted at 30,000 volts with water rheostats in circuit at the Ogden power-house. By careful measurement it was ascertained that this power was transmitted with a loss of only 9 per cent., 4 per cent. of which was lost in the step-up transformers. The drop in pressure due to inductance was practically nothing. The power-house is located near the mouth of the Ogden Canyon, the water for which is brought through a pipe line about 32,000ft long. The generators are three-phase alternators, giving 2,300 volts at 60 cycles. Ordinarily, the current is fed into the step-up transformers and raised to 16,000 volts on the transmission line.

The Blackpool Press.—The local newspapers of Blackpool keep a keen eye on the electrical department of the Corporation, and do not forget to make liberal ex... of their own views. The following is a good example of the same: "The members of the Tramway Committee had an interview in London last week with the officials of the Board of Trade respecting the introduction of the overhead system of tramway traction in Blackpool. The Hans... deputation laid their views before the great presences of the Board, and told them a thing or two they probably didn't know about electric traction. That famous deputation—every man-Jack of them—are now 'experts' in electric traction. All about electric lighting (to our cost) they mastered long ago; now they know everything about electricity, and to hear them talk about ohms, volts, amperes, 'E.M.F.,' etc., is a liberal education for all who are lucky enough to sit at their feet for an hour or so. In the meantime, just by way of holding up a high ideal before our Electric Lighting Committee, may we say that electric lighting is proving a successful business in the hands of the St. Pancras Vestry. The profit on last year's working has sufficed not only to wipe out a deficit of £800 on the previous year's accounts, but to provide a balance in hand of £5,717. This gives electric current consumers a lively expectation of reduction in the price some time—if not sooner! When Blackpool does as well, the members of the

ommittee ought to have another Continental outing—on he same terms as the last one!"

Telephone Committee.—On Monday last, in the Iouse of Commons, Sir W. Walrond moved that a Select Committee be appointed to enquire and report whether he telephone service is or is calculated to become of such general benefit as to justify its being undertaken by municipal and other local authorities, regard being had to local finance; and if so, whether such local authorities should have power to undertake such service in the districts of other local authorities outside the area of their own jurisdiction but comprised wholly or partially in the same telephone area, and what powers, duties, and obligations ought to be conferred or imposed upon such local authorities; that the minutes of evidence taken before the Select Committee on the telephone service in 1895, and the report of the commissioner and the evidence taken before him in the inquiry recently held at Glasgow, be referred to the committee for consideration in so far as they relate to the subject of the present enquiry; that the committee do consist of 17 members; that Mr. Bartley, Mr. Griffith Boscawen, Sir Harry Bullard, Mr. Cawley, Mr. Cohen, Mr. Colville, Mr. Firbank, Mr. Fry, Mr. Hanbury, Sir Reginald Hanson, Sir Henry Howarth, Sir James Joicey, Mr. Nicol, Mr. John Redmond, Mr. James Stuart, Mr. Tully, and Sir James Woodhouse be members of the committee; that the committee have power to send for persons, papers, and records, and that five be the quorum. The motion was agreed to, so that we may now get a definite decision on the matter. We are indebted to the *Times* for the above list of names and report.

Magnets Without Magnetism.—The *Electrical World* asks: "What becomes of the internal lines of force in permanent bar magnets when there is no opportunity for the lines to complete a magnetic circuit, is a rather interesting problem, although of no practical value. Such a condition can be imagined by conceiving a hollow sphere made up of truncated pyramidal bar magnets, their north poles all aiming toward the centre and their south poles pointing radially outward and mutually fitting each other to make a mass of steel of the shape mentioned. If any opening is left between the internal hollow of the sphere and the exterior space, some lines, of course, will return through this opening, but provided the hollow shell is made up of perfectly fitting magnets, all of the same E.M.F., there is no opportunity for the lines of any one to close upon themselves. It would seem as though such a sphere would exhibit no magnetic effect on its outer surface, though the perfectly analogous case of a sheet or wall of finite thickness, but infinite length and breadth, made up of permanent bar magnets, their south poles all on one side of the wall and their north poles on the other, would appear to give a polarity on either side. Obviously the lines of force in this case have no better opportunity of completing a magnetic circuit than in the former case." This most interesting question is not difficult to answer, but the following questions of a similar nature are perhaps the best method of treating the subject: "What becomes of the current in a circuit when there is no E.M.F. in it?" "What would become of the Niagara Falls if the head of the falls was at the sea-level?"

The History of a Paragraph.—It is curious, when a number of electrical papers passes through one's hands, to note the way a certain article will run the round of the papers of the world, and, due to faulty acknowledgment of source, be often dished up as original. A full case of this is brought to our knowledge by the March number of abstracts now issued conjointly by the Institution of Electrical Engineers and the Physical Society. To begin with what we believe to be the source, *Dingler's Polytechnisches Journal* published in August last a short illustrated article on "An Apparatus for Indicating a Broken Wire in a Multiphase System." The apparatus is question was devised by Messrs. Schuckert and Co. We translated and condensed this article, using only one set of the illustrations, and published our version with acknowledgment on Sept. 10, 1897. Our namesake, the *Electrical Engineer* of New York, lifted the article whole from our columns and published it on Oct. 7, 1897, without acknowledging our translation and condensation. It then retraversed the ocean, and was used, still untouched, by the *Electrical Review* on this side on October 29. In this case both the German source and the supposed American translation were duly acknowledged. Then the news went eastward, and the French paper *L'Electricien* translated the article as original news. The same block was reproduced split up into three sections, and the article printed on January 15, 1898. This, as is usual in the French technical press, is taken full credit for by the translator without any acknowledgment of source. Naturally, the gentleman who looked through this paper for "science abstracts" took it as original, and the fourth translator thus gets the credit for news which is at least nine months old. In the above chain the American and French links are the faulty ones.

Electricity on a Modern Warship.—Mr. George H. Shepard contributes a well-written article on the above subject to the current number of the *Engineering Magazine*. Speaking of the advisability of using electric motors in place of auxiliary steam-engines, he quotes careful tests made by Mr. W. W. White, of the United States navy, on the exhaust from 13 such auxiliary engines showing an average steam consumption of 99·5lb. per indicated horsepower hour. The economy resulting from the use of electric motors is therefore very apparent, and the author deplores the fact that up to the present they have not been used much on warships. From quotations in the article we gather that the United States are adopting electric motors for turning the turrets on their men-of-war, following the lines of our English practice. After touching on the wiring question and the necessary duplication, the author estimates that at least 1,600 i.h.p. would be required to drive the auxiliary plant on a first-rate protected cruiser and about 2,400 i.h.p. on a battleship. Of course, it is not likely that all these plants will be going at one time, so that the capacity of the generating plant need not be so great; in fact, the author thinks 1,200 i.h.p. would be sufficient. He advocates the use of 220 volts, as for some reason he does not think the 80-volt dynamos can be made sufficiently large. Thus he fixes 1,000 amperes as the maximum current output of a dynamo on board ship, and is thus able to reduce the number required from 13 to 6 by raising the voltage to 220. The additional complication in the search-lighting arrangements appear to us to be against the change, and also the fact that a number of smaller generating sets give more spares on circuit running than a few large sets. The author finally concludes that the extra weight of the electric plant is against the introduction of it into ships for power purposes, but does not consider the fact that the saving in weight of coal to be carried would compensate this.

Electrical War Inventions.—Our American contemporary *Electricity* has evidently sent all its technical staff to the war. Thus, in their editorial column we get such matter as the following: "Examiner Seely, chief of the electrical division of the Patent Office, is credited with having devised an electrical dynamite gun for throwing a large number of projectiles in an exceedingly short space

of time. The weapon consists of a tube made up of a series of coils of wire—a solenoid, in short—which is fed with the explosive shells from a hopper. Along the tube there runs a copper channel, and wires are so arranged as to connect the two ends of the gun with a suitable electric battery. The spherical projectile, as it runs through the tube, closes the circuit at a number of points, its velocity being gradually augmented until it is finally projected from the mouth of the gun with sufficient force, so it is claimed, to throw it a distance of six miles." Again, we learn that "General Edward W. Serrell, the inventor of the hydraulic vertical gun-lift for barbette guns, has also invented a device by means of which a bolt of electricity can be hurled from a height upon the deck of an enemy's vessel that happens to come within certain bounds. The exact nature of General Serrell's invention is not as yet generally known. It is understood, however, that the device calls for the erection of two towers on opposite banks of a river or bay high enough to allow of a vessel passing under a cable stretched between them. On the latter will operate the electrical engine of destruction, which will be under thorough control from the shore. In connection with the device, and in order to show the exact position of the vessel, there will be an instrument somewhat resembling the range-finder. When a vessel enters a certain zone, a discharge of electricity will take place, so it is claimed, striking the ship's deck and tearing its way through to the water." The office boy should get a severe dressing down when the editorial staff comes back.

Building Cars for Export.—Street railway managers, says the *Street Railway Review*, generally express a desire for American cars. As it would be a very expensive arrangement to ship the cars fitted up, "knock down" cars were invented. The knock-down car was a car that after being erected was taken to pieces again and boxed up for shipment. This type of car had some serious disadvantages, and an improved system has been invented by which these are done away with. The J. G. Brill Company, of Philadelphia, have developed a system of building cars which can easily be taken apart and packed for shipment. By this system the car is completed and the wood and iron work properly finished. No glass or upholstery is, however, put in. The inside woodwork is then treated with oil or shellac. After this the car is taken to pieces and packed in heavy iron-bound boxes. The packing is comparatively easy. The parts of the car may be placed in actual contact without sustaining injury. In the old system one of the greatest difficulties was to prevent the varnish and decorated panels from chafing and the glass from being broken. Great expense was incurred in packing the parts, and the boxes were necessarily bulky. In the new system there is little to be injured, as the treated faces of the wood are not easily injured. The space occupied by the new system is 70 per cent. less than was required in the old. The cars built in this style have also a great advantage over those of the old in point of durabilty. There is no sawing apart of the different sections, and it is not necessary to trust to bolts and nuts, as formerly. The new cars are as strong when rebuilt as when first made. All the parts are carefully numbered, and do not require special men to rebuild them. The cars are built to hold 62 passengers, and have one saloon, and are very much the same when finished as the ordinary steam road cars, the posts, however, being rather smaller, and the upper parts are lighter.

North-East Coast Institution.—At the closing business meeting of the above institution's present session, to be held this evening at Newcastle-on-Tyne, the following agenda will be gone through: The discussion on Mr. A. E. Long's paper on "Some Points of Interest in the D of Cargo Steamers" will be concluded; Mr. James will reply to the discussion on his paper on " Ratios"; the discussion on Mr. A. L. Mellanby's "The Effect of Different Arrangements of Crank upon the Economy of Quadruple Expansion Engi be concluded. The president, on behalf of the cou move that the following alterations be made in stitution and by-laws: "Constitution, Article council of the institution shall be elected from and members, and shall consist of one president, t presidents, 18 vice-presidents, 15 ordinary mem council, and an honorary treasurer. Constitution, Ar first paragraph—The president and honorary treasu be elected annually; three vice-presidents and five members of council shall be elected annually. The vice-presidents shall be those who have served six ye ordinary members of council those who have serv years from their last election. By-law 11, secon graph—Any voting paper returning either more than one president, 18 vice-presidents, one h treasurer, and 15 ordinary members of council disqualified for the section or sections in which such occur, and the votes shall be lost for the said se sections. The votes given as president, to a mem is not elected president, shal. count to him as president; the votes given as vice-president, or tr to persons not so elected, shall count to them as o members of council, unless they have just completed of office in such capacity. Addition to By-law synopsis of the subject-matter of each paper s forwarded to the secretary, by the writer, for inser the circular convening the meeting at which the p to be read."

Oxy-Hydrogen as a Mining Explosive idea of employing as an explosive the oxy-hydro generated by the decomposition of water into its ele hydrogen and oxygen—is not new. The stored-up exceeds, weight for weight, that of any other ex known. With oxy-hydrogen gas at atmospheric p the explosion produced is not sufficient for p blasting action. Experiments in this directio *Kuhlow's Review*, have lately been made by Dr. of Cologne, in which the difficulties have been to extent successfully avoided. The new method essentially in decomposing water by the electric in a closed vessel, though the gas generated is not to pass off freely, but is highly compressed by co decomposition of the water, while the receptacle u decomposing the water afterwards serves as a b cartridge. According to *Glückauf*, the generati oxy-hydrogen gas by the electric current is dependent on the current led through it, but in dent of the pressure set up in the vessel, and o account it is possible to store up a larger quan explosive under considerable pressure in a compar small receiver with slight expenditure of power. cartridges used in the experiments consist of two p the pressed-out steel cylinder and the closing plug, a to which latter are the electrodes and igniting wires. steel cases are 18cm. (7in.) long and 3cm. ($1\frac{3}{16}$in.) in dia while the thickness of metal is 2·5 mm. ($\frac{3}{32}$in.), a cubic content 80 cubic centimetres (5in.), the res being put at 1,200 atmospheres. The closing p screwed in, the conductors, insulated with vulcanite, led through it, and both electrodes being formed by or iron nails. The cases are filled with 22·5 grm. (0 distilled water, to which 2·5 grm. (0·087oz.) of che pure soda lye is added to increase the conductivity.

:he cartridge is connected to two electric ignition oduced into the shot hole in the usual manner, and The explosion is brought about by causing an park to pass from one electrode to the other by a Nobel or Bornhardt igniting apparatus.

i Hydrogen.—The *Times* of yesterday announces . Dewar liquefied hydrogen last Tuesday at the nstitution, and exhibited the liquid to Lord , who was fortunate enough to be on the premises ime. Hydrogen has been liquefied before—in That is to say, experimenters have seen or supit they saw a momentary mist inside a glass tube, eked out that equivocal observation with a mass ated results. But Prof. Dewar has actually prole liquefied gas to the amount of half a winein five minutes, by a process which would equally duced a pailful had the requisite supply of pure been forthcoming. This is a perfectly unique ecedented feat. Liquid hydrogen in quantity is of enormous scientific interest in itself, but is also ase importance as placing a new and potent instruthe hands of investigators who have hitherto found gress barred by its absence. The boiling point of id may be placed at from 30deg. to 35deg. of temperature, or, in other words, at about 240deg. ro on the Centigrade scale. Some conception gree of cold attained may be gathered from the a tube closed at the lower end, when immersed in l, was almost instantaneously filled with solid air. e observed, as a matter of scientific interest, that ity of the liquid far exceeds that arrived at by a. There is reason to believe that it will be found out 0·6, water being unity. This result would ry closely with the density of hydrogen when by palladium, as established by Prof. Dewar s ago. Helium is a rare gas which has resisted all attempts to effect its liquefaction. ed in considerable quantity at the Royal Institu- was also liquefied on Tuesday by the use of the rdrogen. Its boiling point appears to lie not very that of hydrogen itself. Liquid hydrogen will as cheap as liquid air, because nature does not he gas in equal abundance. But nothing except now stands in the way of producing liquid n in any quantity that science may require, for investigation of its own properties or for the ion of various lines of research into the constitution r in general.

Origin of the Aurora.—Mr. W. Stuart-Smith, in *Electrical Engineering*, both reviews some theories L. McAdie as to the origin and nature of the aurora and advances new theories of his own. The conclusions are summed up as follows in favour northern lights being due to ozone: We have as lerable ingredient of the atmosphere a magnetic se which probably exists in greater quantities in gnetic polar regions than elsewhere, especially in ather; we find that this magnetic substance is of existing in a state of molecular strain when it s properties very different from those common n its normal condition; we find that this peculiar f strain is produced whenever there is an electric ge in the magnetic substance, or when there is a f intense dielectric strain which may or may not electric discharge; we find that when a mass of this the substance in this strained state has its molecules by a magnetic field, the mutual attractions of the s of the mass should cause it to have a certain of stability which will prevent easy dispersion; sometimes during thunderstorms when violent electric discharges are certain to result in the production of the molecular strain in considerable masses of the magnetic substance, feeble and sporadic displays of aurora are seen. We find that at certain regular periods great disturbances occur in the sun, and that these disturbances are accompanied by violent electric and magnetic changes on the earth, and that electric discharges take place or dielectric strains are set up such as may result in the strained condition of large masses of the magnetic ingredient of the atmosphere; we find a probability of there always being a considerable amount of the strained magnetic material in the polar regions, especially in the upper regions of the atmosphere, away from the dispersive influence of the wind; also there is every probability that the amount of strained material in the polar regions is very great during periods of great sun disturbance, both because the production is greater during those periods than at other times, and because there will be a great tendency to accumulate owing to the magnetic field being more intense during those periods than at other times; finally, there is generally some aurora to be seen in the polar skies, the brilliancy becoming a maximum during periods of great sun disturbance.

Electrical Work in South Africa.—The *British and South African Export Gazette* gives many items of news which show that the advantages of electric transmission of power are bringing it to the fore. Thus we learn that "a power plant has just been installed at the York gold mine, comprising two belt-driven 50-h.p. three-phase inductor type generators, running at 750 revolutions per minute and supplying power to two 24-h.p. motors coupled to belt-driven pumps; also a 3-h.p. motor connected to a centrifugal pump; and several small motors for various kinds of machinery, including one of 9 h.p., coupled direct to a continuous-current dynamo of 15 volts 300 amperes output, for cyanide work." Again, "an electrical plant recently sent out to the Vogelstruis gold mine by the General Electric Company, Manchester, consisted of two 150-kw. three-phase generators, belt-driven at a speed of 300 revolutions per minute, a frequency of 30 cycles and a pressure of 950 volts; three triplex single-acting pumps, with plungers 6½in. by 8in., coupled direct to 35-h.p. motors running at 360 revolutions. Speaking of the increasing difficulty which the South African mining industry, and in particular that of the Rand, has experienced in procuring a sufficient supply of native labour, this fact has given a great stimulus to the introduction of machine drills. A variety of these have been imported, chiefly from America, or invented to meet the requirements of the mining industry, and have been largely adopted by mining companies. Opinions, however, differ as to the economy of their employment as compared with hand labour, although it is admitted that they have the advantage of placing the mines in a position of independence with regard to hand labour in cases of emergency, and often do away with the necessity of stopping driving power. The drills in use have been found to work well in large stopes, but less so in small. The chief desiderata of a good stoping drill are considered to be (1) lightness, so as to be easily handled; (2) strength, so as to reduce repairs to a minimum; and (3) economy in air (or other power) consumption. The drills known on the Rand are driven by air and steam, but the latter has been found very objectionable in working. No electric drill has, however, yet been placed on the market so far as we are aware. This affords an opening for English electrical invention, which it is to be hoped may be taken advantage of for the credit and profit of home industries, as the market for this class of tool in South Africa is undoubtedly large and growing.'

ELECTRIC SHOT-FIRING IN MINES.

The most economical, up-to-date, and safest method of shot-firing is a matter for consideration and of great importance, both in mine-sinking operations and in the workings of the mine, especially when the explosive is used on a large scale. Considering the danger attached to shot-firing by the ordinary powder fuse for sinking purposes, it would prove to be advantageous, safer, and more economical both for the employer and employed if an Act was brought into force for it to be abandoned, and the shots compelled to be fired by means of electricity.

At the Grimethorpe Colliery there are from 750 to 1,000 shots fired weekly by means of electricity on the low-tension system, arranged from the lighting mains at a distance of about 1,000 yards from the dynamo, which has an output of 12 kw. at a terminal voltage of 110. Electric shot-firing is a method by which a large number of shots can be fired at the same time, the limit being determined by the following factors: (1) the terminal voltage and current of the source of supply; (2) the method of connecting the detonators to the mains—*i.e.*, in series or parallel; (3) the difference of potential between the source of supply and the electric detonators; (4) the voltage of one detonator; (5) the difference of high and low tension electric detonators.

Before these factors are known or determined, it would be unwise to proceed with the practical work of electric shot-firing, therefore I will devote a few lines to each of them. (1) The terminal voltage and current can easily be determined by using volt and ampere-meters, and it must be in excess of the voltage and current required by the detonators and the drop in volts in the line. (2) The method of connecting up—*i.e.*, in series or parallel—is determined by the voltage and current available at the point of connection of the detonators to the mains when the voltage of the source of supply is considerably in excess of the voltage required by the detonators; then couple the detonators in series, and when the current is large and the E.M.F. equal to the E.M.F. required by the detonators, couple up in parallel. (3) The difference of potential between the source of supply and the detonators which have to be fired is equal to the C R loss in the line. (4) The voltage which is required by one detonator is determined by using a rheostat or regulating resistance, placed in series with a primary battery of about three volts, arranged so as to put the resistance in the circuit with the detonator so as to lower the voltage of the battery to about ·2 of a volt at the commencement of the test; the resistance is gradually taken out of the circuit until the detonator fires; at this point the resistance of the rheostat is noticed, then the voltage which has fired the detonator is thus obtained. It is very essential that the test should be properly carried out—that is, the detonator put into an enclosed iron box—so as to prevent an accident occurring.

When the above particulars have been carried out and thoroughly understood, as the fifth factor is determined beforehand, when the detonators are bought, I may say that if the source of supply is low-tension, then it would be useless to buy high-tension detonators, and *vice versâ*. It is very essential for economy that, before putting the detonator in the explosive, it should be tested for continuity and short-circuits, and properly sealed at the point where the wires enter the detonator, by means of a suitable insulator, so as to prevent moisture or water entering into the detonator, and so destroying the connections of the detonator wires at the small platinum contacts. A cheap and efficient insulator for this purpose is Chatterton's compound, mixed with a small quantity of tallow, or it may be made by using Stockholm tar, resin, and guttapercha in the ratio of 4, 2, and 1. It is then put into the explosive and the whole properly sealed off and made ready for taking into the borehole; it should be connected up to the mains so as to give the best result in firing. The connections between each detonator and the mains must be properly insulated, which, if not done in a workmanlike style, may result in a miss-shot. The free ends of the detonators are coupled to a circuit that must be left open at the other end by means of needle points for contact-making or a co[...] plug and socket. When the circuit is completed b[...] of the concentric socket and plug, or by the needle[...] pierce through the electric lighting mains in[...] so as to touch the conductor of the cable, a [...] flows through the detonators, causing the small p[...] wire to become incandescent. As the platinum wi[...] contact with fulminate of mercury and chloride of [...] sium, it causes it thus to explode, the force of the ex[...] or detonation firing the shots.

In order to do the firing and lighting by means [...] same cable in the shaft, it is essential to be able to w[...] cable up from the bottom of the shaft a distance of [...] than 80 yards, because of the shattering effects of t[...] injuring the cable. At the above distance from the [...] a small cable should be suspended to the side of th[...] by means of rubber or leather bands, these support[...] arranged so that the small cable can be gradually low[...] the sinking operations proceed. This small cable is [...] so that it is impossible under ordinary circum[...] to fire the detonators whilst it is being co[...] up. The persons superintending the shot-firing [...] make any mistake if the shots are so arranged to [...] at the surface or at the aforesaid distance from the [...] of the shaft. An instance occurred at our work[...] shots which were to be fired by means of electricit[...] same time missing fire. The 20 electric detonat[...] properly tested by means of the magneto machine [...] tinuity before being sealed off in the explosive; th[...] then connected up to the cable, which was fixed to [...] side. The circuit was properly closed by mean[...] needle points piercing the insulation of the lighting [...] The detonators were afterwards examined, and it w[...] that the insulation between the mains and the d[...] connections had broken down, thus earthing the m[...] short-circuiting the detonators. Another effort w[...] to fire them, this time firing 10 only. The caus[...] remaining 10 being unfired was a dead earth betw[...] tenth and eleventh detonators, there being a smal[...] of leakage on the mains, thus short-circuiting [...] detonators not fired. Therefore it is necessary [...] everything properly insulated as far as possible, [...] mains free from leakage anywhere between the [...] and the detonators.

If the above conditions are carefully carried out, [...] be no doubt of the superiority of the electric metho[...] firing over the fuse method. When the number [...] to be fired at once is large, then it is impracticab[...] a magneto unless specially designed. A magneto [...] is all right to use when there are only a few ho[...] fired, and it is also very useful for testing the [...] of the low-tension detonator wires, as it is the [...] effects of the current which cause the low-tension d[...] to fire; and as the magneto generally gives off fro[...] 150 volts, and only a small current depending on [...] of rotation of its armature, it therefore answers [...] factorily for a low-tension detonator tester.

Now the advantages of the electric method over [...] method of shot-firing for sinking purposes are not [...] seek. For instance, take a case of 20 shots to be [...] distance of 500 yards from the surface. Each fuse [...] lighted separately by means of a red-hot iron or b[...] when the shots are lighted, the shot lighter ha[...] ascend the shaft by means of the winding engine [...] he gets into the trunk and then rings the sign[...] engineman. Just imagine the result if the signal [...] the engineman does not understand the signals, [...] engines fail to raise the trunk off the bottom [...] being short of steam. There he is, conscious of th[...] What is the result? He cannot stop the fuse from [...] the shot and exploding it, so there he has to remain, [...] to be sent into eternity or get injured for life. S[...] have occurred in the past. There is no fea[...] when using the electric shot-firing method, as [...] can be fired on the surface or in the dynam[...] preferred. Then, again, the fuse method cann[...] much work as the electric method for the same n[...] shots, owing to each shot being fired separately, by [...] rate fuses not being cut exactly the same length, [...] the time of the fire from the fuse reaching the [...]

r to the uniformity of the fuse itself; and as go separately as a rule, they cannot cause so nount of energy to be brought into force on the all the shots will fire at the same time by the thod there is more work done, and greater shatter- brought to bear on the rock, hence there saving in time. As disastrous results have when using the fuse method, in some cases ses of an explosive nature being ignited when the been lit, it is far preferable to use the electric ving to its being more free from this risk.

lusion, in comparing the costs, they are about for electric low-tension detonators the cost is er 1,000, and £6. 6s. per 1,000 for high-tension. etonators the price is £2. 5s. per 1,000, and the ed for the 1,000 detonators is 250 coils at 7½d. ost of the fuse would be £7. 16s. 3d., total cost onators and fuse = £10. 1s. 3d. Therefore, the -tension method of shot-firing is only 8s. 9d. per than the fuse method of firing; but, as I have the electric method of shot-firing more work e, and it is in about the ratio of 2 to 1.

COMMITTEE ON ELECTRICAL ENERGY.

Generating Stations and Supply.

THIRD DAY.

(Continued from page 556.)

nburne *(continued)*.—The witness stated that the network must be arranged to suit the district and supply. The demands upon central stations should be first lighting, then power for motors, light railways, electrolytic works. With large central stations, places might adopt the light that could not afford to do so if they had to find capital for stations as well as mains. He thought in many districts where factory work had stopped home work, the ability to get power might lead to the development of home work, because any small cottage could have its motor and run its looms. Suitable motors are now to be obtained, and as people realise this they will increase in use. Light is wanted mostly in the winter and in the evening; power is required during the whole working hours. He thought the authority at the end of the 42 years would be in a good position to put pressure on the station outside its area, for it might purchase the mains, and the station would have nothing to do unless it could supply the authorities, and this being so would supply very much on their terms. As regarded compulsory powers, they were wanted as a means of overcoming the obstinacy of any few people that might give trouble. Central stations were not such a nuisance as engineers' shops, but folks looked at the stations with a microscope, finding fault with everything that they could not notice in ordinary business. There ought to be no irremediable trouble so far as telegraphs and telephones were concerned. As regards voltage, conditions could be made to guard against danger. Niagara was working with 11,000 volts, and was going to work at 22,000. He had for experimental work used 160,000 volts; and abroad high-pressure and extra high-pressure mains were carried both overhead and underground. In colliery districts an element of danger to underground mains is due to subsidences.

Mr. Henry Graham Harris.—This witness put in a list of power transmission stations—thus:

ST OF LONG-DISTANCE TRANSMISSION OF POWER BY ELECTRICITY AT HIGH VOLTAGE.

Name of station.	Horse-power of units.	Present total capacity of station in horse-power.	Distance of transmission in kilometres.	Line pressure in volts.	Purpose.
bronn (see Lauffen-Frankfort) ...	300	600	10	5,000	Light and power.
rich	300	300	15	5,000	Power.
Oerlikon (see later)	300	900	25	13,000	Ditto.
rol..........................	100 200	300	2	1,800	Light and power.
urtemburg	100	200	11	5,000	Ditto.
France	300	600	6-15	5,000	Ditto.
rance	100	200	—	5,000	Ditto.
many	150	300	15	5,000	Ditto.
France.......................	600	600	0·8	1,000	Power.
-Zurich......................	325	1,300	18	5,000	Ditto.
Tyrol........................	100	200	2	1,800	Light and power.
in	200	200	2	1,800	Ditto.
gen, Germany	175	350	4	5,000	Ditto.
....	150	450	—	3,500	Light.
fornia	120	—	12·5	3,390	—
-Lucerne	—	120 Transmitted.	Portion above ground, 3,040m.	1,000	—
-Zurich......................	—	300	12·5	3,000	—
orks (see earlier)	say 77	say 231	14·5	up to 13,000	Power.
angesburg, Sweden	100	300	8·5	up to 9,000	Ditto.
Mines, South Africa..........	—	—	5	3,300	Ditto.
....	—	—	—	—	—
....	300 kw.	1,800 kw.	19	5,000	Power and light.
is, Spain	110	220	30·7	6,500	—
nkfort	300	300	175	25,000	—
tuttgart	250	1,000	13	5,000	Light and power.
....	75	300	—	4,500	—

the telephone wires and high-pressure mains laid in the same trench, and had been so working r four years. There is considerable economy in large central stations over small ones. With the coal cost to a station at the pit's mouth, as sted the Midland Company's station would be, ct price to that station is 2s. per ton as against 15s. and 17s. 6d. at some London stations. The is not so good as that used in London, but is —smudge. The witness agreed with Mr. Swin- o the practical safety to use overhead wires for ge.

Mr. John Francis Albright gave it as his opinion thrt a station desirous of selling only in bulk should be relieved of the liability at present involved in working under a provisional order, of supplying any individual who demanded a supply. Work for the general good, again, should not be at the mercy of any one authority. He had calculated that they could sell electricity on an output of 16,000,000 units at an average price of 1·33d. per unit. When the consumer used the energy eight hours a day, to those whose demand was over longer hours they could probably sell at 1d. per unit. In the order being promoted by witness the maximum price for lighting is

6d. for the first hour and 3d. for subsequent hours, but for power 3d., and even 2d., is too high a price for the Black Country. The consumer could not afford to pay it. They would use the demand indicator system in the Black Country, charging 3d. for the first hour and ·825d. subsequently, that averages out at 1d. per unit for the customers who use it 12 hours. For a 12 hours' use per diem it would be as nearly as possible £12 per annum per horsepower.

Mr. Henry Laurence Cripps explained the position of the Metropolitan Electric Lighting Supply Company, whose business has so increased, and who found it impossible to get suitable sites within their area, that they are seeking powers to have a station outside London. An agreement has been made with the Grand Junction Canal Company as to running mains, and the Metropolitan Company requires compulsory powers as to a strip of land.

Mr. Lloyd Higginbottom explained the work carried out by the city of Manchester, and that with the consent of the Board of Trade they could supply outside authorities. Some authorities have agreed as to the supply, and others are arranging to do so. The expenditure at Manchester is £356,169, with 230 miles of mains and a lamp load of 184,542 8-c.p. lamps, which are being added to at the rate of 1,300 a week, with never less than 22,000 waiting connection. They have just bought $8\frac{1}{3}$ acres of land within the city area to build a station of 100,000 h.p., which, with the existing station, will give them a total of 120,000 h.p. It had been decided to municipalise the tramways and equip them electrically, and they feel strongly that no private company should have power to break up the streets. The Manchester undertaking has been profitable and advantageous to the citizens. The result of deductions since commencing working is that the price averages 4d. per unit, and the other authorities taking energy in bulk will be treated as themselves. Power is supplied at $1\frac{1}{2}$d. per unit, and they have about 2,000 h.p. on every day, with an average of eight hours per day. The views of the authority as regards the question of reference was handed in as follows:

"Electrical energy (generating stations and supply). Memorandum of Manchester and others upon questions referred to Joint Committee:

"*First Question.*—Local authorities should be enabled to acquire lands compulsorily for generating stations, and the Electric Lighting Acts should be amended to enable the Board of Trade to confer the power by provisional order. It is also agreed that companies should be enabled to acquire lands compulsorily, either by provisional order or by Bill. Undertakers in the exercise of their statutory powers should be exempt from proceedings for nuisance if they carry on the undertaking with due care. The exemption should apply whether the lands are acquired compulsorily or by agreement, but should only apply in respect of lands scheduled to the provisional order. No impediment should, however, be placed in the way of undertakers using other lands than those scheduled for a generating station, subject to the ordinary liability in respect of nuisance. Prior to making the application in respect of scheduled lands, the undertakers should be required to serve notices upon the owners and lesees of dwelling-houses within 50 yards of such lands.

"*Second and Third Questions.*—As far as possible, the whole of the undertaking should be kept within the area of supply, and the generating station should not be placed in another district in the absence of special circumstances, and unless distinct power is conferred upon the undertakers, and such power shall not be conferred without the consent of the local authority for the district in which the station is proposed to be placed, unless under the special circumstances of the case the Board of Trade consider that such consent should be dispensed with. Provision should be made in regard to the laying of mains between the generating station and the area of supply, the local authority having the power to prescribe the route and manner in which the work should be done, subject to the appeal of the Board of Trade. The local authority should also have the right to do the work (if they think fit), at the expense of the undertakers. If the generating station is placed outside the area supplied exclusively from such station,

power should be conferred upon the local authori
area to acquire the station and the intervening m
the terms of Section 2 of the Act of 1888.

"*Fourth Question.*—No such schemes as are r
in this question should be authorised without t
of the local authorities of the districts compri
the proposed area of supply or affected by any
works, unless under the special circumstances o
the Board of Trade consider that such consent be
with. If there is to be any alteration in th
practice of Parliament (who at present refuse
Bill powers which can be obtained by provisio
under the Electric Lighting Acts), the same cou
adopted in the case of tramways should be follow
Standing Order should be passed prohibiting the
of powers to supply energy in any district wi
consent of the local authority of such district. I
where power is conferred to supply energy i
districts, the local authorities should be empo
acquire the undertaking jointly, and each authori
be empowered to acquire so much thereof as
within their own district (other than works not
for the supply thereof or required for the suppl
districts), upon the terms of Section 2 of the Act

(To be continued.)

THE WIMBLEDON ELECTRIC LIGHTING SC

BY A. H. PREECE, A.M.I.C.E., ELECTRICAL ENG

Wimbledon was the scene of one of the earliest a
the use of electricity for street-lighting. In 1884 a l
of experiments were carried out, under the superinte
W. H. Preece, C.B., F.R.S., for the Local Board an
Commissioners of Sewers. Many interesting res
obtained. However, nothing more was done in t
until 1890, when a license was obtained from the
Trade, and a complete scheme was prepared by M
Preece and Mr. Kapp for the lighting of all the
Wimbledon and for the supply of electricity to priva
For various reasons this scheme fell through, but
1896, the author was instructed to prepare a ne
which was unanimously adopted by the District
After having obtained a provisional order from P
in 1897 instructions were given to obtain tenders,
the last two months contracts have been entered in
carrying out of the scheme. There is every possib
supply for public and private lighting being ready
1899.

For reasons which it is unnecessary to enter into,
have been lighted for many years by oil lamps, whic
the average 20 c.p. It is generally considered that
streets, at any rate, require better illumination. Oil
cheap, the average cost being about £2. 10s., and th
been somewhat difficult to increase the street-lightin
increasing the annual cost. The author, however, h
able to show that there is little reason to expect
increased cost, though the total quantity of light wi
than doubled.

The present scheme provides for the lighting of th
the existing public lamps. There are at present
fixed, and these will be replaced by the equivale
lamps of 32 c.p. A certain number of the lamps, in
positions, will be provided with two or more lamps
Besides these public lamps, which alone will ta
200 h.p., provision is being made for a demand of 6,
of 8 c.p. in private houses. In order to supply ele
all the public lamps, it is necessary to lay mains in
every street in the parish; and, as means will be
enable private consumers to be supplied at the sam
will be possible for every house to obtain a supply if
Of course, special mains will not at present be l
where for private houses, but, by means of the syste
it will be possible without great expense to suppl
mains anywhere, and to enable either public or pri
to be supplied.

System.—The system of generating and distribu
tricity which has been adopted is that known as
pressure alternating-current system. The electrica
generated by alternators at a pressure of 2,200
wherever it is required for use in lighting public
private houses it is transformed down to the safe p
200 volts. This system is the only practical system
be used in the Wimbledon district owing to the larg

* Paper read before the meeting of the Incorporated
of Municipal and County Engineers at Wimbledon, Apr

the scattered houses. By using high pressure it is possible to transmit the energy everywhere with small copper cables, and thus the expenditure is kept within reasonable limits. The transforming apparatus, which is stationary, and consists of a mass of iron plates surrounded with two windings of copper wire similar to an induction coil, is placed wherever necessary to serve low-pressure circuits for public lamps or distributing mains for private houses, and also, in some cases, where a large installation has to be supplied. They will be placed in underground chambers of varying sizes, according to the quantity of electricity which has to be transformed. When electricity is distributed by low pressure, the three-wire system will be used with 400 volts across the outer, or 200 volts between each pair of wires. The disadvantage of the alternating-current system is the necessity of having generating plant running all day and night, as it is not possible to use a storage battery economically. But as the generating works will be placed adjacent to the sewage pumping station, and also in conjunction with dust destructors, this disadvantage will not be so great as usual, as steam will be available throughout the 24 hours.

Site.—The site of the generating works has been fixed on the north-western side of the existing pumping station, the advantage being not only the possible combination of the two plants, but also the extent of the ground available and the existence of the repairing shops, etc.

Buildings.—The buildings will consist, in the first place, of an engine-house, about 30ft. wide and 45ft. long, built alongside an existing cottage which will be utilised for offices. A temporary wall will be left at one end to enable extensions to be conveniently added. The first boiler-house is being built wide enough for dust destructor as well as the boilers, and it will be 45ft. wide and 80ft. long. The existing coal store will be utilised as far as possible, but when the tipping platform for the refuse is built, a coal store will be arranged beneath. The chimney will be 120ft. high and 6ft. in diameter inside, and arrangements are being made to have two inlets, so that one line of flues may be cleaned as required without interfering with the working of the plant.

Engine-Room.—The engines and alternators first installed will consist of three Willans engines, coupled direct to three Crompton alternators with exciters. The output of each set will be 120 kw., or approximate 200 i.h.p. The Willans engines are high-speed engines running at 350 revolutions. They are closed in, and lubricate themselves. The alternators have revolving armatures of the disc type. The guaranteed combined efficiency of the plant is to be 80 per cent., and the steam consumption will be 28·5lb. per kilowatt.

Boiler-House.—The first plant installed in the boiler-house for the generating plant will consist of three Babcock and Wilcox boilers. They are of the water-tube type. Each boiler is guaranteed to evaporate 5,000lb. of steam per hour, and they each have a heating surface of 1,700 square feet and a grate area of 35 square feet. To one of the three boilers a dust destructor will be afterwards added, but the remaining two will be kept for hand firing alone. A fourth boiler will be connected to the second dust destructor, and both the destructor boilers will be arranged so that hand firing can be used when required.

Condensing Plant, Pumps, etc.—It is not intended to fix a condensing plant at once, but arrangements will be made for the addition of a surface condenser. The pumps and all steam and feed pipes will be arranged in duplicate, so that the failure of any portion shall not affect the working of the plant.

Switchboard.—The switchboard, to which the electricity generated by the alternators is taken and thence distributed to the various circuits, will be fixed in the engine-room. It will contain all the necessary regulating and recording instruments for the alternators, exciters, and circuits. One pole will be earthed, so that only single-pole switches and fuses are necessary. The regulating will be done entirely by hand on the switchboard, and with the system adopted it is anticipated that no difficulty will be experienced in providing an equal pressure over the whole district. A maximum loss of 5 per cent. is being allowed, and this is arranged so as to be equal in all feeders. For measuring the energy produced, separate meters will be provided in each of the main feeders, so that a complete record will be kept of the output. It is probable that separate meters will also be provided in the main sub-station, to record the amount of energy used in the public lamps. Testing will be carried out by means of standard instruments, which will be fixed in a special room in the offices.

Mains.—The mains are divided into two sections, the high pressure and the low pressure. The high-pressure mains consist of the feeders or trunk mains, which conduct the energy for public and private lighting to the principal distributing points of the district, and the sub-feeders, which are arranged separately for the public and for the private lighting. Thus at the distributing centres the public lights and the private lights are separately controlled, and therefore independent of each other. The whole of the high-pressure feeders and sub-feeders are concentric lead-covered cables. They are drawn into earthenware pipes, and they can thus be increased as the demand in the different districts increases. There are three distributing centres, and thus three trunk mains. These trunk mains are interconnected in case of accident to any one of them. They are of large area. The sub-feeders are of small area, and each feeder supplies the high-pressure energy along certain routes, and at fixed points it is transformed in sub-stations as required. The sub-stations for the public and for the private lights are kept generally distinct from each other. It is intended that the public lamps shall be turned on and off from the main distributing points, and thus it will only be necessary to send a man to three points to light up all the streets. The low-pressure mains are both concentric and three-core cable, and these are laid on two systems: (*a*) wherever the demand for private lighting is uncertain, and the pavement is such that it will be somewhat difficult to cut and remake, pipes are to be laid so that the low-pressure for the private lighting and the public lighting may be drawn into the pipe as required; (*b*) wherever the demand for private lighting is certain to arise, both public and private lighting mains are heavily armoured and laid direct in the ground. Where it is doubtful as to the private lighting demand, and where only gravel pathways exist, public lighting mains only are to be laid, and these will be also armoured and laid direct in the ground.

Sub-Stations.—The sub-stations, or transforming points, will be of such a size as is consistent with the demand. In them the transformers will be placed, and also fuses to control the different public lighting circuits. The private lighting sub-stations will be similarly arranged.

Public Lamps.—The public lamps will be arranged from five to ten in a circuit, on the three wire-system. Each lamp will be provided with an accessible joint-box to facilitate testing and connections, but switches or fuses will not be provided to each lamp. The lamps are generally 32 c.p., but in the main streets, such as Broadway, Hill-road, High-street, and part of Merton-road and the Ridgway, two or more lamps will be provided in each part. It is intended to utilise as far as possible the existing oil-lamp posts, which are easily and simply adapted for electric lamps. It will only be necessary to remove the oil lamps and fix a tripod carrying the incandescent lamp. It is not intended at present to use arc lamps anywhere, but it is possible that a few enclosed ones may be experimented with. It is, however, generally found that the mixing of arc and incandescent lamps tends to considerably reduce the effect of incandescent lamps, however large, owing to the different colour in the light given.

Expenditure.—The cost of the scheme will be as follows, exclusive of the dust destructors:

Buildings	£3,000
Machinery	8,500
Mains	15,000
Transformers	2,000
Public lamp connections	1,100
Private house connections	600
Engineering and contingencies	1,800
	£32,000

From the tenders already accepted it is not anticipated that the above estimate will be exceeded. It will be observed that the expenditure in mains is the most serious item. This is due to the enormous area to be covered. It has been necessary to provide for about 40 miles of streets, involving no less than 15 miles of high-pressure mains, 50 miles of low-pressure mains, and 20 miles of pipes.

Income and Expenditure.—The great advantage of starting an electricity supply works with a large quantity of public lighting is that it ensures a comparatively even output. The generating plant is kept working at a high state of efficiency for many hours instead of, as is frequently the case in works without public lighting, for two or three hours per day. In Wimbledon the works are certain of using the plant for the first year or two at 50 per cent. of its full output for an average of 10 hours a day, and throughout this time one engine and dynamo will be working at full load—that is, at the best efficiency. This makes a very large difference in the cost of generating electricity. The author has hopes of producing energy as low, if not lower, than many stations which have been at work for some years. The undertaking also starts with an assured income. The present cost of public lighting is about £2,000 per annum, and this income will belong to the electricity department. It has not been expected that the adoption of electricity will effect a reduction in the cost of public lighting—in fact, the author stated in his report in 1896 that the additional cost will probably be £550. It cannot be considered an excessive increase when it is recollected that the quantity of light is more than doubled. The revenue from the private lighting is naturally uncertain, but from the applications and enquiries which are already coming in there is little doubt that it will not be long before the full capacity of the plant is reached. Assuming, however, that 5,000 lamps are connected, then, with 6d. per unit, which has now been agreed upon as the price to be charged, it is a moderate estimate to take the probable income as £1,750, or about 7s. 6d. per lamp.

The expenditure necessary for lighting the public lamps, and for providing electricity for the 3,500 private lamps, can be fairly accurately estimated from results obtained from other undertakings. The quantity of electricity required to be produced is known, and there is no reason to doubt that it will be possible at Wimbledon to produce electricity as economically as in other works. At Hammersmith, where the author has erected works for the Vestry, the result of the first nine months' working shows that the cost per unit, when 40 per cent. of the total output is for public lighting, is 2d. In Wimbledon no less than 80 per cent. of the output will be for public lighting; thus there is every possibility of the cost being even less. If, however, the costs are taken at 2d. per unit, the total annual expenditure to produce the quantity of units required by the public and private lighting will not be less than £2,500. In addition to these costs there are the charges for interest and the sinking fund. This will not be less than £1,700 per annum. Thus the total annual expenditure will be:

Generating costs	£2,500
Interest and sinking fund	1,700
	£4,200

The revenue would be:

Present cost, public lamps	£2,000
Income from private lighting	1,750
	3,750
Deficit	450
	£4,200

That is to say, the extra cost of the improved public lighting will be about £450. But this is likely to be reduced as the demand for private lighting increases. If the private lighting is not so great as anticipated above, then the deficit will be slightly greater, and though this may happen in the first 12 months, it will be exceedingly doubtful whether the second complete year will not see a larger revenue than is anticipated.

Utilisation of House Refuse.—This is about to be tried in connection with the electricity works, but it is impossible to be able to state what results will be obtained by the generating plant. It depends greatly on the calorific value of the refuse. In any case, however, the District Council will be able to get rid of the refuse cheaply. The destructor is necessary, and a combination of the electricity works and the destructor is therefore economical as regards capital expenditure, and likely to be of value in the combination of two stoking staffs. There is little doubt that a certain quantity of heat will be available from the destructors, but during the evening it is not likely to be sufficient to produce all the steam required for the generating plant. However, in the daytime, and perhaps after midnight, the steam generated from the dust should be sufficient to supply both the pumping works and the electricity supply works. This alone should reduce the annual expenditure in coal. Therefore, even if the question is looked at from an entirely unbiassed point, it seems that there is every possibility, if not probability, of great advantages being obtained. The author has no reason to doubt that it will be shown that the streets of Wimbledon will be economically and well lighted by electricity, that the private supply will be largely taken up, and that the destruction of the refuse will enable the ratepayers to get full benefit from the investment of the moneys under their control in these commercial undertakings.

INSTITUTION OF ELECTRICAL ENGINEERS, May 5.

The Prevention of Interruptions to Electricity Supply.

BY LEONARD ANDREWS, ASSOCIATE.

It is probable that some central-station engineers will remark, on reading the title of this paper, that it is several years behind the times; that interruptions to the supply from a properly-equipped modern station never now occur; that at their own particular stations the supply has never once been interrupted since it was started, etc. It speaks volumes for the progress of electrical engineering during the past few years that there are several existing central stations that can show an absolutely clean sheet in this respect since their commencement, and everyone will agree that their engineers hold a very enviable position. It is very doubtful, however, if any one of them can say that they have not a consumer connected to their mains who has during the past 12 months ever had his supply disconnected; and, if that is so, surely there is sufficient room for improvement to make the matter worth discussing. After all, it is these local interruptions that are so irritating to consumers. Our experience has been that we get far more abuse from a consumer whose lights fail when his neighbour's lights are burning satis-
factorily than we do if they are both suffering
Some of the engineers who have achieved such an
record attribute their immunity from failures to the
they use fuses made of copper of the same sectional ar
mains. There can be no doubt that a large majorit
interruptions that do occur are caused by fuses blowi
they have no business to do so. Yet it does seem rat
to use no safety devices at all. We have already heard
than one case where an arc of a few thousand horse-p
been started under the pavement, and would not be
until the supply had been switched off from the wo
the other hand, when one remembers upon what a nu
fuses the continuity of an average consumer's supply
dent, it is really wonderful that he is not more ofte
darkness. It is no exaggeration to say that there
from 15 to 20 fuses between the generators and the la
supply. Is it, then, to be wondered at that we are
told that electricity supply is not to be relied upon!
be different if we could always depend upon fuses bl
approximately the current they are set for. But we
It is no uncommon case to take two similar fuses t
been in use for some months and find that one requir
100 per cent. more current to blow it than does th
The fuses used on alternate-current circuits appea
particularly erratic in this respect.

The *Electrical Review* drew attention to this fuse tr
one of its leading articles a few months ago. Sti
recently, Mr. W. B. Sayers, in an article on the subjec
"In a city less than 100 miles from where I live the
electricity works which, so far as I am aware, has not f
maintain its supply for a single minute during the last
five years; and yet the popular belief that the 'electric
not reliable' is maintained to this day, and with good
. . . Now the only proper cause, in my opinio
main fuse 'blowing' is a short-circuit on the mains, a
have no hesitation in saying that less than 1 per cent
cases of main fuses 'blowing' are due to this cause."

The conclusion that we have come to at Hastings is
only reliable conductor of electricity appears to be a
cables; and, consequently, it seems advisable to re
fuses, switches, safety devices, and mechanical connec
any description to a minimum. If any fuses that it is cu
to use can be omitted, everyone will admit that they
source of danger, and, consequently, better omitted.
for instance, the fuses between alternate-current ge
and the 'bus bars: what are they used for? They ca
necessary to protect the machines from being over
because all modern makers claim that their machines
short-circuited with impunity. Presumably they are i
to prevent a generator that fails short-circuiting other m
working in parallel with it; but everyone knows that
or three machines of an equal output, and equally fa
working together, it would be the fuses of the healthy ge
that would blow, and not those of the faulty one, beca
former have to carry sufficient current to blow the la
addition to all the useful work on the mains at the time.
what should we think of an omnibus driver who cut th
of one of his horses because it attempted to do more
share of the work, or who, when one of them fell dow
made the remaining horse drag the dead one along in a
to the extra work thrown upon it by the decease of its co
This sounds absurd, but it practically represents the ma
which we alternate-current station engineers have been e
to treat our machines, for are we not taught carefully to
them with safety devices to cut them out of circuit just
time when all their energies are required to burn out a
circuit on the mains? whereas any device to prevent a
machine from short-circuiting others is considered q
unnecessary piece of apparatus.

In continuous-current stations, zero cut-outs or di
nating cut-outs are generally used in preference to
current cut-outs—the word "discriminating" being
designate a cut-out that operates only when the
is flowing through it in a reverse direction to its
Magnetic cut-outs of any description have not hithert
looked upon with much favour in this country. The maj
those now in use require too careful and delicate treat
be popular. Only people who have attempted to design a
and trustworthy discriminating cut-out can realise the
of difficulties that have to be overcome in doing so. It
enough to make an apparatus that will operate under
specific conditions in the workshops, but it is a very d
matter to construct a cut-out that can be relied upon
the circuit of a failing generator with a very small
current, and that can be guaranteed never accident
operate at any time when it is not required to do so.
first place, the sectional area of the winding must b
enough to carry the maximum current of the generator
undue heating; at the same time, the apparatus must b
and compact, consequently the turns must be few; and,
it must operate with a return current of only a small per
of the maximum current, therefore the ampere-tu

force must be small. This generally involves the ıte releasing mechanism or relays, which require nent, or they will operate at the wrong time, and ailure occurs. These are only workshop difficulties. ious are those which confront us when the apparatus er actual working conditions. Take, for instance, ero magnetic cut-outs. Everyone knows that these e to operate only when the current falls below a ed amount, and yet it is also well known that if a

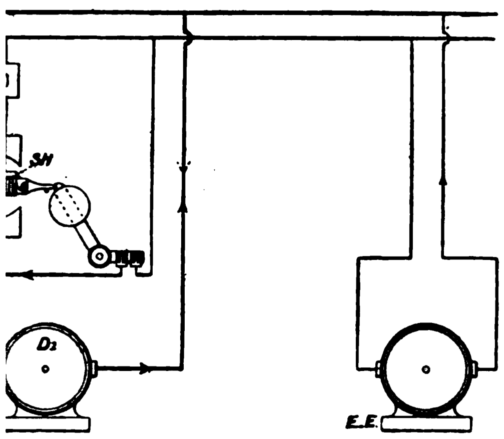


Fig. 1.

occur on a system of mains supplied by a number s equipped with zero cut-outs, several of the genebe promptly cut out of circuit. This is simply a the many troubles which it is impossible to foresee gainst in the manufacturer's workshop. Between ur years ago we realised that a reliable discrimiut was badly wanted, and since that time coner 100 different combinations of compound windings g mechanisms have been experimented with. Many e only reached the experimental stage, but a fair ave had several months' actual use under working efore some unforeseen difficulty made it necessary n for some new and improved arrangement. The en that we have at last been able to secure a cutears to be perfect.

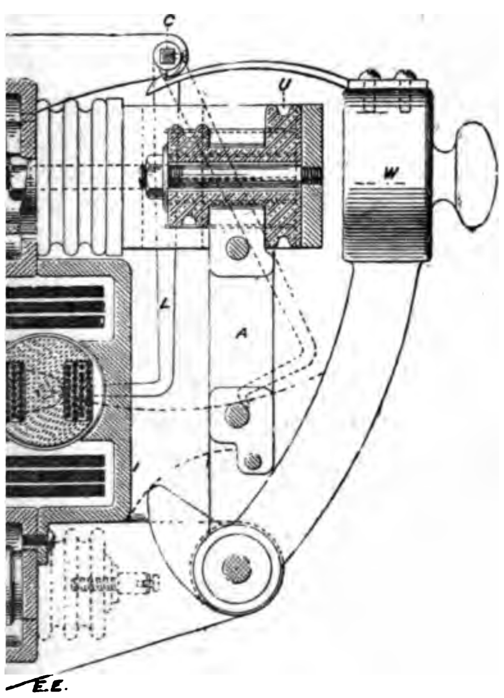


Fig. 2.

ı at first sight impossible to design a satisfactory ng cut-out for use in connection with alternate-current ı which the current is reversing in direction some mes a minute. So long as one considers these ı relation to a constant polarity, it is, of course, but as soon as the direction of the current through machine is considered relatively to the direction ent in all other parts of the system, the problem omparatively simple one. Fig. 1 illustrates diagramhat we have found to be the most satisfactory applying this principle. The operating device in ment is practically a shunt-wound motor, the thick winding of which is connected in series with one of the leads from the alternator it is intended to control, and the shunt winding is connected across any transformer excited off the 'bus bars. Now it is obvious that the direction of the current in the shunt winding, S H, will pulsate synchronously with the current in the 'bus bars, and will be quite independent of the direction of the current in the series winding, S E, whereas the direction of the current in the latter relatively to the current in the 'bus bars will depend upon whether the machine to which it is connected is generating current or is being driven as a motor. If both machines are generating current, then the direction of the current throughout the whole system at a given moment will be represented by the arrow-heads shown full.

Fig. 3.

But if, say, alternator D_1 fails, it will tend to short-circuit the rest of the system, and the current will rush back into it in the direction shown by the dotted arrow-heads, whereas the direction of the current in the other circuits will remain the same. In the former case the relative direction of the shunt winding to the series winding in the cut-out device will be such as to tend to make the armature rotate in a clock-wise direction, and so to lock the switch securely; but when, as in the latter case, the direction of the series current relatively to the shunt current is reversed, the armature will rotate in a contra-clockwise direction, and so open the circuit.

Fig. 2 is a sectional elevation of a mechanical application of this principle to a low-tension cut-out suitable for use with continuous-current generators, transformers, and low-tension mains. The weight, W, is held in a nearly vertical position by the catch, C. Attached to the catch is a lever, L, the free end of which engages in a pin projecting from a metal disc on the end of the armature, S H. The series winding,

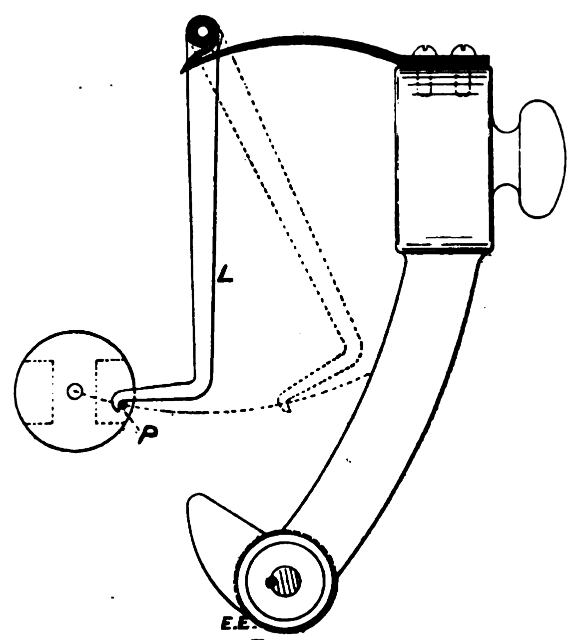


Fig. 4.

S E, consists of a few turns of thick copper tape wound directly round the armature. One end of this is sweated and riveted directly on to a brass plate screwed and sweated to one of the contacts, and the other end is sweated on to a thimble, T (Fig. 3), which forms one of the series terminals. The other series terminal is screwed and sweated directly on to the second contact. The whole of the series connections and contacts are supported on three corrugated porcelain insulators sulphured into the base. Fig. 3 shows these series connections removed from the rest of the cut-out. This series winding encloses a practically closed double magnetic circuit, consisting of the armature core, a portion of the base,

and the cast-iron covers. For alternate-current working these parts are, of course, laminated.

An important feature of this cut-out is the releasing catch. This is shown in detail in Fig. 4. The pin, P, is fixed in such a position on the armature disc that an extension of the arc described by the lever, L, will cut the pin, P, and the centre of the armature disc. The result of this arrangement is that no amount of vibration or pressure applied to the weight, W, will tend to make the disc rotate in either direction. And, consequently, when the armature is rotated by a return current it releases the weight without having first to lift it, as it would have to do with any other form of catch. We find this an absolutely reliable and extremely sensitive form of release.

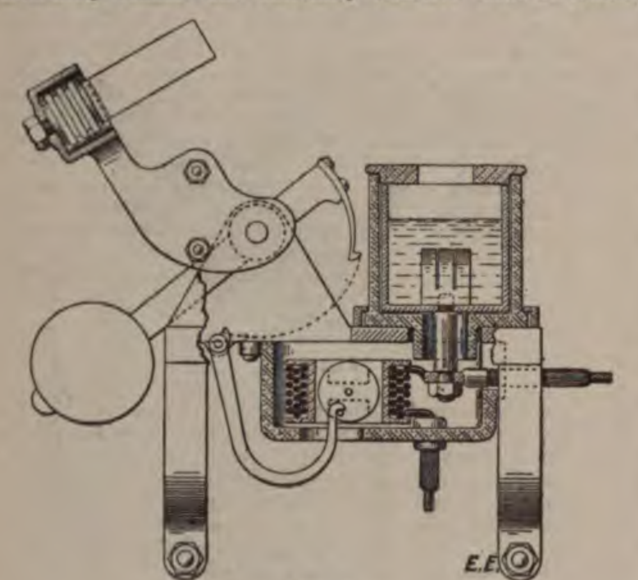


Fig. 5.

When the weight, W, is released it falls through an angle of about 60deg., then with a sharp blow it strikes the arm carrying the contact connecting piece, thus overcoming any sticking of the contacts due to a good fit or to corrosion. A specimen 500-ampere cut-out of this description is shown on the table. You will see that it is so reliable that, even when there is no forward current on to lock it in position, it may be knocked about with a mallet to show that no amount of vibration will release it, whereas it is so sensitive that the pressure of a feather upon the armature will do so. The same general arrangement without any winding on the armature makes a very sensitive and reliable excess-current cut-out.

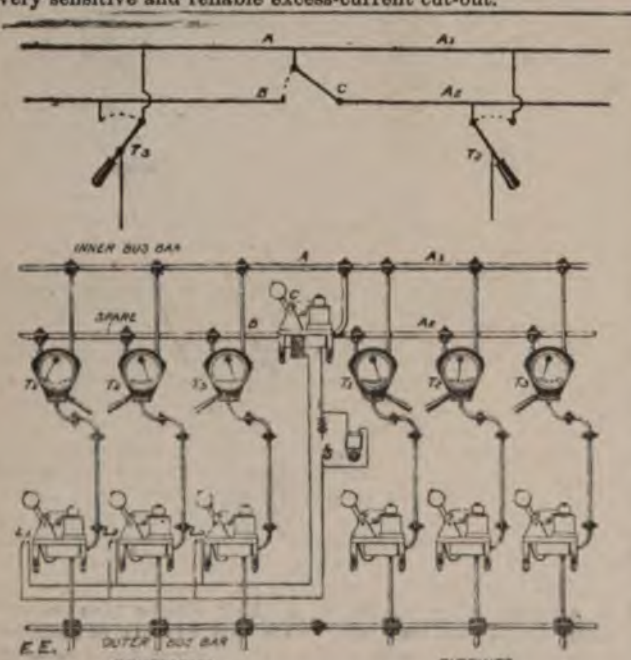


Fig. 6.

Fig. 5 is a sectional elevation of a similar cut-out modified for use in connection with high-tension currents. In this arrangement the contacts are screwed and sweated into metal pots, and immersed in water. This serves effectually to quench any tendency to arcing when large high-tension currents are interrupted. All the high-tension parts in this cut-out are entirely covered with porcelain or other insulating material.

The releasing mechanism is practically the same as in t[h]
tension cut-out. Fig. 6 is a diagram of the Hastings
gear. We have found this arrangement entirely satisfa[ctory in]
every respect. It has not only enabled us to cope with
breakdowns to machinery without interruptions to the
but it has also effected a saving in coal, etc., during the
months of over £400. This has been saved by the arran[gement]
referred to enabling us to work safely without running
plant.

All the machines are arranged to feed into a comm[on]
of inner and outer 'bus bars. The inner 'bus bar, h[owever,]
is divided at A, by a change-over switch, C, into two
branches. One of these, A_1, is permanently connected
but the other branch, A_2, may be connected either to th[e]
'bus bar or to a spare 'bus bar, B. Normally, it is co[nnected]
to the former. Each machine and circuit is equipped
two-way switch, T, by means of which any machine
circuit may be connected either to the inner 'bus bar o[r]
auxiliary branch. In the diagram only three circuits an[d]
machines are shown. The maximum output of the m[achines]
is 60 amperes, and the total load of the three cir[cuits]
assumed to be 120 amperes—namely, 60 on No. 1,
No. 2, and 20 on No. 3. By setting the circuit t[wo-way]
switches, T_2 and T_3, over to the left, Circuits 2 and

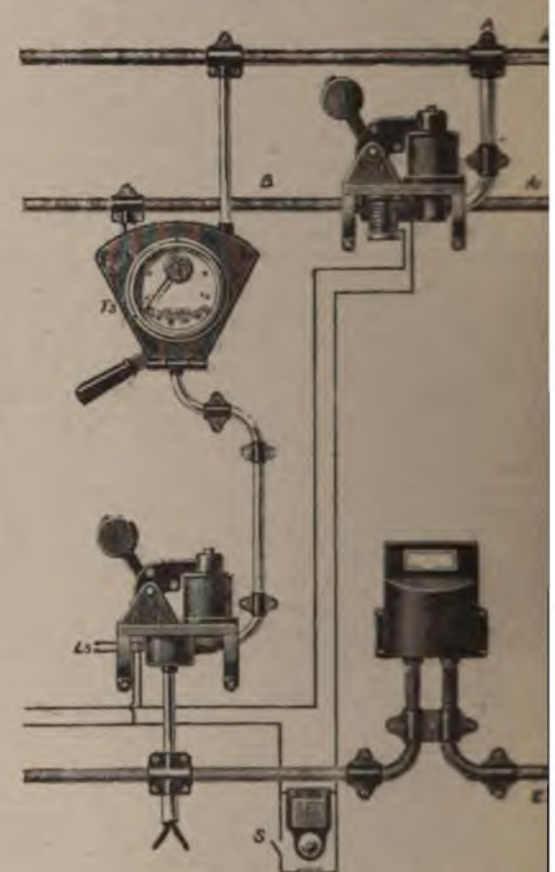


Fig. 6A.—Details of one Section of Fig. 6.

connected directly on to the A_1 branch of the inner 'b[us bar,]
whereas, T_1 being set over to the right, Circuit 1 is conne[cted]
to the A_2 branch. The machines Nos. 2 and 3 are co[nnected]
in parallel by their two-way switches directly on to the
'bus bar, A. And the machine No. 1 is kept turning as
with its two-way switch over to the right, thereby con[necting]
it on to the spare 'bus bar, B. The change-over switc[h is]
constructed to be released by a solenoid excited off a
venient source, E. Inserted in series with it are two s[witches,]
S and L_1, L_2, or L_3. Both the S and one of the L switch[es]
be closed together to excite the solenoid. When S only i[s]
it completes a circuit through an electric bell, which
heard anywhere in the station. The driver has instructi[ons]
whenever that bell rings he must immediately run th[e]
plant up to speed. Now if either of the running plants
down, the switchboard attendant merely has to close s[witch S,]
and then as soon as the volts on the spare machine hav[e]
to normal, or before if necessary, he releases the cut-ou[t]
of the faulty machine. The weight of this on falling
switch L, and so completes the circuit through the sole[noid of]
the releasing change-over switch, C. This disconnects t[he]
bar A_2 with its load of 60 amperes from the inner 'bu[s bar,]
and transfers it to the spare 'bus bar, B, at precisely th[e]
moment as the generator supplying 60 amperes is disco[nnected]
from the inner 'bus bar. Thus the lights on the circuits
and 3 are not affected as they would be if the change-ov[er]

simultaneously with switching out the faulty machine; lights on No. 1 circuit only give a momentary flicker, as a rule, is not even noticed by the consumers. Of the use of a spare 'bus bar is not original, but we believe simultaneous method of change-over is.

discussion on a paper read before the Northern Society neers on switch-gear last year, it appeared to be the opinion of engineers present that all high-tension con- should be absolutely enclosed. But it was objected lid not appear possible to do so without having exposed ions at the back of the board, and boards with backs increased rather than decreased the risk of accidents. stion was also made in this same paper that a full-sized of connections painted on the walls above the switch- uld often prove useful, but other engineers thought that tch-gear should be its own diagram. We venture to

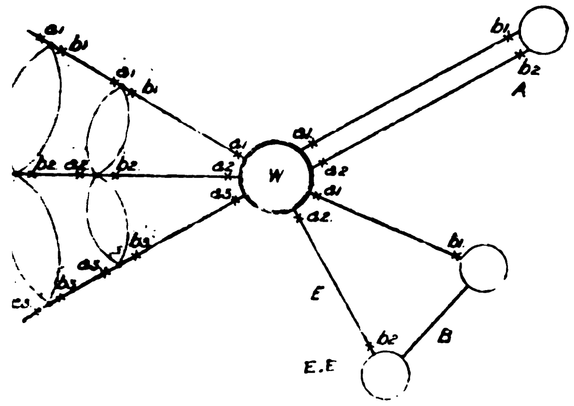


FIG. 7.

that in the switch-gear shown in Fig. 6 we have suc- in complying with both of these specifications. The from the machines are carried in porcelain or other ing pipes directly up to their respective cut-outs, from o the two-way switches *viâ* their ammeters, and so on to s bars. All the high-tension connections, both in the t switches and the two-way switches, are entirely enclosed, s these switches and the conductors are bolted and l to the surface of a brick wall, all the connections are mmatically shown at a glance.

e form of excess-current cut-out should certainly be used feeders. We prefer magnetic cut-outs to fuses, as we em more reliable. They can also be used as switches if ary, which is a distinct advantage. At any rate, whatever f cut-outs is used, their operation should on no account mitted to interrupt the supply to any consumers.

s curious that engineers have not paid more attention duplication of electrical mains. It is the custom to

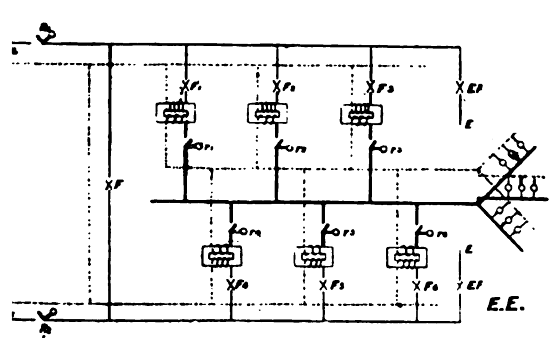


FIG. 8.

thousands of pounds on duplicating boilers, engines, ос, and other plant which is directly under the engi- control; but no steps are taken efficiently to duplicate part of the system over which he has no direct control, which is always at the mercy of such external forces s explosions, burst water-mains, fires, pick-holes, etc. true many engineers arrange their mains on some ring n, so that any portion of it may be made dead for repairs, sions, etc.; and some go even further, and fix fuses at vals round the ring, so proportioned that a fault will only ct a certain section of the lights. But that is not sufficient. ught not to be satisfied until we are able to guarantee an stely constant supply to everyone. The problem of how this has been troubling us at Hastings for years; re now feel satisfied that we have solved it. Our method ing so is shown in Fig. 7. Each sub-station or feeding is supplied from the works, W, by two feeders, either by ng to each two distinct mains, each sufficiently heavy to without excessive fall of pressure half the load of the sub-station, as shown at A, or by connecting together two sub-stations, each supplied by separate feeders, as at B; or, in the case of low-tension distribution, by running radial feeders from the generating station, and connecting the several feeding points on these to corresponding feeding points on an adjacent feeder by the distributing mains, as shown at C. If a fault occurs on either of these feeders the current will be supplied to it both directly from the generating station and also *viâ* the adjacent feeder and connecting mains. To prevent this fault from short-circuiting the whole of the system, fuses have previously been inserted in the feeders at a_1, a_2, b_1, and b_2. A little consideration will show, however, that this arrangement can never be satisfactory, for it is obvious that either one of these feeders may at any time have to carry as heavy a current as the others, consequently they must all be equally fused. Now, if a short-circuit occurs at say, E, fuse a_2 will blow. The current will then be supplied *viâ* a_1, b_1, and b_2. Now, fuse b_2 should, of course, blow, and so cut out the faulty main, leaving both sub-stations to be supplied *viâ* feeder 1. But this will not happen, because a_1 and b_1 would have to carry sufficient current to blow b_2, in addition to the useful current taken by the sub-stations. The result will naturally be that a_1 or b_1 will invariably blow before b_2, thus cutting off the lights supplied by both feeders. Now, if fuses b_1 and b_2 are replaced by discriminating cut-outs no amount of current flowing in its normal direction will cause them to operate, but a comparatively small return current will immediately release them. As the only conditions that can possibly cause the current to flow back from

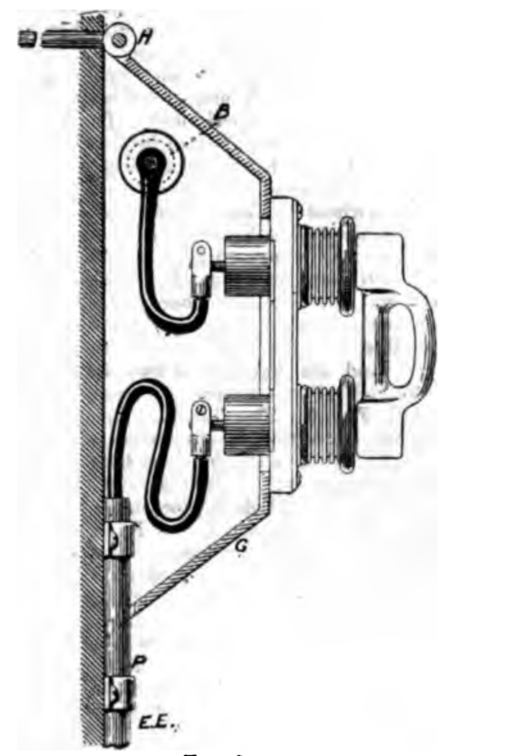


FIG. 9.

the sub-stations to the generating station is a fault on the feeder between these points, this form of cut-out can be relied upon to operate only when it is required to do so.

It is, of course, very essential that the cut-outs used for this purpose should be made not to operate if either the series or shunt current is interrupted separately or simultaneously, as it would cause a great deal of trouble if the supply from the works was ever interrupted for a few seconds and all the cut-outs on the mains were thereby caused to operate. Cut-outs that are opened with a spring or springs should also be avoided, as it is impossible to make them sensitive and reliable, owing to the fact that the catch has to be released against the maximum tension of the springs; and, further, these springs must be very stiff, as, in addition to overcoming the friction of the contacts when they are clean, a large margin must be allowed to overcome the increased friction that will certainly be caused by corrosion of the contacts after they have been in, say, a few months. A falling weight seems much better suited for the purpose than a spring, for the pressure on the releasing catch is comparatively small, and the sharp blow upon the contact arm is just what is required to overcome with certainty any tendency to sticking due to corrosion. Cut-outs should have no screws about them liable to work loose and so release the catch and open the circuit. For burying under the pavements they should be as compact as possible, as the space is then very limited. They should also be unaffected by rust, dust, damp, or corrosion, and precaution should be taken to prevent any possibility of their being caused to operate by

external vibration. They should be made to cut out with as small a current as possible to prevent excessive arcing when the circuit is interrupted. The cut-out illustrated in Fig. 5 has been designed to comply with these and other requirements.

Another very frequent cause of local interruptions is the failure of primary fuses of transformers. It certainly appears to be advisable to use some form of excess-current cut-out between the primary winding of transformers and the mains supplying them, but the object of this cut-out should be, not to prevent the transformers from being overloaded, but to protect the mains from being short-circuited by a faulty transformer. Where two or three transformers are coupled together no good can come of cutting one of them out of circuit because it is overloaded, for if one is cut out the extra load is thrown upon the others, thus invariably blowing their fuses as well and cutting off the supply to the whole district. We consider that a transformer fuse should not blow unless the excess current exceeds the normal current by about 300 per cent. Fuses between the secondaries of transformers and secondary 'bus bars are invariably worse than useless. Take, for instance, the case of three transformers of equal size feeding a common 'bus bar. If one of these fails, the current will rush back into it from the other two; but as these have to supply the useful current to the mains, in addition to that required to blow the faulty transformer's fuse, they will blow their own fuses before that of the faulty transformer. Obviously these fuses should be replaced by discriminating cut-outs.

Fig 8 is a diagram showing the equipment of a sub-station we now have in hand. The two high-tension feeders from the generating station, M_1, M_2, terminate in two return-current cut-outs, R_1 and R_2. Beyond the cut-outs they are connected together by the fuse F. Fuses, F_1 and F_2, etc., are inserted in series with the primaries of each transformer. Return-current cut-outs, r^1, r^2, r^3, etc., are inserted in series with the secondaries of each transformer. The primary connections of the sub-station are divided into two distinct halves; the inner 'bus bar of each half is equipped with an earthing fuse, E F. Any man found working on the primary connections of either side without the earth fuse inserted will be instantly dismissed. Either half sub-station can, of course, be made dead by opening the return-current cut-out of the feeder to which it is directly connected, fuse F, and the secondary return-current cut-outs of that side. There are no high-tension connections exposed in this sub-station. The primary cut-outs are of the type illustrated in Fig. 5. The fuses are also of an enclosed type, and are screwed to two cast-iron frames—one frame for each half of the station. A section of these frames is shown at G, Fig. 9. The 'bus bar, B, to which the transformer fuses are connected, is supported on insulators inside this frame. These frames are hung on hinges, H, so that they can be lifted to enable the connections to the fuses to be periodically examined. High-tension cables are run down to the transformers in porcelain tubes, P, clipped to the walls. The high-tension apparatus for one-half of the station is on the north wall, and that for the other is on the east wall. The low-tension return-current cut-outs, which also serve as secondary switches, are on the south wall, and the distributing 'bus bars and instruments are on the west wall. This sub-station is a building 12ft. long by 8ft. wide by 7ft. 6in. high. It is built above ground in a back garden in the centre of the district it supplies. We pay £10 per annum for the rent of the ground it stands upon.

Several of our existing sub-stations are placed under the pavement. These have been such a source of trouble to us that we are now abandoning them entirely. Arrangements are made to cut off all the transformers except one small one during the hours of light load, not only for the purpose of saving the current wasted in exciting them, but also to allow them to cool down between each heavy shift. We expect by so doing to greatly increase the life of our transformers. Whether it is advisable to equip the low-tension distributors with cut-outs or not, is a question upon which we should be glad to hear the opinion of other engineers. We are inclined to think that, if a 200-volt short-circuit occurred on a cable not exceeding one square inch sectional area, it would in most cases burn itself out before it damaged other parts of the cable. If we could be sure of this, we should endeavour to loop all of our distributors and insert in series with each main a magnetic cut-out adjusted to operate when the current exceeded five times the normal. If the main burnt asunder before the cut-outs operated, the supply would not then be interrupted to any consumers. Presumably everyone will admit that excess-current cut-outs are necessary on electric light services where they enter consumers' premises, but we think the majority of central-station engineers will agree with Mr. Sayers when he says that they should not operate until the normal current has been exceeded by at least 300 per cent. Is it not possible that the number of branch cut-outs at present used to comply with the fire insurance regulations might be reduced? It appears to us to be rather a question whether or no so many of these cut-outs do tend to reduce the risk of fires. Consumers who are repeatedly troubled by these branch fuses melting are apt to discover that a fuse replaced by a stout piece of copper wire gives them
trouble. Now, if the connection to one of these short-
fuses should work loose, it gets hot, the heat is trans
the cable, and a smell of burning is the result. Of cour
branch fuses were used, it would be advisable entirely to
the house wiring in some form of fire-proof conduit in
in wood casing; but we are inclined to think this wou
preferable arrangement both for the prevention of inter
to the supply and for the reduction of fire risks.

DISCUSSION.

Mr. J. S. Raworth, in opening the discussion on Mr. A
paper, said that it was only because he had been asked to
Mr. Andrews that he took part in the discussion. He
had done something in the way of inventing a discriminat
and had therefore not wished to say anything on the subj
thought that the author had hit the right nail on the
bringing forward this subject as one in which improveme
needed. They could all tell of the futility of using a fus
connecting link between the machines and the 'bus ba
first accident in the City of London Company's works
through the fuses not working properly. In trying to fi
out of this difficulty he had invented what he claimed t
first discriminating fuse ever used. In this arrangement t
in parallel were used for each circuit, and a differenti
forming device caused the first to blow with a return curr
second fuse then went immediately, being overloaded. T
objection to all fusible cut-outs was the time they took in op
He had seen Mr. Andrews's experiments at Hastings,
found the apparatus to work very successfully. He did n
Mr. Andrews had named his paper correctly; the titl
have been "A Means of Saving Anxiety to Station Eng
Those gentlemen who claimed never to have had i
tions in their supply had not, he thought, made these
without a great deal of mental anxiety. With regard
water-switch, he had used it under very trying conditions,
he had not tried it without water, and found it quite
break a 2,000-volt circuit without any appreciable spar
time for inventing switches was now over, but he could,
heartily wish Mr. Andrews every success with his inventio

Mr. R. A. Chattock said he had made one or two atte
similar switches himself. He had in hand now an inventio
he hoped to have perfected and tried by the City of Lond
pany in the summer. He quite agreed with Mr. Andrews h
that the present method of using fuses and switches was
In Fig. 7, he thought that if a short-circuit occurred bet
and the central station the current would not be properly

Mr. A. J. Lawson said that he had seen what this swi
was capable of doing down at Hastings. He himself thou
they were, if anything, too sensitive. If by any mischance
backward current occurred in switching into parallel,
should break the circuit, the delay so caused might resul
speed of the engine falling to such an extent that it w
difficult to synchronise again. With regard to its act
thought that in the case of two cables feeding an extens
he should prefer to adopt the method shown in Fig. 7. H
arrange it so that it could be fed round the other way in
using separate feeders. Mr. Andrews said that during t
18 months the switch-gear had effected a saving of £400 in
would like to ask if this saving was not for the greater par
the increase of load factor. Regarding the statement th
switches were more reliable than fuses, he thought th
reliable. These cut-outs were so sudden in their action th
would often be someone coming round to find out why the
was not giving a supply.

Mr. F. C. Raphael said he would confine his remarks
point of interruptions to private consumers by fuses blowin
insurance companies would, he thought, be quite within the
in preventing such high-capacity fuses as the ones the
mentioned as standing an excess current of 300 per ce
being used. The leakage to earth from either wire was
cause fire risks long before the main fuse blew. His me
obviating this was to use the ordinary heavy fuse as at
and an additional light fuse to go if an earth current
This light fuse acting in the way shown in Fig. R autom
short-circuited the mains and blew the main fuse in cas
earth contact. He thought the iron barrel system withou
such device was dangerous. He thought the fire insuran
panies were pursuing a very short-sighted policy in stopp
use of inventions for the prevention of house interruptions.

Mr. F. Bathurst said the last speaker aroused his curiosi
he spoke on the subject of light fuses as well as heavy
housework. He thought they ought to thank Mr. Andr
having called attention to the subject of interruptio
certainly thought something ought to be done to preven
and to guarantee a constant supply to their custom
thought that they should differentiate between circuit
and leakage current. He would like to make a suggesti
his point of view, which was antagonistic to lead-cover
Last week, at their works, his company had been trying
ments with insulated tubes. These were not injured to a
extent by the electric arc, while iron pipes under simil
ditions were burnt right away. By using these tubes
possible to carry the wires without the slightest risk of lea
of fire in case of a short-circuit.

Mr. R. W. Weekes said that when he was down at H
two years ago he took a friend into the station who did no

use of alternating-current machinery. This friend to "throw in" in parallel an alternator, but was suc-y after three attempts. During the whole of this time lid not show the faintest flicker, thanks to Mr. Andrews's but still, he thought that Mr. Andrews was rather hard milar cut-outs. At Newcastle, in 1888, he had fitted a :h which answered the same purpose as Mr. Andrews's and which he had found to work very well for direct It also cut in after the voltage had risen to the amount › give a forward current.

est Kilburn Scott said he was rather sorry Mr. Raworth as he should have liked to ask him a few questions. He hat Mr. Raworth had given up designing fuses. Direct-itches had been made at Wolverhampton with a similar and they were working very well. They were not quite ite things as Mr. Andrews's.

P. Thompson said that magnetic cut-outs had been a number of years. Anyone who had tried discrimi-se would know how unreliable they were, and that some-› was needed. There was one discriminating fuse which all known some time, and that was the wattmeter. Mr. invention was on the same principle, and must, he e taken a lot of trouble and thought to perfect. Some had been made for allowing for excess current ralleling. This, by doing away with the danger ing-in," would be welcomed by the inexperienced. A iould, he thought, be able to pull up its own engine, he machines in a certain station did not do this was a 'hich could not be answered just then. One thing more ay, and that was that fuses were excellent things to do

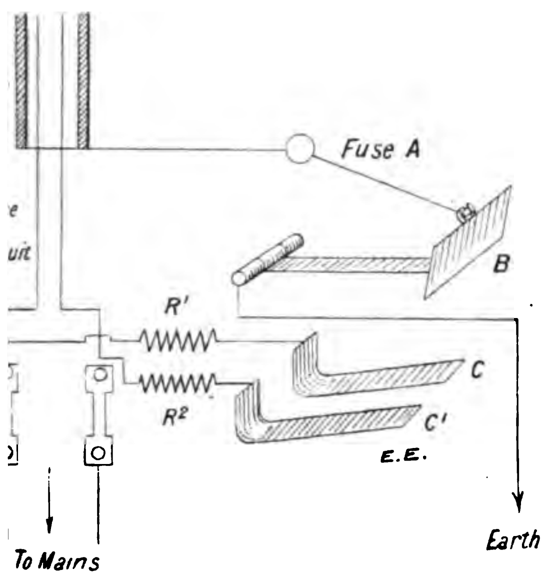


Fig. R.

Andrews, in replying, said that Mr. Chattock found one of his diagrams. This, he explained, was an omis-awing. The mains they were now laying in Hastings n to the various stations round the town. In this way, if failure in the supply at the works, it will be easier to se than by having them all direct from one station. With › the saving of coal, it was not due to the increased r, as with an increased output less coal was used than se switches were used. The reason for this was that in times they had to keep some spare plant running in case of an emergency. This was now rendered unneces-he arrangement of duplicate 'bus bars. As to the cut-g too quickly, he thought that when a short-circuit was the rest of the system that the quicker it acted the Mr. Weekes had said he was rather hard on inventors of -outs. He was not aware of it; in fact, he thought he r complimentary than otherwise. Mr. Raworth had said al similar switches had been in use for a considerable the thought that none of them had produced such good › far as reliability was concerned.

Y AND GUILDS OF LONDON INSTITUTE.

TRIC LIGHTING AND POWER TRANSMISSION.

PRELIMINARY EXAMINATION.

following are the questions set by the Examina-epartment of the City and Guilds of London , 1898 :

scribe three different types of primary batteries, › what kind of work each type is most suitable for. a.)

hree resistances, r_1, r_2, r_3, are joined in parallel, he resultant resistance? If 75 yards of $\frac{7}{18}$ cable allel with 50 yards of $\frac{19}{20}$, what is the joint resistance? A single No. 16 wire has a resistance of 0·8 ohm per 100 yards; a single No. 20 a resistance of 2·75 ohm per 100 yards; and a stranded conductor has 3 per cent. more resistance than a solid conductor of the same cross-section. (18.)

3. Describe, with sketches, any system for wiring houses with which you are practically acquainted other than that of using wooden casing and capping. (10.)

4. Give a diagram of the connections of a resistance set, such as is used in the testing of the insulation of house wiring. (18.)

5. What are the merits and demerits of marble, slate, vulcanised fibre, porcelain, and wood for switch bases, etc.? (15.)

6. Define a dyne, watt, horse-power, joule, Board of Trade unit. (10.)

7. If two similar iron bars are put together inside a solenoid, what is the effect on them (1) when the bars are placed end to end, (2) when they lie side by side? (10.)

8. Describe, with sketches, any form of clutch or brake mechanism for an arc lamp. (12.)

9. What is an enclosed arc lamp? What are its advantages and what its disadvantages as compared with the other type? (15.)

10. Describe in detail how you would true up the commutator of a dynamo. (10.)

11. Describe, with sketches, a magneto-generator, such as is used for telephone calls. (12.)

12. In what way does the construction of a 200-volt lamp differ from that of a 100-volt lamp? What are the relative advantages of the two kinds? (10.)

13. In connecting up a shunt dynamo to run as a motor, would you join the positive pole of the circuit to the positive or negative terminal of the machine? Give full reasons for your answer. (10.)

14. Describe the construction and use of a wattmeter. Give sketches. (15.)

15. What special precautions must be taken in laying paper or fibre insulated mains? (12.)

16. What is your experience with the use of vulcanised indiarubber flexible cord? (12.)

17. A 20-h.p. dynamo is running at 550 volts; what is the current, in amperes, produced, and how many 16-c.p. glow lamps, approximately, could such a machine be used for? (10.)

18. What are the advantages and disadvantages of using, for low-pressure mains, bare conductors supported on insulators in conduits as compared with lead-covered paper-insulated cable drawn into pipes? (12.)

FORTHCOMING EVENTS.

FRIDAY, MAY 13.

Royal Institution, Albemarle-street.—At 9 p.m., "Recent Experiments on Certain of the Chemical Elements in Relation to Heat," by Prof. W. A. Tilden, D.Sc., F.R.S.

Physical Society.—At Burlington House, at 5 p.m., "Galvanometers" (Part II.), by Prof. W. E. Ayrton and Mr. T. Mather.

Electro-Harmonic.—At 28, Victoria-street, at 4.30 p.m., annual general meeting.

MONDAY, MAY 16.

Society of Arts.—At 8 p.m., third of a series of four Cantor lectures on "The Electric Locomotive," by Prof. Carus Wilson.

THURSDAY, MAY 19.

Royal Institution, Albemarle street.—At 3 p.m., the Right Hon. Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S., on "Heat." Second lecture of three.

SATURDAY, MAY 21.

Institution of Electrical Engineers.—At 11 a.m., students visit to the works of the Electric Welding Company.

At last night's meeting of the Institution of Electrical Engineers the following were the candidates balloted for.

Associates.—M. J. Buckley, Town Hall, Drumcondra, co. Dublin R. H. Covernton, Electric Light Station, Johannesburg; H. K. De Lacy, 17, Oxton-road, Birkenhead; H. S. Gladstone, 34, Brechin-place, S.W.; J. F. Lamb, Engineer-in-Chief's Office, G.P.O., E.C.; A. Miskin, 110, St. Martin's-lane, W.C.; L. Mirabel, manager of the Cie Française des Cables Telegraphiques, Bundaberg, Queensland; M. G. S. Swallow, Schlossbergplatz, Baden, Ct. Aargan, Switzerland; P. J. S. Tiddeman, Electricity Works, Pontypool.

Students.—G. F. R. Jacomb-Hood, 19, Sherriff-road, West Hampstead; T. Kerr-Jones, 21, Charlton-lane, Charlton, Kent.

THE

ELECTRICAL ENGINEER.

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BLAST-FURNACE GASES AGAIN.

In our last issue we referred to the work Thwaite for the utilisation of blast-furnace the production of power. Mr. Thwaite's pa soon followed by another on the same sub M. Adolphe Greiner, director-general of the Works at Seraing, read before the Iron an Institute last week. We refer to the subjec because of its importance, and that the secon forms a corollary to the first. If we assum the gases produced per ton of pig iron same in quantity and quality at all blast fur a wrong assumption, but permissible moment—these papers give some idea power at present going to waste. At Ser average turn out is 600 tons of pig iro and M. Greiner agrees with the calc of Mr. Hubert, who gives a surplus p 2,000 h.p. per 100 tons of pig iron, but on the safe side would take 1,000 h.p. tons of pig. England produces annually so to nine millions of tons of pig iron—say, an daily output of 25,000 tons. If each 100 ton sents a waste gas to give 1,000 h.p., then an available amount of 250,000 h.p. to be from our blast furnaces. It is admitted that obtained is of a very poor quality. With the mental engine at Seraing 187·18 cubic horse-power were required. The engine w giving only 4 h.p., its normal output being hence, from Prof. Kennedy's figures it was that 141·27 cubic feet per brake hors would be required at full load. The co problem then becomes somewhat simple, and put as follows. Assuming a daily output of of pig, and an available 1,000 h.p., will it erect the necessary machinery for distribut 1,000 h.p.? The gas obtained is very necessitating cleansing, and even then carr it many impurities that at first sight it wo must increase the working wear and tear engines. These experiments of Mr. Thwaite Seraing prove that the poor quality of impure be utilised in specially adapted engines; it now to know at what actual cost. The figure Thwaite are not exhaustive enough, and much of the nature of estimates to be co but ere long it may be certain exact figures forthcoming, for the commercial use of 250, is too important to be neglected.

LIVERPOOL AND ITS TRAMWAYS.

In our last issue we stated briefly that Sir Forwood had resigned his position upon th pool Council because of an adverse vote u question of the tenders for engines. We h always agreed with the policy of Sir Arthur F but in this case we are in entire sympat him. It looks as if the adverse vote w by a majority of the Council throug ignorance, or at the instigation of som engine builder. It is usually assume a special committee dealing with a spec ject duly examines all sides of the questi

s to a conclusion after examination. That lusion is placed before the whole council, which ked to agree with it. An axiom of local govern- ; is that it must be carried on by committees, not by councils, and the council as a whole y upsets the conclusions of a special com- e. We do not say there should never case in which the council rules counter e committee, but we do say, and emphati- say, the case of the engines at Liverpool not the exceptional case when this was ssary. Here are some thirty-five councillors, may be deemed to know as much about the ts of the case collectively as does the man in noon, opposing the deliberate conclusions of a nittee which has specially investigated the sub- some of the members of the committee having wed the question for years. What reason given? "The engines are unsuitable." But, y, the committee have duly investigated the bility and unsuitability of these engines, have l what is to be said for and against them, and had a far better opportunity of judging the ctness of adverse views than members of the cil who only listen to the hearsay of interested es. Our point, however, is not concerning the es, but concerning the ways and vagaries of cils in dealing with their committees.

OTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

[*Copyright.*]

CX.

ong the questions of frequent occurrence in the uction of accumulators are the following:

en a grid, or a plate perforated, grooved, or otherwise ed, what will be (*a*) the volume and (*b*) the weight ive material that will be contained within the alveoles, s, or recesses? And in the case of an embedded cting support, what will be the thickness, above the of the support, of a given weight of active material (*a*) the support is a plain plate, and (*b*) when it is ated or grooved?

cubic inch of lead (VIII.) weighs 6·56oz. avoird. 70 grains. A square inch of lead of thickness t (inches) s $6{\cdot}56 \times t$ oz.; its volume will be t cubic inches. Let eight per average square inch of a grid, or of a per- d, grooved, or recessed plate, of thickness t, be), the volume of the residual metal will be $\frac{w}{6{\cdot}56}$ cubic ; and the volume of the metal removed by the per- g, etc., which is the volume of the active material contained in the perforations, will be

$$v = t - \frac{w\ (\text{oz.})}{6{\cdot}56} = t - \frac{w\ (\text{grains})}{2{,}870} \text{ cubic inches.}$$

l, taking the weight of a cubic inch of water as = 252·5 grains, the weight of active material per inch will be

$$= v \times {\cdot}577 \times \text{sp.g. (oz.)} = v \times 252{\cdot}5 \times \text{sp.g. (grains)};$$

" being the specific gravity of the active material ns of water as unity.

lem 1.—I have a 6in. × 6in. Gadot double grid ing, with lug, 15¾oz. The lug weighs about 2oz. ickness of the double grid is ·2in. What bulk and of active material having the specific gravity 8, formed, will it hold?

The number of square inches = 6 × 6 = 36. The weight of one square inch of solid sheet lead ·2in. thick is $6{\cdot}56 \times {\cdot}2 = 1{\cdot}31$oz. The weight of the grid (without lug) is 13·75oz., and the average weight of one square inch of this grid is $\frac{13{\cdot}75}{36} = {\cdot}382\text{oz.} = w$ oz. Then the volume or bulk of active material per square inch of grid will be

$$v = t - \frac{w}{6{\cdot}56} = {\cdot}2 - \frac{{\cdot}382}{6{\cdot}56} = {\cdot}142 \text{ cubic inch.}$$

And the average weight of active material per square inch of grid will be

$$a = {\cdot}142 \times {\cdot}577 \times 8 = {\cdot}655\text{oz.}$$

N.B.—This value—the weight of active material per square inch of surface—is useful in calculating capacity; it must be halved when both surfaces of the plate are taken into account.

The total bulk of active material in the plate will be

$${\cdot}142 \times 36 = 5{\cdot}1 \text{ cubic inch.}$$

And the total weight will be

$${\cdot}655 \times 36 = 23{\cdot}6\text{oz.} \qquad (\textit{Answer.})$$

Problem 2.—What weight of active material of specific gravity 8·2 will fill up the perforations in a square inch of perforated sheet lead 50 mils thick, weighing 86 (w) grains.

The thickness in terms of 1in. is here $t = {\cdot}05$. The weight of one square inch of a solid plate of lead of this thickness is $2{,}870 \times t = 143{\cdot}5$ grains. The space cleared by the perforations is

$$v = t - \frac{w\ (\text{grains})}{2{,}870} = {\cdot}05 - \frac{86}{2{,}870} = {\cdot}02 \text{ cubic inch.}$$

And the weight of active material that will fill this space is

$$a = {\cdot}02 \times 252{\cdot}5 \times 8{\cdot}2 = 41{\cdot}4 \text{ grains} = {\cdot}095\text{oz.} \qquad (\textit{Answer.})$$

CXI.

The thickness (τ) of a layer of active material on one square inch of surface is its volume in cubic inches. From the equation for weight (a) of active material in the foregoing section,

$$v = \frac{a\ (\text{oz.})}{{\cdot}577 \times \text{sp.g.}} = \frac{a\ (\text{grains})}{252{\cdot}5 \times \text{sp.g.}} \text{cubic inch.}$$

Problem 3.—The required density of (discharge) current in a given accumulator is $\Delta = {\cdot}07$—*i.e.*, this fraction of an ampere per square inch of surface is the current of discharge. The time of discharge (θ) is six hours, the specific gravity of the active material (peroxide) is taken as 8, and its weight per ampere-hour is taken as $\cdot 6 \times 1{\cdot}155 = {\cdot}7$oz. nearly. It will be seen that the weight of active material required per square inch is $\Delta\ \theta = {\cdot}07 \times 6 = {\cdot}42$oz. What will be the thickness (τ) of the active material in the case of a plain support?

The volume of active material per square inch will be

$$v = \frac{{\cdot}42}{{\cdot}577 \times 8} = {\cdot}091 \text{ cubic inch.}$$

And the same numerical value will be the fraction of an inch, expressing the thickness of the layer of active material.

Thus $\qquad \tau = {\cdot}091\text{in.} = 91 \text{ mils.} \qquad$ (*Answer.*)

Problem 4.—It is required to know what will be the thickness of the layer if, instead of a plain lead support, a perforated sheet of lead 75 mils thick, and weighing 129 grains to the square inch, constitutes the embedded conductor.

It must here be borne in mind that—excepting in the case of the terminal plates—the perforated conductor is coated on both sides with the active material, and that, consequently, only one-half of the active material contained within the perforations belongs properly to each layer.

The weight of a solid plate of lead 1in. square and

·075in. thick is $6·56 \times ·075 = ·492$oz. $= ·492 \times 435·5 = 214$ grains. The weight per square inch of the perforated support being $w = 129$ grains, the space cleared by the perforation is

$$v = ·075 - \frac{129}{2,870} = ·045 \text{ cubic inch.}$$

Half of this volume, or ·0225 cubic inch, properly belongs to the layer of active material on each side of the square inch of perforated lead. Subtracting this from the ·091 cubic inch of active material per square inch of area on each side of the plate, the remaining ·0685 cubic inch will be distributed above the surface of the plate; and the same numerical value will express, as a fraction of an inch, the thickness of the layer above the plane of the surface.

Thus, instead of 91 mils, the thickness of the layer will be in this case

$$\tau = ·0685\text{in.} = 68·5 \text{ mils.} \qquad (\textit{Answer.})$$

ON COMMERCIAL METHODS OF UTILISING BLAST-FURNACE GASES FOR POWER PRODUCTION, AND THEIR POSSIBLE EFFECTS ON THE PIG-IRON INDUSTRY.*

BY B. H. THWAITE, A.M.I.C.E.

The most powerful agent for bringing about changes in established industrial procedure is the irresistible screw of determined and intelligent competition. Under the pressure of the competitive screw, obsolete elements of industrial plant and wasteful processes are inevitably crushed out of existence, and the owner is compelled to look around for conveniently reducible margins for effecting such economies as will permit him to survive in the struggle for industrial existence. The saddest pages in industrial history are those describing scenes of abandoned centres of industry, where the silence of the factory testifies that prosperity has departed. We have too many such in this country, and unless the grit of our once supremely enterprising race asserts itself anew, the record of our industrial decadence will be greatly extended. Even now, in a period of temporary recurrence of industrial prosperity, of the total number of blast furnaces in this country only some three-fifths are in blast.

At a recent meeting of ironmasters held in Düsseldorf, a graphic picture was exhibited representing the lines of industrial progress of the three great ironmaking countries—the United States, Germany, and Great Britain—and to a patriotic Englishman this picture was extremely disappointing because the story it told meant that the flag of the British iron industry had already been lowered, not only to the United States, but to Germany as well. And if the axiom is really a true one—that the factor of the proportion of iron made in a country is the truest index of its industrial position in the scale of nations—then Great Britain has lost her supremacy, and the sooner this fact in all its serious import is fully realised the sooner will the needful steps be taken to, at any rate, attempt to recover the position we held so long and so proudly. The agencies that have enabled our German and American cousins to pass us in the industrial race in the great art of ironmaking—and the explanation is good for other staple industries—may be conveniently divided into two portions. One may be considered to be an internal and the other an external cause. The internal cause is under the control of the ironmaster. The external agency is too often outside his control. The former refers to the character of the process and the industrial plant used; the latter, or external cause, refers to the costs of railway and shipping in bringing the raw products to his works and carrying thence the saleable product. The external agency can only be altered by State interference, and it is the first duty of the State to see that her captains of industry are placed on a level of equality with the enemy. The internal agency is to a great extent subject to the control of the ironmaster, and the responsibility for this is therefore his own. It is for him to reduce the margin for improvement in industrial procedure to the irreducible limit; and one of the greatest margins for improvement and consequent economy is that to which the subject of this paper relates.

It is little consolation for us to remember (excluding the latest American practice) that modern pig-iron making has been evolved by the inventive capacity and the pioneering enterprise of Britishers. This fact gave us a start in the race, which in capitalised value has meant many millions sterling to this country, but that we shall be permitted to reap the advantages of renewed inventive and pioneering activity is obviously impossible under the changed conditions, and against the determined tactics of our industrial opponents. We may invent, initiate, and risk our capital in pioneer work, but the intelligent, and, sometimes, one regrets to say, entirely unscrupulous competitor, ever on the *qui vive*, will quickly adopt the invention, or innovation, or imitate it, but only after the invention has gone through the ordeal of experiment by the Britisher. Our competitor will risk very little in a speculative way; he prefers to await the result of British enterprise. This fact, serving as evidence of the determination of the foreign competitor, both honourable and otherwise, to almost feverishly adopt every move of proved progress in procedure and plant of industry, must of necessity compel British ironmasters to be at least as ready to adopt and defend (if he has risked the cost of pioneer experiment) the movements of progress; he must not hesitate to do all that is necessary to reduce the margin of improvement that is involved by the cutting down of waste to an irreducible minimum.

The author of this paper realised some years back, as the result of a close investigation* into the efficiencies of fuel employed in everyday industrial operations, that it might be possible to still further reduce the thermal or heat waste associated with smelting processes, and, *inter alia*, with blast-furnace practice; and, as a result, he invented and patented in May, 1894, the method of directly using blast-furnace gases in internal-combustion or gas-engines. In conjunction with Mr. Frank L. Gardner and others, the author has developed and perfected numerous inventions that, in their *ensemble*, attack all the points of heat waste in blast-furnace practice. It is only fair here to express the obligation that the metallurgical world owes to Herr Otto, who in the year 1876 patented the famous cycle bearing his name. Any arrangement prior to this would have made the new process irrational in proposition and impossible in practice. The evolution and practical development of the system has already occupied several years, but the child is now fully matured, and is capable of assisting every blast-furnace owner, because, although it is found that each blast-furnace plant will require separate and distinctive treatment, it is nevertheless satisfactory to know that the system, in one or more of its divisions, is advantageously applicable to every blast furnace.

The author in his prolonged investigations, and in conjunction with his assistant, Mr. Horace Allen, realised that great thermal economies could be effected in blast-furnace plant of even the most modern type, and in the following directions. The alphabetical sequence is given in the order of relative importance: (*a*) in the combustion of blast-furnace gas for power development purposes; (*b*) in the prevention of the waste of the blast-furnace gas during the fuel, flux, and mineral charging operations; (*c*) in the improvement of the hot-blast stoves by which the air blast can be heated to the required degree with a reduced expenditure of gas; (*d*) the prevention of the entrance of the dust into the hot-blast stoves without the necessity of reducing the sensible temperature of the blast-furnace gas.

In the sequence given the first source of possible economy (*a*) is the means of effecting the development of power from the combustion of the blast-furnace gas. The author, as already explained, satisfied himself by laboratory investigation that blast-furnace gas could be employed in

* Paper read before the conference of British Iron Trade Association, May 5, 1898.

* See paper on "Fuel and its Efficiency," Part 1, vol. I., 1892, *Journal* Iron and Steel Institute.

internal-combustion engines for the direct production of power. When the system, after being patented, was explained to certain ironmasters, it was ridiculed because it was, they said, absurd to suppose that a gas so poor as to be incapable sometimes (and in great volume) of being maintained in continuous ignition, in a steam-boiler flue, would constantly ignite under such delicate and rapid conditions involved in its combustion as an explosive charge in a gas-engine cylinder. Thanks, however, to Mr. James Riley, who tendered the author his fullest confidence, the bold step of removing the electric lighting steam-engine and displacing it by a gas-engine to be driven by blast-furnace gas was undertaken in 1895, and this pioneer plant has nightly been driving the electric lighting machinery of the Glasgow Iron Company's works ever since the date of its installation. The success of this pioneer installation has been a record for pioneer work, because, although the plant occupied the anxious care of the author for some months, there was no doubt from the first revolution of the engine flywheel that the step was destined to be an important one in the history of iron-making. The plant has been seen in operation by very many competent judges, and all have expressed their delighted satisfaction with it. The result of the success has been the inevitable imitation. Although this imitation may be very flattering, it is not quite the return that pioneer experimenters have a right to expect. There is, however, in addition, a more encouraging manner of appreciation than that of imitation. The Thwaite-Gardner system is being applied on a large power scale to important works in the North, the South, and the East of France, in Westphalia, Germany, and in several important works in Great Britain. After the success of the Glasgow Iron Company's plant was firmly established, the next step was to apply the system to a more crucial test, and the Frodingham Iron Company had the privilege of testing the patents applied to the gas from their coke-fed open-top furnaces. The results have been satisfactory, and it is promised that in the future power extensions of this work the new system will be applied on a comparatively large scale.

The economic results of the Thwaite-Gardner blast-furnace power system are almost startling, for whereas with blast-furnace gas-fired Lancashire boilers and with ordinary good steam-engines some 400 to 500 cubic feet of blast-furnace gas consumed at atmospheric pressure are required to develop 1 i.h.p. of energy for one hour, with the new system from 80 to 120 cubic feet only are required to develop the same power. The economic advantages of the new blast-furnace power system, compared with that of steam power in every-day practice, is as 4 to 1 in favour of the former. The thermal units that are required to develop 1 i.h.p. of energy for one hour are:

	B.T.U.
For steam power as developed in ironworks boilers, equal to ..	43,000
By the new system are required only	10.828
The comparison in kilowatt units is by steam power	72·544
The comparison in kilowatt units is by new system	18·136

The average pressure developed on the gas-engine piston, with gas of a calorific value of 100 B.T.U. per cubic foot, which is fairly representative of blast-furnace gas, should never be less than 70lb. to the square inch. The value of blast-furnace gas is raised to such a height that it would not be an exaggeration to say that every cubic foot of gas saved is a motor driven. It is actually true to say that one cubic foot of average quality blast-furnace gas will raise 22,372lb. 1ft. high, and the gas gives, measured in proportion to intrinsic thermal value, a higher thermo-dynamic value than town or retort gas.

The financial value due to the change will, of course, depend upon various conditions, but in all cases it can be proved to be of substantial proportions, as further reference will demonstrate. Here are a few other advantages to be gained by substituting the new power system for the old: (1) the special gas treatment plant displacing steam-boilers can hardly be said to require any labour supervision at all, and it is practically independent of any water supply; (2) the gas treatment process involves the establishment of only the lowest pressures above the atmosphere, never more than 1lb.; (3) the process is so safe as to remove all fears due to the operations of the new Act for the compensation of workmen for injury; (4) no chimney is required and no smoke is generated; (5) beyond the mere puffs due to the escape of the exhaust gases the process is noiseless; (6) there is no necessity to obtain expensive insurance policies; (7) the plant constitutes a constant calorimetric register of the working of the furnace.

The difficulty of applying the internal-combustion system for very large units of power production has been due hitherto to the instability and variability of the gases employed. The photometric value of town or retort gas varies from hour to hour, and so does the calorific value of the gas, and the result is that it would be difficult to formulate a specification for a gas-engine of a power unit of 500 i.h.p., using retort gas, that could be safely relied upon for driving electrical machinery. The conditions required to permit the construction of large power gas-engines are, however, fully provided for in the new system, when properly applied. These conditions cover the chemical character: chemical and consequent calorific uniformity; dryness and purity; equable pressure. As regards uniformity of chemical and calorific character, the colossal proportions of the gaseous effluent issuing from a blast furnace ensures alone an extraordinary uniformity. The least neglect in charging, either in proportions of time intervention or in the quality of the charge, is so serious that furnaces are fed with almost the regularity of mathematically-adjusted instruments, and the working goes on sometimes for months with clockwork precision. The air blast is also very carefully regulated, with the result that the products, both liquid and gaseous, are by natural sequence of great uniformity. Given, then, the uniformity of blast-furnace gas, a working of the gas-engine can be secured that will satisfy the most exigent conditions of regular driving. The author has designed a plant employing coke and air blast gaseous fuel of 98 B.T.U. of calorific value, the engine of which, when developing 140 i.h.p., ran so steadily that a penny placed edgeways on the engine frame remained standing. There is consequently hardly any limit to the power capacity of the blast-furnace gas-driven engine. The thermo-dynamic efficiency of a 240-i.h.p. engine is so great that there is really no necessity to enlarge the cylinders beyond this unit of power production. For installations of 1,000 i.h.p., the author prefers to have the multi-cylinders arranged so that not only are the effected energy impulses evenly balanced, but the number of impulses are so increased on the turning circle as to secure sufficient and well-distributed increments of effected impulses.

The Constructional Simplicity of the Modern Gas-Engine.—The valvular and other actuating organs of a modern gas-engine have brought down its constructive simplicity to the level of that of an ordinary Corliss engine. With well-designed lubricating arrangements, the properly-designed gas-engine involves no greater supervising cost than does a good steam-engine. The thermo-dynamic efficiency of the modern gas-engine attains in every day practice the satisfactory figure of 28 per cent., and higher figures are being claimed, whereas the best steam-engine does not attain a figure greater than 12·5 per cent. Compared with the ordinary ironworks steam-boilers, exposed to the open air—monuments of danger, waste, and rustiness—the new system is simply ideal, and is practically indifferent to the temperature conditions and other influences of the weather. The ordinary factors of maintenance and interest usually applied to cover steam generators, risks, and depreciation can be divided by four when applied to the special treatment plant associated with the new power system.

The Waste in Charging Operations.—The high power-producing quality of the blast-furnace gaseous fuel should make it imperative that no avoidable waste of this gas should be permitted. The present arrangement of charging bell involves loss of gas at every operation, and this loss is not only one of volume, but is also one of pressure. In a day of 24 hours the bell is lowered some 48 times, each operation involving the escape of the gas during a period of 30 seconds, so that the bell allows the furnace to be open to the atmosphere for 24 minutes in the day, or during each day there is a loss of gas equivalent

to $\frac{180,000 \times 24}{1,440} = 3,000$ for each ton of coke fed into the furnace in 24 hours. This is equivalent to a loss of some 33 indicated horse-power hours for each ton of fuel fed into the furnace. There is, in addition, the loss at the candlesticks, which is a variable quantity. The new system has involved the prevention of this waste by means of a simple and inexpensive arrangement applicable to all furnaces. The commercial value of this saving can be shown to be considerable.

The Loss of Gas by Imperfect Stove Arrangement. — The law insisting on the absolute prevention of gaseous waste involves the adoption of the most perfect form of stoves, and also a close analytical and thermal examination of all existing hot-blast stoves, so that such combustion arrangements shall be secured as shall bring the result of the initial combustion temperature to the maximum and the final sensible temperature degree of the effluent gases leaving the stove to the minimum. By this means a very considerable proportion of the gases can be diverted for power purposes.

The Prevention of Dust Ingress into the Stoves.—Another and most serious cause of inefficiency in hot-blast stove working is the introduction by the hot gases from the furnace of suspended dust particles that clog up the checkers and passages of the stove and prevent the transmission or exchange of heat from and to the brickwork. The prevention of the ingress of dust into the stove is the obvious remedy, and this should, if possible, be done without such clearing action involving any appreciable reduction of the sensible temperature of the gases as they leave the furnaces. This last essential qualification puts out of court any method of dust clearance that involves the water washing of the gases. The importance of this qualification will be understood by the following: Every ton of coke consumed in an ironmaking blast furnace generates some 180,000 cubic feet of gas, weighing 13,824lb.—this weight of gas leaving the top of the furnace at a sensible temperature of, say, 670deg. F., or for facility of computation, and allowing the reduction to be down to the temperature of the atmosphere, say 600deg. F. The heat that will thus be thrown away by the cooling of the gases by any washing process, and employing as a specific heat factor the common one of 0·2377 (which is less than the actual, because, as Berthelot has proved, the specific heat increases with the temperature), then $13,824 \times 0{\cdot}2377 \times 600\text{deg.} = 1,971,579$ B.T.U. If we accept the factor 13,000 B.T.U. as the thermal coefficient for coke, then the above quantity of heat is equal to that which would be generated by the combustion of 151·5lb. of coke. This would be equivalent to a heat loss on each ton of coke introduced into the furnace of 6·7 per cent. The new system of cleaning the gases before they are introduced into the furnace does not involve any of this serious loss. The new system permits when required the displacement of the blast-furnace gases for stove-heating by gas made from inferior and low-priced coal, permitting the entire blast-furnace effluent to be employed for power purposes. The dependence of ironmasters upon ironmaking as a means of sustaining the continuous operation of their furnaces involves the seriously wasteful operation of blowing out the furnaces when pig iron fails to become sufficiently lucrative. The new system may permit the working of the furnace at a profit, pending the return of sale rates of lucrative proportions. The slag product during this non-iron-producing term can be made chemically suitable for several industrial purposes. The tendency to carbon-starve the iron in the search and striving for the record minimum proportion of fuel fed into the furnace in its ratio to iron produced will lose its *raison d'être*, and when the *locale* of the furnace is well situated for the disposal of power, it may actually become a question as to whether the iron or the power-selling department attains the figure of greatest importance. This leads on to the question of the desirability under certain circumstances of recurring to the old system of cold-blast iron practice, or (in the new development) warm-blast iron; because the new system in this application involves the employment of the recuperative principle by which the sensible heat of the effluent gases is recovered.

The question that naturally suggests itself to a[l] masters is: What is the sale value of the power t[h] be developed in excess of that demanded by hi[s] requirement? Now, had this question been raised 25 years back, an economically satisfactory reply not so easily have been found as it is to-day. It is the remarkable facts in the history of the evolut[ion] practical science that progress is always proceeding same rate in various and associated directions; [w]e have a striking exemplification of this fact in the s[ide] side development of the caloric or internal-comb[ustion] engine, on the one hand, and of electric energy gen[eration] and power transmission on the other. By the electrical science we are able to transmit any powe[r] a central source to distances of 30 miles and mor[e] a loss of less than 25 per cent.* The silent conv[eyance] of power to the different mechanical elements throug[h] works is almost magical, and no one who has compa[red] two systems (electric power transmission *v.* stea[m] and steam-engines) can hesitate a moment in the in[…] conclusion of preference for the electrical aid advantages external to the works are still greate[r] indeed, it has no rival in steam transmission. The power can be transmitted so conveniently, and with small loss, that the ironmaster and power seller area of power sale equal to some 2,827 square [miles] equal to a circle of 60 miles in diameter. The regu[…] of long-distance electric power transmission in the States is familiarising us with the success of this pr[…] and the obstacles that our own timid Board of people constantly throw in the way of progress wi[ll] tually be removed. The sale value of the excess available at the ironworks will obviously depend up[on] cost of a unit of power at the already established light and power stations in the vicinity of th[e] works. Fortunately, this factor of sale value determi[…] is already available through the publication of the de[…] the working costs by the different electric lighting panies and corporation electrical departments, an[d] author, on the basis of the official figures, has cal[culated] the average cost of the power applied to the di[…] ironmaking centres throughout Great Britain.

(To be continued.)

QUESTIONS AND ANSWERS.

Under this heading we insert questions and a[…] of a practical character relating to central-station tramway work, or construction work; and for eac[h] able question offer *one shilling*, and for the bes[t] tion of any question we offer *ten shillings.* W[e] give *five shillings* for every other answer we print. answers to any question should be sent within 1[…] after the question has appeared, and should be writ[ten] one side of the paper only. We would call the att[ention] of those sending in answers to the fact that the n[…] of any sketches sent in is considered when marki[ng] relative values of these answers. Questions may b[e] at any time.

QUESTIONS.

62. What are the relative merits of two and three phase lations for supplying power and light in such places factories?—C. P.

63. What are the relative advantages and disadvant[ages] carrying steam-pipes (*a*) overhead, and (*b*) beneath room flooring?—S. G. P.

ANSWERS.

Question No. 57.—What are the advantages and disadv[antages] of superheating?

Best Answer to No. 57 (*awarded* 10s.).—Ste[am] said to be superheated when the temperature

* For information respecting the possibilities of electric transmission the reader is referred to an article in the N[ineteenth] *Century*, 1894, by B. H. Thwaite, and to a joint artic[le] *National Review*, 1895, by Earl Russell and B. H. Thwaite.

ıg to the pressure at which it is generated is by externally-applied heat. The apparatus for g this consists of a series of tubes, through which ım is made to pass on its way from the boiler to the These tubes are heated either by an inde- tly-fired furnace, or by being placed in the flues. reat advantage of superheated steam is that it to a minimum the condensation losses, and enables ork with really *dry* steam. The steam-pipes from erheater to the engine can contain no water as long superheat remains at the admission valve, and the cylinders may theoretically be kept entirely free ater by so arranging the degree of superheat that ım is dry at cut-off and at exhaust. Practically this m attained, as it has been shown by experiment that ıt 120lb. pressure requires to be superheated by F. above its normal temperature on entering the to ensure dryness at cut-off, and 300deg. F. super- ıuld be required for the steam to remain superheated expansion. On the other hand, it is an undoubted ıt remarkable economies have been shown by the use erately superheated steam, and the economy is most when the engine is supplied with wet steam by a rhich primes badly. The following table contains ırticulars of the gain in ordinary cases by using ated steam :

;ine.	Pressure.	Percent. of condensation.	Ratio of heat lost by condensation and expended on superheat.	Amount of superheat.
....	50·100	50 to 30	5 to 1	100deg. F.
nd	75·125	30 to 20	3 to 1	75deg. F.
....	125·180	20 to 10	2 to 1	50deg. E.

dinary cases 100deg. F. superheat will show a steam l economy of about 20 per cent., allowing for the d in superheating.

idering now more particularly the advantages from superheating in central-station working, we 1) The boiler power is increased 20 per cent., with nall increase in capital cost or floor space; this em is often a very serious consideration for central- engineers. (2) The capacity of the condenser is d, as the engine uses less steam per indicated horse- (3) The consequences of priming, caused possibly ers having to be forced to meet a sudden load—*e.g.*, or thunder cloud—are much less serious, the final eing to reduce the superheat at the engine while ng dry steam. (4) The condensing water should be l for reasons given in (2). (5) A somewhat better fficiency when the heater is placed in the flues.

ı central station, however, it is advisable to have a s furnace for superheating arranged so that steam used direct from the boilers in case of necessity.

disadvantages are: (1) The necessity for using a xpensive lubricant for the cylinders and slightly it, due to the higher temperature in the cylinders. re is more friction in an engine using superheated nvolving more wear on the cylinders and valves, in ı to reducing the engine efficiency. This must n increased cost of maintenance, but at present the of this increase is an unknown quantity. These s increase in importance as the amount of superheat used, so that it is not at present considered advis- ordinary cases, to superheat much above 100deg. F., engines have been worked with over 300deg. initial at for months without the cylinders showing signs . (3) There is some difficulty in regulating the of superheat, and the tubes of the heater are liable ry from scaling and subsequent burning. With y precautions as to purity of feed water, however, ıot serious.

ly, we may look forward to a time when a super- rill be considered almost as much of a necessity as aser now is.—E. M.

er to No. 57 (*awarded* 5*s*.)—The special advantages reverse derived from the use of superheaters depend number of factors, primarily the type of superheater that is employed, the design of plant it is used in conjunction with, and the manner in which it is treated. Of course, the chief advantage of superheating is the reduction in condensation losses in cylinders, steam-pipes, etc., obviating one of the greatest difficulties that is met with in steam-engine design. The same results can be obtained by steam-jacketing, but the benefits derived from its use are neither so great nor so economical as in the case of superheating, insomuch as the latter supplies the extra amount of heat for preventing condensation when it is required—that is, during the admission stroke—while a jacket wastes steam in heating up the exhaust steam also. It is a well-known fact that superheated steam cannot exist in the presence of water, so that directly admission occurs the film of water formed on the walls of the cylinder is re-evaporated. The full advantages of superheating are not realised if the steam is in a saturated condition before the end of the stroke. Probably to prevent this the temperature of the steam at the engine, say, for 160lb. per square inch would have to be from 500deg. to 600deg. F.—that is, about 130deg. to 230deg. F. superheat. If much below this, with ordinary ratios of exhaustion, the steam will be saturated at the end of the stroke. To obviate this difficulty, the experiment has been tried in receiver engines of passing the steam from the receiver through part of the superheater again, thus drying it before its admission to the low-pressure cylinder, but the extra amount of capital outlay and complication involved in this almost prohibits its adoption The loss by condensation which occurs in steam-pipe engine cylinders varies so widely in different cases that it is impossible to state its amount. Probably the following table gives a fair average :

	Pressure.	Per cent. loss by condensation.
Simple.......................	50·100	50·30
Compound	75·125	30·20
Triple	125·180	20·10

From this it will be seen that the greatest economy with superheating is obtained in the worst cases—namely, those of the simple engine using comparatively low pressures. Another point often overlooked is that the net economy is very much greater with slow-speed engines than with high, thus the fact that superheating has been used to such a limited extent only in electric light stations. There have been many tests taken of the economy obtained by the use of superheaters, but the type of plant used and the conditions which existed during the tests in the various cases have made the results obtained so widely different that they are practically useless for purposes of comparison. The following is a test taken of a plant at a woollen mill, consisting of a Lancashire boiler 7ft. 6in. by 28ft., working at 85lb. per square inch, fitted with McPhail and Simpson's superheater, and a compound "Corliss" engine of 250 h.p.:

Results (Boiler).

	Without superheater. Lb.		With superheater. Lb.
Coal burnt per square foot of grate per hour.	21·94	...	16·29
Water evaporated per hour { No. 1 test from 190deg F. / No. 2 test from 160deg. F. }	4740	...	4621·5
Water evaporated per square foot of grate per hour......................................	158	...	154
Water evaporated per pound of coal (as used)	7·2	...	9·45

Engine.

Mean indicated horse-power per hour	240	...	251·8
Coal (as used) per indicated horse-power per hour..	2·62	...	1·94
Water (as measured) per indicated horse-power per hour	18·9	...	18·35

Thus showing that the efficiency of the plant has been improved by about 31 per cent. This gain has been solely effected by the utilisation of the waste furnace gases, part of the heat being imparted to the water and part to the engine in the form of superheated steam, a principle peculiar to the McPhail superheater, which consists of two stacks of steel tubes set at the back end of the boiler, their upper and lower ends terminating in boxes or headers. The course of the steam from the anti-priming pipe is into the top box of one set of tubes, through the tubes into the bottom box, and from thence

through a copper pipe traversing the whole length of the boiler under the flues; from here it goes into the bottom header of the next set of tubes, up them and through a corresponding copper pipe to the one mentioned above, only set just below the water-line, and finally to the stop-valve. The action is this: The saturated steam entering the first lot of tubes gets highly superheated, and passing through the copper pipe at the bottom of the boiler imparts some of this heat to the surrounding water, which is about the coldest part of the boiler. From here, going through the second set of tubes, it again gets highly superheated, but in traversing the second copper pipe just below the water-line gives up some of this heat, thus ensuring that the amount of superheat shall not assume dangerous proportions. Again, if by any chance the superheater should tend to act as a condenser (such cases are on record), these copper pipes would obviate the difficulty. There are a number of superheaters which do not utilise the furnace gases, but are independently fired; in these, of course, the amount of coal used to heat them must be added to the amount burnt in the boilers to estimate the gain from their adoption. The Schwoerer is usually an example of this type, and consists of a number of vertical pipes surrounded by gills, which effectively absorb the heat from the furnace below them, no attempt being made to regulate the superheat by passing the steam again through the boiler.

From the above it will be readily seen that there are some very solid arguments in favour of superheating, so that its comparatively limited use points to the fact that there must be some counterbalancing disadvantages. They are: (1) Lubrication troubles due to the high temperature of the steam decomposing most low-class lubricants, such as tallow, rendering them ineffectual and causing pitting of the cylinder, etc. During the last few years this difficulty has been partially overcome by the attention that has been paid to the manufacture of high-class mineral hydrocarbons, whose composition will not alter under the action of heat, but even then the consumption of oil is very much increased. (2) Excessive cutting of piston rods, valve faces, etc., in the absence of any lubrication, necessitating, as a rule, the use of piston valves in place of the ordinary slide valves for any but the most moderate pressures. (3) Inability to use any form of packing but the metallic type, owing to the rapid charring and depreciation of any of the former class. (4) Difficulty to control the amount of superheat, making it possible for the steam to attain dangerous temperatures if not properly regulated. This does not apply to any extent with the McPhail superheater. (5) Increased radiation losses in steam-pipes, etc., on account of the absence of any non-conducting film of water on the metallic surfaces, which there would be with saturated steam. (6) The difficulty to adapt the type using the flue gases very successfully to any but the Lancashire boiler, and in some instances debarring the use of an economiser. (7) Danger of breakdown, and depreciation in the superheater itself on account of the number of joints, pipes, etc.

Reviewing the above, it will be seen that the point to decide is whether the increased efficiency of the engine and boiler is counterbalanced by all these disadvantages, a great many of which are only defects in the design of the apparatus and are gradually being obviated, so that at a time not far distant it is probable that superheating will be utilised to an extent far greater than applies at present.—H. Bell.

Answer to No. 55 (*awarded* 5s.).—The advantages incidental to superheating of steam are: (1) The prevention, or, at all events, a great reduction of the loss known as initial condensation in the engine cylinders. This results from the fact that although heat may be taken from superheated steam (the heat in this instance is absorbed by the metallic surface of the cylinder, etc.), no condensation takes place until the temperature is reduced to that of saturated steam at the boiler pressure. It is possible, therefore, by a sufficient degree of superheat to reduce the quantity of steam to the exact amount required to fill the cylinder up to the point of cut-off. But this requires a large amount of superheat, about 300deg. F. usually, but depending upon the class of engine. Whether it is economical to superheat to this temperature has yet to be proved, experience pointing to 100deg. F. as the most economical degree, and this is usually enough to prevent all initial condensation, and 15deg. or 20deg. F. will often produce a gain, the actual amount of saving varying with the type of engine and the steam pressure. The more wasteful the engine, and the lower the steam pressure, the greater degree should be the superheat, and the saving will be much larger than with good compound or triple-expansion engines using high-pressure steam. For instance, a simple engine with steam pressure of 60lb. to 100lb. superheated 100deg. F. would probably give a gain of 50 per cent. in steam. This gain would be reduced to 25 per cent. with a compound engine with steam at 120lb. pressure and 75deg. superheat, and a further reduction to 10 per cent. in the case of a triple-expansion engine with steam at 120lb. to 180lb. pressure and 50deg. superheat. The second advantage is the certainty of the engine always receiving a supply of absolutely dry steam, it being impossible for water to exist in the presence of superheated steam. This fact can be fully appreciated when considering the serious accidents owing to water getting into the engine cylinders from the boilers or from the condensation of steam in the steam-pipes. The quantity of water may be small in the case of Lancashire boilers and a well-designed system of steam-piping, but in the case of water-tube boilers and long lengths of steam-pipes it is often considerable. A third use of superheaters is to add to the evaporative power of the boilers.

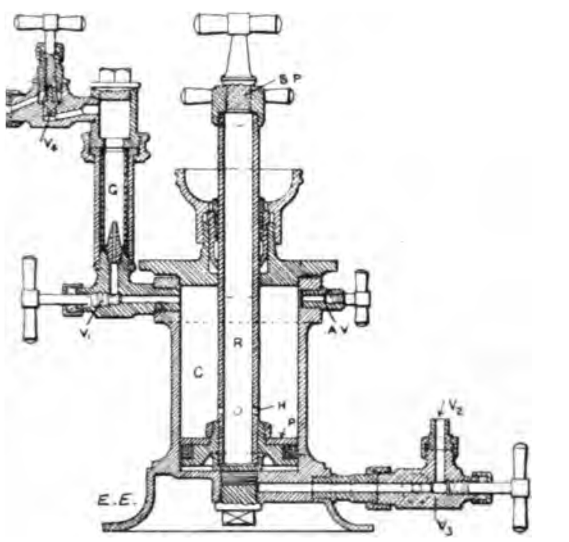
The objections brought against superheating are, first, the difficulty of maintaining efficient lubrication in the engine cylinders owing to the high temperature of the steam. This difficulty has been the chief factor in retarding the progress of the superheater, especially as the introduction of high-pressure steam with its own high temperature leaves very little increase possible to the point where lubrication can be maintained. But with the high-grade hydro-carbon lubricants now obtainable this objection is reduced to a minimum, although the increased cost in the quantity and quality of the lubricants must be taken into account in considering the economy of superheating. Secondly, the difficulty in designing a good superheater, owing to the great heat to which the tubes are subjected; this also seems to have been successfully overcome, as there are several good types on the market. The regulation of the degree of heat in the superheater may also be mentioned as a difficulty in the way of superheating.

Looking at the question from exclusively a central-station point of view, the best practice is to keep the superheater entirely removed from the boilers and flues—that is to say, fired independently. It is also necessary to so arrange the steam-pipes that the engines can be supplied with either saturated or superheated steam, or any mixture of the two. The pipes should also be as short as possible and well covered, as the specific heat of steam being so small, a few degrees of superheat are quickly lost. In conclusion, the gain from superheating is sufficiently obvious to warrant the extra capital outlay, excepting in cases where the difficulties in the way of laying down the plant for want of ground space or other reasons are such as to counterbalance any saving in fuel, and this can only be decided upon the conditions under which each station is erected being considered.—H. A.

Question No. 58.—Describe with sketches one good form of sight-feed lubricator for cylinders and explain its action.

Best Answer to No. 58 (*awarded* 10s.)—Many of the ordinary forms of lubricators for steam-engine cylinders are very unsatisfactory, being somewhat uncertain in their action. In the sight-feed lubricators as generally used, the oil is forced into the cylinder by a head of water formed by condensed steam. There is the pressure of the steam on both sides of the oil, but it is the extra pressure due to the condensed steam which causes the oil to enter the cylinder. The best form of sight-feed lubricator, and one which is positive in its action, is the Grandison patent piston type. A section of one of these is shown in the drawing. The oil-chamber, C, consists of a bored cylinder in which is fitted a piston, P, which has a hollow piston rod, R. The oil is supplied to the chamber through the hollow rod, the screw plug, S P, being removed. The action is due to a direct pressure of steam. There is

·e on both sides of the piston, but owing to the · effective area on the upper side, the piston is up by the difference in the pressures so caused, ıg oil with it, which finds its way past the regulating V_1, and through the nozzle into the chamber, 'his chamber has a glass tube for its sides, h which the rate of flow of the oil can be seen, drops rise through the water contained therein. ·he chamber, G, the oil passes on to the cylinder of ;ine, the steam-chest, or valve. Several outlets for may be fitted to the apparatus, and each can be ed to supply at different rates. The rate of feed ı varied from 1 to 200 drops per minute. An advan- ı this type is that the height of the piston rod will e how much oil is left in the chamber, C, and also it requires refilling. This is done by closing the V_2, at the bottom of the cylinder, opening the air A V, and the valve V_3 to run off the condensed The piston must then be pushed down in the r, and oil poured in through the plughole, S P, at of the rod, whence it finds its way into the chamber h the holes, H, above the piston. This type of tor can be placed in any convenient position on the and have pipes leading from it to the various parts



ng oil. By being away from the cylinder the tem- re of the oil is kept more constant, and therefore the ency is more constant. It may be put within easy nstead of on the top of the steam-cylinder—a position is very inconvenient, especially with vertical engines. glass of the chamber, G, should break, the valve V_4 ly closes, so preventing escape of steam from the cylinder.—T. A. LOCKE.

er to No. 58 *(awarded* 5*s.)*.—The lubricator shown . 1, 2, 3 is a very good one, and may be relied on action. It is of "the displacement type," and s for its action on (1) the head of water in chamber, pipe, C, connecting B to the bottom of D; (2) the gravity of oil is less than that of water, the oil will ı the top of the water. The usual construction is in the figures, and the material used is brass. Fig. 1 ertical section. (B is also made in a spiral, and a : cooling surface is then obtained.) Fig. 2 is a side showing outlet, O″, for water, and Fig. 3 is a plan ıg how the connection is made between D and outlet, he position of this lubricator is usually on the steam- ust as it enters the steam-chest. A is directly con- d to the steam-pipe and leads to B, which is the con- ng chamber. D is the oil-chamber, G glass tube, and lift valve. P is connected to steam-pipe. When first l, T, T′, T‴, and N being closed, B is filled with water ı W, D is filled with oil from M, and the glass, G, filled ı water from L. When steam is admitted through A ndenses in B. T′, T″, and N being now open, water s into D, oil is displaced, flows down E, up through h N, up through G, lifts valve, V, and passes out by P steam-pipe, and enters steam-chest and cylinder with am. The flow is regulated by adjusting T′ and l the required amount of oil passes drop by drop. To refill, close T′ and T″, open T‴, then open M; the water will now run off from D, when empty close T‴, fill with oil, now open T′ and T″ and regulate flow. The action now goes on as before. Should the glass, G, be broken, close N, T′, and T″. Steam is now entirely cut off from the glass, G; unscrew nuts 1 and 2, take out broken pieces, and replace by new glass and rubber washers, screw up again and fill with water from L, and start again by opening N, T′, and T″. If watched and kept filled no trouble will be found with this form of lubricator if kept clean, and it will remain fairly cool, but if allowed to run empty and

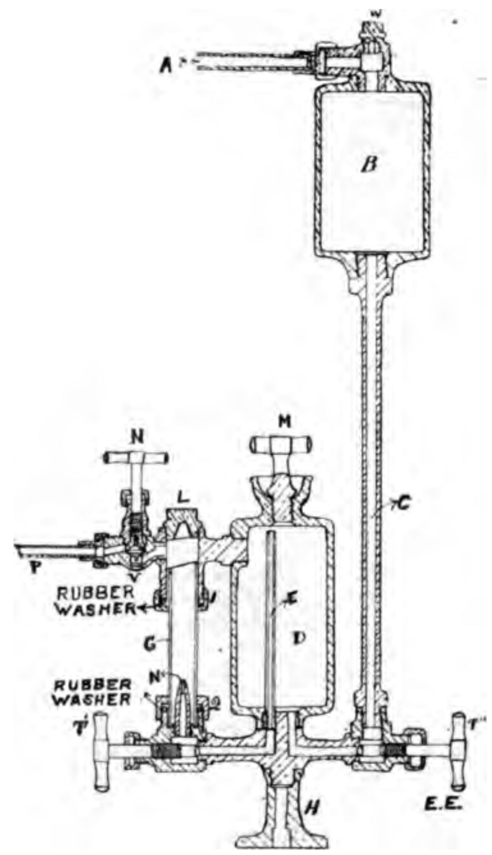
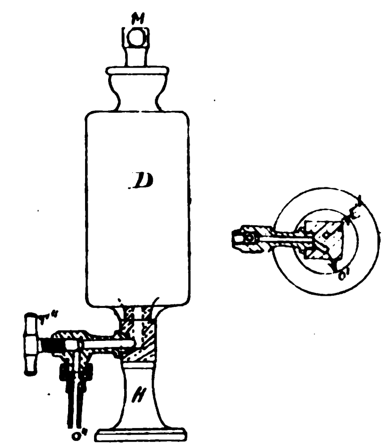


FIG. 1.

remain for some time the water in B will get very hot, also the whole apparatus, and will result in a cracked glass generally. After a short usage the time for each refill is

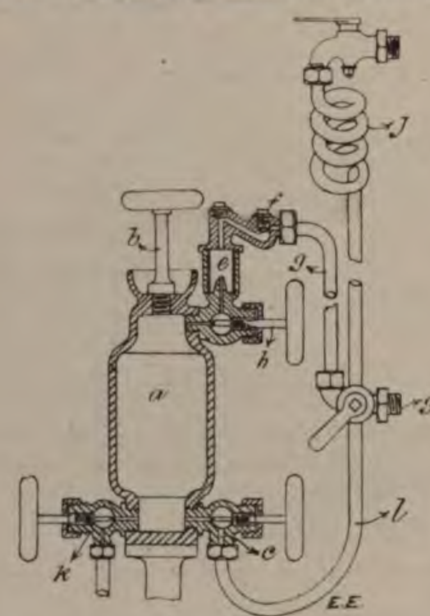


FIGS. 2 AND 3.

found out, allowing for a certain feed, then it will only require an occasional look between these times.—R. GRIGG

Answer to No. 58 *(awarded* 5*s.)*.—For lubricating internal moving parts of an engine, a sight-feed lubricator is generally used. By this means a small amount of oil at regular intervals is supplied, which has been found to be the most efficient and economical way of lubricating. The illustration shows a sectional elevation of a Crosby sight-feed lubricator, and the following description will show its working: A is a circular reservoir for the oil, B the plug for filling the same, C is the inlet for the condensed steam, E is the sight glass, F is the check-valve to prevent steam

from entering the reservoir, G is the delivery pipe for the oil into the steam-pipe, H is the plug for regulating the oil, J is a special condenser, and K is a drain cock. The theory of the working is that the water is supplied from the condenser, J, elevated above the oil reservoir; it is then delivered through the pipe, *l*, underneath the oil, and thus there is no intimate mixture by water passing through it. Pressure given by this water column acting underneath floats the oil upwards and drives it through the cock, H, which regulates the number of drops which rise through the small nipple in the water-filled sight-glass, E, after which the oil passes beyond the check-valve, F, and the pipe, *g*, when it then mixes with the steam, to be carried as a lubricant between the slides and all internal parts of



the engine. The lubricator should be connected up on the boiler side of the stop-valve of the steam-pipe so as to be got to work before starting the engine, and the location of the lubricator should be in some cool part of engine-room, as it is unreasonable to expect steam to condense or the apparatus to work when in close proximity to hot steam-pipes.—RICHARD E. PROSSER.

GLASGOW ELECTRICITY WORKS.

The following is the report of Mr. W. A. Chamen to the Sub-Committee on Works as to proposed extension of works for supplying current within the whole municipal area:

On Feb. 14 last it was remitted to me to prepare and submit a detailed report as to the scheme or schemes which I would propose should be adopted by the Corporation in carrying out the permanent installations to be put down within the new generating stations to be erected upon the ground at Port-Dundas and the ground at Pollokshaws-road with the view of ultimately supplying current, either for lighting or motive power, to all persons who may desire to take and to whom the Corporation are or may be entitled to furnish such supply. In terms of that remit I now beg to submit the following report:

When I entered upon my position as chief engineer to the Corporation, at the end of January last, it immediately became clear to me that a strong effort would require to be made to secure some plant to meet the demand of next winter. The Waterloo-street station, which contains about 3,300 h.p. of engines, boilers, and dynamos had been completely overloaded during a fog which occurred the week before Christmas, in spite of the fact that two large accumulator stations had been put down—one at Claremont-street and the other at Tontine-lane—during last autumn, with the object of helping the steam plant at times when the heaviest load is on. On looking through the records for the last five years I found that the annual rate of increase in the number of lamps fixed had been, on the average, about 30 per cent. Having regard to this fact, as applied to 3,300 h.p., it means that an increase in demand of about 990 h.p. may be expected this year. An increase of street-lighting on account of the erection of over 100 lamps along the Springburn electric tramway route has also to be met, in addition to ordinary demands, and it therefore seemed necessary to have at least 1,100 h.p., with a proper amount of reserve plant fixed complete, in time to meet the winter's demands. To have waited the necessary time to make a full report before taking some active steps to meet those demands would have been to lose all chance of getting the plant

in time, and I therefore recommended you to advertise
in an open way for offers of any size or make of plant wh
be delivered by August of this year. The result of this a
been that orders have now been placed for 1,100 h.p. of
boilers, and dynamos, in duplicate (making a total of 2,2
together with various other necessary accessories.
Waterloo-street station is quite full already, it is of
impossible to fix anything more in it, and therefore the
which has been purchased in Port-Dundas, beside the F
Clyde Canal and between Sawmillfield-street and Corn-st
been commenced upon, with a view to getting in suffici
dations, and, if possible, buildings also, for the purpose
ing the new plant just referred to before next autumn. P
of the ground was obtained in February last and every e
has been and is being made to press the work forward.

Whilst dealing with this immediate extension, it was n
to consider at the same time how the general lighting sc
Glasgow should be developed so as to deal with the e
hereafter to be expected year by year, both in the numbe
sumers and the area to be supplied. Arrangements had
been made for the purchase of another site for a generatin
on the south side of the river in Pollokshaws-road, near
street railway station, and it seemed to me that, for so
to come, this and the Port-Dundas station ought to be ca
supplying all that would be required. At Port-Dundas t
be no difficulty about installing some 30,000 h.p., and at
shaws-road another 15,000, making a total of 45,000 h.
not safe to prophesy what the annual increase in the dem
be hereafter, but, if it is maintained at the present rate
cent. per annum, eight years will find these two sites fully o
It is, however, uncertain if this rate will continue. The
as to how this amount of electrical energy is to be distribu
the municipal area next had to be considered. The W
street station is now delivering a supply on a three-w
tinuous-current system at a declared pressure of 100 and
at consumers' terminals. I believe it was decided, when
poration first took over Messrs. Muir, Mavor, and
installation, to continue at the same voltage—viz., 100-
were using rather than exchange the lamps for others of
115 volts.

When the Board of Trade regulations were altered so
years ago it was decided to take advantage of the in
pressure allowed at consumers' terminals, and, in consequ
100-volt lamps are gradually being exchanged for other
volts, with the intention of ultimately rearranging the
as to make it a three-wire system with 200 volts each sid
volts altogether. This is a very great advantage, as it en
supply to be carried much further, and saves very large
amount of copper required in the distributing mains and
and, consequently, in the cost of them. It is, however,
to do even better than this, and to use a three-wire sys
250 volts each side (or a total of 500 volts), which is the
pressure allowed by the Board of Trade as a low-pressure
Several towns—among which may be mentioned Edinbu
already using 230 volts at consumers' terminals, and as
no difficulties in the way, I recommend you for all new
declare 250 volts as the standard pressure to consume
point is of greater importance than would at first appear,
the increase proposed—viz., from 400 to 500 volts—is
increase of 25 per cent., the real effect produced in th
saving copper in the mains and feeders is about 50 per ce
new plant already ordered is all designed with a view to
out the supply from Port-Dundas at this increased pres
of course, the plant for the Pollokshaws-road station
similarly designed. There will be no difficulty about sup
feeding points about two miles distant from each of the
generating stations, and in further supplying an area of a
a mile radius from such distant feeding points. Upon referri
map to be submitted to the committee, it will be seen tha
area as can be reached in this way, from the Port-Dundas
the north side, and from the Pollokshaws-road station on t
side, will include, commencing at the west, Anderston,
North Kelvinside, Maryhill, Possilpark, Springburn, De
Bridgeton, Hutchesontown, Govanhill and Polmadie, Moun
Crosshill, Langside, Shawlands, Crossmyloof, Pollokshield
the intervening districts. As this area includes practi
whole of the municipality, there is no necessity for re
high-tension current for supplying any district within th
municipal boundaries, although, if those boundaries sho
time hereafter be extended so as to render longer feed
sary, it may be desirable to adopt a partial high-tensio
and there will be nothing to prevent the fixing of thi
plant in either of the two new generating stations he
this should be found expedient, provided that the who
which these two stations are capable of delivering is not p
fully absorbed within the present municipal area.

The use of an increased voltage, whether it be 400 or
renders it impossible to work the new stations directly c
with the same mains which at present distribute the e
Waterloo-street station, unless they are first disconnec
that station. It will, therefore, be desirable to hem in th
area supplied from Waterloo-street station on all side
mains and feeders at the higher voltage, and graduall
connect the mains, street by street, from the Waterloo-st
and reconnect them to the new feeders. Thus, in d
Waterloo-street station will be relieved of its entire load,
supply will then be far more economically managed from
new stations only. The engines and dynamos at present
the Waterloo-street station can for the most part be
altered and removed therefrom into one or other of the

s. The Waterloo-street buildings are valuable property, ill still be useful as offices, stores, and probably a testroom ment for meters, and other useful purposes. The accumu- stations at Claremont-street and Trongate will also be ed unnecessary in their present positions, and the accumu- in these stations can also be economically used at either of o new generating stations.

section of the new buildings at Port-Dundas which it is now ed to erect is being designed to cover the centre portion of ound, and will measure some 222ft. in length and 202ft. in It will be capable of containing boilers, engines, dynamos, ccessories equal to about 9,000 h.p., with spares equal to cent. in addition, and will supply about 146,000 lamps of , lighted at one time, or the equivalent in other forms t or power. As the present ratio of lights burning to lights s only about 50 per cent., it may be roughly taken that the umber of lamps fixed which could be supplied from this as at present proposed would be 292,000. The maximum r of lamps which Waterloo-street station can safely deal ourning at one time, is about 48,000, or, say, 96,000 lamps allowing a proper margin of spare plant, but a demand to about 66,000 lamps, burning at one time, has been made t, resulting in failure to maintain the proper pressure. It refore, necessary to relieve the Waterloo-street station of of its present connections before next winter, in order to a recurrence of the overload.

ay be remarked here that these figures as regards Waterloo- station do not take into account the assistance rendered by o accumulator stations at times of full load, as such assist- only available for about two hours. The accumulators are d at some period of the 24 hours when the load is light and the engines and dynamos are not fully occupied, and, in the of darkness lying over the city the whole day long, necessi- the use of the whole plant, including all reserves, the ulators fail to be of any assistance after about two hours. ew plant already ordered for the Port-Dundas station will be re than is required to meet the load of the coming winter, s manufacturers require so long to make delivery, it will be o consider immediately what further extensions may be ary for the winter of 1899-1900. I have therefore to recom- that authority be given to prepare specifications and to ise for tenders for, at least, two more boilers, engines, and os of about 1,100 h.p. each, with the necessary accessories, Port-Dundas station, so that these may be ready in due This will leave plant equal to about 5,600 h.p. to be here- rdered for the section of this station now to be erected. No as as yet been ordered for the Pollokshaws-road station, e Corporation does not obtain possession of the site until ginning of June. There is no reason, however, why the s of the buildings and the manufacture of at least a portion plant—say, 2,200 h.p.—for this station should not now ceeded with so as to avoid all possible delay hereafter. , therefore, further to recommend that authority be given pare specifications and to advertise for tenders for two of about 1,100 h.p. each, with engines and dynamos of such s sizes as may be most convenient, and also for the necessary ries. I have likewise to recommend that an architect and urer be appointed for the buildings and other work at this

next question to be considered is that of distribution. It ready been decided to lay distributing mains along the burn tramway route from the end of Sauchiehall-street *viâ* nentary-road, Castle-street, and Springburn-road to the far the tramways at Springburn, and it has also been decided a feeder for lighting Ruchill Hospital. The necessary for these extensions have been ordered, and are already delivered. It is desirable also to run a distributing rom Ruchill Hospital, past Saracen Foundry and along orn-street to Springburn, to join up the feeding points, is may also serve to supply some of the Possilpark district. re are several applications from Cowcaddens, New City-road, . George's Cross district, including the "Zoo," which the ation is already lighting by means of temporary plant, it expedient to lay new distributing mains in the upper ends hanan-street, West Nile-street, and Renfield-street, and rcaddens, St. George's Cross, New City-road, and Great n-road districts. As there is also a considerable demand ting at Hillhead, it will be well to lay further distributing along the Great Western-road as far as the Botanic Gardens some of the streets around this district. To meet the d for light at Bridgeton Cross, the dead-meat market in Moore- and other places in the eastern district, it will be necessary distributing mains in this direction through various streets east as Bridgeton Cross. On the south side it will be well distributing mains in some of the roads about Pollokshields t, Eglinton-street, Kingston, Gorbals, and Hutchesontown, so in Govanhill and Crosshill. The routes along which it is ed in the meantime to lay down distributing mains for the of all districts alluded to in this report, and the feeding are shown upon the plan before referred to.

capital expenditure necessary to carry out the works indi- n this report is approximately as follows:

at Port-Dundas (already purchased), exclusive of luty	£23,000
g and fencing site, and erecting shed for stores, etc.	1,500
gs (about 200ft. square)	31,000
qual to total of 10,000 h.p.	135,000
Total for generating station	**£190,500**

Mains and two feeders for Springburn route, including distributing main between Possilpark and Springburn.	£14,012
Feeder to Ruchill Hospital	4,850
(These two items are already sanctioned.)	
Mains and one feeder for Bridgeton district, as before mentioned	7,600
Mains and two feeders in St. George's Cross district as far as the Kelvin	11,600
Distributing mains only for Hillhead, no feeder being at present required	2,000
Ducts only for street-lighting, to be laid along Cowcaddens, New City-road, Great Western-road, to Botanic Gardens	950
Branches and services to consumers	1,760
Meters	2,860
(These are the districts which appear to require immediate attention.)	
Next would follow feeders from Port-Dundas to the Waterloo-street area to take over all the present lighting from Waterloo-street and from the two accumulator stations	28,700
Probable extensions of network in new and old districts	8,000
Branches and services to consumers	5,800
Meters	9,425
Total for distribution	£97,557

When this point is reached the 10,000 h.p. will probably be fully employed.

For the Pollokshaws-road station the capital expenditure is estimated approximately as follows:

Site, exclusive of feu-duty	£5,000
Clearing, fencing, etc., say	1,000
Buildings (section for about 7,000 h.p.)	16,000
Plant, 2,200 h.p. (of which part will be reserve)	43,000
Total for generating station	£65,000
Distributing mains in various districts, as before detailed, including five feeders	£25,350
Branches and services to consumers	3,000
Meters	4,680
Ducts only, for arc lighting in Eglinton-street	400
Feeders across Glasgow Bridge to relieve part of present Waterloo-street area	3,900
Feeder to Bridgeton Cross	5,600
Total for distribution	£42,930

Summary of Capital Expenditure.

Port-Dundas generating station	£190,500	
Mains connecting to ditto	97,557	
		£288,057
Pollokshaws-road generating station	65,000	
Mains connecting to ditto	42,930	
		107,930
Total		£395,987

The cost per horse-power for the first instalment of plant to be put down in the Pollokshaws-road station is considerably greater than that for the first instalment to be put down in the Port-Dundas station. This, however, arises on account of the cost of the accumulators and other accessories (which are the same in both cases) having to be spread over 2,200 h.p. as against 10,000 h.p.

Of the above expenditure of £397,987 the approximate sum of £45,000 will be required to pay for the plant already ordered, together with that which must still be obtained to make the Port Dundas station complete up to 2,200 h.p, a good deal of this being necessary expenditure in order to make a start, the full benefit of which cannot be reaped until further plant is put in. The portion of the Port-Dundas station now to be proceeded with, exclusive of site, which is already paid for, will cost, say, £31,000. This building will be large enough to accommodate 10,000 h.p. all told. The clearing and fencing of the ground are already nearly completed, and partly paid for. The new mains already being proceeded with are those in the Springburn route (£14,012) and Ruchill (£4,850). These items together make a total expenditure of £94,862, which the Corporation stands at present committed to. After the Waterloo-street station plant is relieved from duty it can, as already indicated, be removed to one of the two new generating stations, and for present purposes it will be convenient to consider it as being removed to Pollokshaws-road station. I am not as yet in a position to say exactly what the removal, alteration, and refixing of this plant may cost, but probably £5,000 will cover it. The Waterloo-street station plant is capable of supplying some 96,000 lamps fixed, as before mentioned, and the 2,200 h.p. of proposed new plant for the Pollokshaws-road station will supply some 64,000 more, thus making the portion of the last-mentioned station to be at first proceeded with capable of supplying some 160,000 lamps fixed. Adding the capacity of the first section of the Port-Dundas station—viz., 292,000 lamps—the grand total which can be supplied will be 452,000 lamps fixed.

The capital expenditure at the present time is about	£150,000
Capital expenditure proposed in this report, say	396,000
And cost of removal of Waterloo-street plant	5,000
Making a total capital expenditure of	**£551,000**

The revenue per lamp fixed for last year worked out to 6s. 4d. Although a reduced rate might possibly result in a lower revenue per lamp, this will only be consequent upon reduced total works costs, so that it will be safe to assume that last year's figures will hold good for both sides of the account. It is indeed possible, or even probable, that a reduced rate will not result in reduced revenue per lamp fixed, as the extensions now proposed may reach customers who burn their lamps or take power for longer hours. Manchester earns 7s. 11d. per lamp fixed on a rate lower than is at present in force in Glasgow. The total revenue on 452,000 lamps fixed at 6s. 4d. is £143,000. The total works costs may be taken at 40 per cent. of the revenue as it stood last year, and would therefore amount to £57,000. If depreciation and sinking fund are taken together at the extremely high figure of about 9 per cent., as was done last year, the amount for this item will be £50,000. Interest at 3½ per cent. on £551,000 would be £20,000, making a total of £127,000. This would leave a surplus of £16,000 as a result of the year's working. It need hardly be pointed out that the surest way to arrive at a low rate of charge for the supply of electrical energy is to make the concern as large as possible, and it follows that the sooner the capital expenditure contemplated in this report is reached the better. Applications for light and power are coming in from all quarters, and probably it will not be over-estimating the demand to say that the year 1901 will find the plant corresponding to the amount of capital expenditure before detailed fully taken up, provided, of course, that the plant can be delivered and fixed in time.

The recommendations, therefore, which I have now to make are as follows: (1) That of the total amount (£288,057) proposed to be ultimately expended for the purpose of providing plant equal to 10,000 h.p. for the section of the Port-Dundas station now to be proceeded with, and the mains connected therewith, the Corporation should, in the meantime, authorise the sum of £61,000 (over and above the £95,000 to which they are already committed) to be expended; and (2) that the expenditure of the before-mentioned sum of £107,930, for the purpose of providing (a) the first section of the new station at Pollokshaws-road, (b) the first instalment of plant therefor—namely, 2,200 h.p.—and (c) the feeders and distributing mains, which it is at present intended to lay down in connection therewith, be also authorised. The total expenditure now proposed will be spread over a period of about two years.

LIGHT RAILWAYS.

The British Electric Traction Company have succeeded in taking over the working of the projected Gower light railway from Blackpill, near Mumbles, to Port Eynon.

The Midland and South-Western Junction Railway Company have given notice of an application to the Light Railway Commissioners for powers to construct a line from their existing Ludgershall Station through the parishes of Kimpton, Thruxton, Shipton Bellinger, West Cholderton, and Newton Tony, and thence to Amesbury and on to Bulford.

The Great Western Railway Company have given notice that they will at once proceed with the construction of the new light railway from Pewsey over Salisbury Plain to Salisbury, the same having been sanctioned by the Board of Trade.

The Board of Trade have confirmed the orders for the construction of light railways from the Helston Railway to the Lizard Village, in Cornwall, and between Peakirk, in Northamptonshire, and Postland, in Lincolnshire.

The Light Railway Commissioners have informed the promoters of the Sheppey light railway that they will recommend the Board of Trade to issue an order empowering the construction of the proposed line from Queenborough to Leysdown.

The Penzance and St. Just light railway will be supported by the former and opposed by the latter Council.

The application from the promoters of a proposed light railway from the G.E.R. at Elsenham, through Thaxted, Bardfield, Wethersfield, and Finchingfield, to Hedingham, for permission to cross the roads under the authority of the Braintree Council has been assented to; also a similar application made by the promoters of the Kelvedon, Coggeshall, and Halstead light railway.

Messrs. William Webb and Co. have given notice of an intended application to the Light Railway Commissioners for an order authorising the construction of a light railway from Herne Hill to Farnborough and elsewhere in the counties of London, Surrey, and Kent.

The Glasgow and South-Western Company is making application for leave to construct a light railway from Ayr to Gowan by the Carrick shore.

The British Electric Traction Company have given notice of intended application to the Light Railway Commissioners next month for an order under the Light Railways Act, authorising the construction of several branch lines of light railways in Merthyr, Dowlais, and Cefr.

The surveyor of the East Sussex Council will attend the enquiry to be held into the Cuckmere light railway scheme. The Council have given formal notice of dissent. It was stated that the chief objection is to two level crossings, and although it was not desirable that level crossings should be multiplied, yet as the practical effect of their objection would be that the railway could not be carried out owing to increased expenses, they felt that provided proper safeguards were made for the safety of the public they should not proceed with their opposition.

HAMMERSMITH ELECTRIC LIGHTING ACCOUNTS.

The accounts of the electricity department of the Hammersmith Vestry have just been issued. The supply of current commenced on June 21, 1897, and the accounts, which are made up to March, 25, 1898, are therefore for nine months only. We give the capital account, revenue account, balance-sheet, and statement of electricity generated, sold, etc.:

Capital Account.

Dr.	£ s. d.
Site for central station	1,671 7 8
Buildings, including approach road to station	9,751 18 6
Machinery and boilers	12,487 9 3
Mains and services	11,112 0 2
Public lamps	2,555 14 0
Transformers, motors, etc.	450 1 0
Meters	1,299 0 5
Electrical instruments	107 14 0
Tools and implements	55 15 4
Stores and miscellaneous	67 5 5
Cost of mortgage deed	56 2 0
Total expenditure	39 614 7 9
Balance of capital account	691 12 3
	£40,306 0 0

Cr.	£ s. d.
Mortgage No. 1	1,671 0 0
Mortgage No. 2	38,635 0 0
	£40,306 0 0

Revenue Account.

Dr.		£ s. d.
Generation of Electricity.		
Coal, including carriage	£717 18 11	
Oil, waste, water, and engine-room stores	197 17 4	
Wages at generating station	530 11 10	
Repairs and maintenance—viz., buildings, £12. 10s.; engines, boilers, etc., £14. 12s. 8d.; dynamos, exciters, etc., £1. 10s.; other machinery, tools, instruments, etc., £79. 13s. 1d.	108 5 9	
		1,554 13 10
Distribution of Electricity.		
Wages of linesmen, fitters, and labourers	32 12 2	
Repairs of meters, switches, etc., on consumer's premises	1 0 0	
Ditto of apparatus at distributing stations	2 6 11	
		35 19 1
Public Lamps.		
Wages	85 5 4	
Arc lamps, carbons, etc.	92 10 3	
		177 15 7
Management Expenses.		
Engineer's salary	£124 0 0	
Clerk's salary	28 11 4	
Stationery and printing	67 6 10	
Advertisements	19 17 8	
General establishment charges	17 12 11	
		257 8 9
Special charges: insurance, etc.		51 11 10
		2,077 9 1
Balance carried to net revenue account		1,413 19 6
		£3,491 8 7

Cr.		£ s. d.
Private Lighting.		
Sale of current, September quarter, 1897	£245 16 2	
Ditto, December quarter, 1897	958 14 3	
Ditto, March quarter, 1898	1,272 3 2	
		2,476 13 [illegible]
Public Lighting.		
Arc lamps, December quarter, 1897	489 7 6	
Ditto, March quarter, 1898	489 7 6	
		978 15 [illegible]
Charges for attending private lamps		21 0
London and Lancashire Fire Office re gas explosion		15 0
		£3,491 8

Statement of Electricity Generated, Sold, Etc.

Quantity generated in Board of Trade units		301,9[illegible]
Quantity sold. Public lamps	94,395	234,7[illegible]
Quantity sold. Private consumers by meter	140,377	
Quantity used on works		10,73[illegible]
Total quantity accounted for		245,5[illegible]
Quantity not accounted for		56,42[illegible]
Number of public lamps		[illegible]
Total maximum supply demanded, kilowatts		31[illegible]

BALANCE-SHEET.

Liabilities.	£	s.	d.
London County Council—Mortgage No. 1	1,638	0	0
Mortgage No. 2	37,715	0	0
	39,353	0	0
Redemption of debt—amount redeemed to date	953	0	0
	40,306	0	0
Sundry creditors: one year's interest on mortgage debts and repayment of principal, £2,113. 5s. 5d.; on open accounts, £568. 2s. 3d.; deposits *re* installations, etc., £4	2,685	7	8
	£42,991	7	8

Assets.	£	s.	d.
Amount expended for works	39,614	7	9
Sundry debtors: private lighting, £1,238. 17s. 1d.; public lighting, £489. 7s. 6d.; on open accounts, £10. 4s. 8d.	1,738	9	3
Stores in hand: coal, £73. 17s. 6d.; carbons, etc., £28. 15s.	102	12	6
Cash: on capital account, £691. 12s. 3d.; on revenue account, £145	836	12	3
Balance, deficiency to date	699	5	11
	£42,991	7	8

COMPANIES' MEETINGS AND REPORTS.

WEST INDIA AND PANAMA TELEGRAPH COMPANY, LIMITED.

The report for the half-year ended Dec. 31 states, according to the *Times*, that the amount to credit of revenue is £32,228, against £34,053, for the corresponding half-year of 1896, and the expenses have been £19,772, against £21,398, leaving a balance of £12,456, which, with £1,243 brought forward, and £1,000 transferred from reserve account, makes a total of £14,699. It is proposed to pay a dividend on the ordinary shares of 6d. per share (free of tax), leaving £721 to be carried forward. Owing to the financial crisis through which the Leeward Islands are now passing, Antigua and St. Kitts have reduced their subsidies from £800 to £600 each for the current year. Notice has also been received from the Government of Jamaica that the subsidy of £2,000 per annum, hitherto paid by this Company, has ceased from March 31. The receipts of the Company for the half-month ended April 30 were £3,717, against £2,229 in the previous year.

EASTERN EXTENSION TELEGRAPH COMPANY.

The ordinary meeting of the Eastern Extension Telegraph Company was held on the 11th inst. at Winchester House.

The **Marquis of Tweeddale**, who presided, moved the adoption of the report. He said the gross revenue for the past half-year amounted to £275,142, or a decrease of £50,263, caused partly by a falling off in the Australian traffic and partly by reductions of tariff. The working and other expenses amounted to £102,844, showing a decrease of £3,426. The usual interim dividends had been distributed, making a total of 5 per cent., and a bonus of 4s. per share would bring the total up to 7 per cent. for the year. The extension from Manila to the islands of Panay, Negros, and Cebu had been completed to the satisfaction of the Spanish Government, and the cables opened for traffic. Unfortunately, however, through a further outbreak of the rebellion in the Philippines one of the new stations in Cebu (Tuburan) had had to be abandoned, and it was reported to have since been entirely destroyed. The uncertainty of the land lines between Bolinao and Manila had long been recognised by the Government and the mercantile community of Manila, and many proposals had been made from time to time for improving it, but without any practical result. A contract had been entered into for cutting the Hong Kong cable to Bolinao, and extending it direct to Manila in return for certain concessionary privileges. This work was carried out within a fortnight of the contract being signed, and the Bolinao station and staff removed to Manila. Soon after they had started to operate from Manila hostilities broke out between the United and Spain, and on Monday, the 2nd inst., at 8 p.m., the cable was suddenly interrupted close to Manila. The Company was advised that it was intentionally cut by the Americal admiral, and if that proved to be the case the American Government would doubtless compensate the Company. Communication between Manila and Hong Kong would not be restored, he was afraid, until the Company was in a position to repair the cable and until peace had been restored.

The report was carried

OSWESTRY ELECTRIC LIGHT AND POWER COMPANY.

The annual meeting of this Company was held last week, Mr. E. Bremner Smith in the chair.

The **Chairman**, in moving the adoption of the report and statement of accounts, said the net profit that year was £134. 4s. 9½d. After the payment of £15 as the nucleus of a reserve fund, and the dividend of 2½ per cent., there would still be left a small balance to be carried forward. Last year their sale of current amounted to £326; this year it was £514, or at the ratio of 16 to 21. The directors would encourage anyone who wished to take current for a motive power by meeting them in various ways. The dividend was 2½ per cent., while last year it was 3 per cent. The latter, however, was for 15 months' working, which came to £2. 8s. for the year. This year they were given £2. 10s. In regard to the increasing use of the light, he might say he had already had the order to put it in a church in the town, and he hoped before they met again to have it in three of the chapels.

The report and dividend were adopted, and Messrs. Corrie and Smith were re-elected directors.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bray.—The Commissioners invite tenders for the supply of the materials required at their electricity works for the ensuing year. Tenders by June 6.

Sunderland.—The Corporation invite tenders for the supply of piping, water-softener, etc Tenders by May 27. Full particulars appear in our advertising columns.

Bury St. Edmunds.—The Town Council invite tenders for the supply and erection of plant. Tenders by June 13. Full particulars appear in our advertising columns.

Coventry.—Tenders are invited by the Town Council for the supply of mains, lamps, apparatus, etc. Tenders by June 7. Full particulars appear in our advertising columns.

London.—Tenders are invited for the supply of calcium carbide, delivered free in London, 10 tons or more weekly. Apply to Carbide, care of Bates, Hendy, and Co., 81, Cannon-street, London.

Blackburn.—The Committee of St. George's Presbyterian Church, Blackburn, invite tenders for electric lighting. Specification and plans may be obtained by depositing £1. 1s. with the consulting engineer, Mr. John McLellan, 50, Northgate, Blackburn, before 17th inst.

Madras.—The Secretary of State for India in Council announces that the time allowed for the receipt of tenders by the Chief Engineer for Irrigation, Madras, for the utilisation of water power of the Periyar Lake has been extended from Oct. 31, 1897, to July 1, 1898.

Madrid.—Tenders are invited for the construction and working of an electric cable between Cadiz and Havana, *viâ* Teneriffe and the island of Vieques. The deposit required is 150,000 pesetas. Specifications, etc., are to be obtained from, and tenders addressed to, the Colonial Office, Madrid, by May 16.

Rochdale.—The Guardians of Rochdale Union have under consideration the advisability of lighting their workhouse with electricity. Persons desirous of submitting specifications and tenders for the same are invited to send their names and addresses in writing to Mr. R. A. Leach, clerk, Union Offices, Townhead, Rochdale.

St. Helens (Lancs.).—The Health Committee invite tenders for the erection of destructor shed, new pail shed, electric light engine-house, chimney, weigh-house, offices, etc. Plans, etc., may be obtained on and after May 6 on application to Mr. Geo. J. C. Broom, M.I.C.E., the borough engineer, on payment of £1. 1s., which will be returned on receipt of bona fide tender. Tenders by May 25.

Newport.—The Corporation invite tenders for the construction of tramways, laying wood and granite paving, and other incidental works, in accordance with plans and specification prepared by the borough engineer. Specification, etc., may be obtained from Mr. R. H. Haynes, borough engineer, Town Hall, Newport, Mon., upon payment of £5, which sum will be returned upon receipt of a bona fide tender. Tenders by 10 a.m. on 19th inst.

Darwen (Lancs.).—The Corporation invite tenders for the erection and construction of the various buildings comprised in the new electricity supply works, and also for the tall chimney to be used in connection with the proposed refuse destructor and works, in Robin Bank-road, Darwen: (Contract No. 1) buildings, etc.; (2) chimney shaft. Specifications, etc., may be obtained at the offices of the Borough and Electrical Engineers, where also plans of the site, buildings, and chimney may be seen during ordinary office hours on payment of £2, which sum will be returned on receipt of a bona fide tender. A separate tender must be sent in for each contract. Tenders must be delivered at the Town Clerk's Office by 12 noon on 26th inst.

Victoria (Australia).—Tenders are invited by the Council of the city of Hawthorn for the supply and erection, or for the supply only, of: (Section A) buildings only; (B) boilers, water-heater, pumps; (C) engines, dynamos, switchboard, mains, sub-mains, transformers, meters, arc lamps, insulators, testing instruments; (D) supply of poles and their erection; running of the plant for three years. Specifications and forms of tender can be obtained at the office of the Agent-General for Victoria, Lieut.-General Sir Andrew Clarke, G.C.C.M., Victoria Office 15, Victoria-street, Westminster, London, S.W., on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Tender for Electric Lighting," and addressed to the Mayor of Hawthorn, Victoria, Australia, on June 24, at 5 p.m.

Dublin.—The Corporation of Dublin invite tenders for the supply of the following electric mains and apparatus: (1) high-tension feeders and low tension distributors, laid and jointed complete on a solid system, not including roadwork, but including the connecting-up of existing consumers to the new system of mains; (2) transformers (20 kw. to 50 kw., about 700 kw. in all), with instruments and apparatus in sub-stations erected and fitted complete. Specifications, etc., can be obtained of the City Engineer, City Hall, Dublin, on payment of a deposit of £1. 1s. for each specification, which will be returnable on receipt of specification, accompanied by bona fide tender. Drawings can be inspected and other information obtained either at the office of the City Engineer or at that of Dr. A. B. W. Kennedy, 17, Victoria-street, Westminster. Tenders are to be sent to the Town Clerk by 10 a.m. on 23rd inst. Tenders will only be considered which are sent in by firms who have already carried out the class of work required upon a large scale.

RESULTS OF TENDERS.

Sheffield.—The Watch Committee have accepted the following tenders for erection of new fire and police station in Westbar: Ash, Son, and Biggin, building, £6,568; Wright Bros., heating apparatus, £101; Electric Light and Power Company, wiring, £125.

Waterloo (Lancs.).—The District Council have accepted the tender of Messrs. Waring and Gillow, Bold-street, Liverpool, at £157, for wiring and all fittings necessary for an electric light installation to the Town Hall, Waterloo.

London N.W.—The Vestry of St. John, Hampstead, have received the following tenders for new fireproof floor and sundry works at the electric lighting station in the parish stoneyard, Lithos-road, Finchley-road, N.W.:

W. Thompson, 70, Heath-street, N.W.	£625
W. Flower, Glentworth-street, N.W.	593
R. A. Yerbury and Sons, West End-lane, Kilburn, N.W. (accepted)	572

London, W.—The following tenders have been received for sanitary, decorative, and electric lighting works, etc., at 101, Uxbridge-road, Ealing, W., for Mr. Geo. Harris:

Adams and Johnson	£298	11	0
R. S. Buckeridge	258	7	0
King	254	10	0
E. J. Corpe	213	0	0

Coventry.—The City Council have received the following tenders for wiring the new police buildings for the electric light:

Ellis and Ward, Birmingham	£230	0	0
Drake and Gorham, London	216	10	0
Veritys, Limited, Birmingham	197	10	0
Dobsons and Curtis Bros., Limited, Dublin	187	17	0
Coventry Gas Fitting, &c., Limited	170	0	0
W. Tasker and Sons, Limited, Coventry (accepted)	161	13	0

London, E.C.—The Rotherhithe Vestry have received the following tenders for the erection of refuse destructor buildings, inclined roadways, engine-house, disinfector buildings, and other works in connection therewith at their wharf premises, Rotherhithe-street:

General Builders, Limited, Southampton-row, W.C. (accepted)	£3,400	0	0
H. Knight and Son, Chestnut-row, Tottenham	3,933	10	6
J. E. Johnson and Son, Leicester	4,054	6	7

Colwyn Bay.—The Urban District Council have received the following tenders for the proposed electric lighting of Colwyn Bay and Colwyn:

	Gas plant.	Steam plant.
Eckersley and Co., Manchester	£1,971	£2,101
B. Thomas, Manchester	1,469	1.589
British Insulated Company, Prescot	1,507	1 589
Calvert and Co., Manchester	1,306	1,415
Smith and Co., Southport	1,398	1,413
Siemens and Co., Westminster	1,723	1,833
Sharp and Piper, Westminster	1,684	1,784
H. J. Mills and Co., Salford	1,684	1.807
Leas, Son, and Co., Shrewsbury	1,870	2,008
Laing, Wharton, and Down, London	1,661	1,764
Brook, Hirst, and Co., Chester	1 510	1,627
Crompton and Co., Limited, London	1,635	1.707
Donnison, Barber, and Co., Manchester	1,530	1 611
J. Maxwell and Sons, Dundee	1,490	1 584
J. Lomax, Kendall, and Co., Manchester	1 769	1,864
G. Hill and Co., Manchester	1,522	1,654
Rhodes, Webster, and Co., Bradford	1,431	1,591
Walsall Electric Company, Walsall	1,545	1.648
Belshaw and Co., Chester	1,904	2 034
W. Lucy and Co., Oxford	1.472	1,699
Connisson, Berlyn, and Co., Liverpool	1,474	1 599
Lightfoot Bros., Manchester	1,425	1,541
J. Haynes and Co., Limited, Liverpool	1,577	1,751

Western and Brazilian Telegraph Company.—The directors of the Western and Brazalian Telegraph Company, Limited, have decided to recommend the payment of 6s 9d. per share, making, with the interim dividend paid in November last, a total distribution of 3½ per cent. for the year 1897, and £5,000 is placed to the reserve fund. The receipts of the Company for the past week were £3,173.

BUSINESS NOTES.

Brighton.—The matter of Volk's railway will be before the Council at their next meeting.

Basingstoke.—At a special meeting of the Council it was decided to apply for powers to light the borough by electricity.

Grimsby.—The Council have decided to apply to the Post Office for authority to instal a telephone service on behalf of the town.

Personal.—The Right Hon. Lord Rathmore has joined the board of directors of the British Electric Traction Company, Limited.

Hackney.—The Vestry have granted increased salaries to the engineer and electrician, assistant engineer, and assistant electrician.

Matlock Bath.—The Urban District Council have decided to take steps in opposition to the Bill being promoted by the General Power Distributing Company.

Wolverhampton.—The Town Council have adopted the report of the Lighting Committee with regard to a reduction of charge for the supply of electrical energy.

Blackpool.—Electric energy from the tramway plant is to be supplied to applicants for motive power purposes at 2½d. per unit. The plant is about to be increased to the extent of 1,000 h.p.

Dewsbury.—Electric trams to connect some of the neighbouring districts and Dewsbury are still being agitated for. Representatives of still another company surveyed the proposed routes last week.

Hampstead.—The Vestry has just completed the electric lighting by arc lamps of Haverstock-hill and High-street, Hampstead. There is now an unbroken line of public electric lamps from Oxford-street to Heath-street, Hampstead.

Hyde.—In the year's estimate £100 are included to provide the preliminary expenses in connection with the electric lighting scheme. The Council have accepted the terms of Messrs. Lacey, Clirehugh, and Sillar as consulting electrical engineers to the Corporation.

Luton.—The Electric Lighting Committee of the Luton Town Council, accompanied by the town clerk (Mr. G. Sell), and the borough engineer (Mr. A. J. L. Evans), have paid their visit to Brighton for the purpose of inspecting the electric lighting installation there.

Hammersmith.—The Vestry have decided to advertise for a pupil who must have had at least two years' electrical training in an approved technical college. The said pupil is to pay a premium of £100 for one year, of which £35 will go to the engineer and £… to the assistant engineer.

Swinton.—A meeting of the ratepayers was held last week regarding a resolution passed by the Council to support a petition opposing the Bill of the Electric Light Distributing Company now deposited in Parliament. A resolution sanctioning the expenditure in support of the petition against the Bill was passed.

African Telegraphs.—The Marquis of Salisbury has received a telegram from Captain Daly announcing that telegraphic communication was established between Blantyre and Umtali. The message, dispatched at 9.36 a.m., was received in London at … and had therefore been less than two hours in transmission.

Crewe.—The Electric Lighting Committee's report upon the enquiries, made with a view to obtaining an installation of electric light for the borough, recommended that the town clerk should write to Prof. Kennedy and Dr. Hopkinson to invite from them estimates for the work. The Town Council have adopted the report.

Eastbourne.—In reference to our note last week with respect to the public lighting in Eastbourne, Mr. W. C. C. Hawtayne, 20, Bucklersbury, E.C., has been appointed to advise the Corporation. We understand that the question involves the use of a refuse destructor in combination with an extensive electric lighting scheme.

Shoreditch.—At the last meeting of the Vestry it was reported that Messrs. Manlove, Alliott, and Co. had applied for a further instalment, and the consulting engineer reported that £1,000 was due, but the Lighting Committee adhered to their decision to retain that sum pending the completion of the contract, and the Vestry approved.

Nottingham.—At the last meeting of the Nottingham Town Council the scheme for electric tramways was discussed at length. The report of the Tramways Committee recommending the overhead principle of electric traction and the reconstruction and various extensions of the existing lines, at a cost of £425,000, was read a second time.

Liverpool.—The Corporation Tramway Construction Committee have decided to order for use on the experimental electric tramway 14 electric cars from Germany—seven of the Altona type and seven of the Ring-Bahn type, with trailers to each. The cars with their trailers, will accommodate 50 persons each. It is intended to order 14 more cars from America.

Dudley.—At the last meeting of the Town Council the Mayor said that he had visited with a deputation the electric lighting station at Worcester. The engineer kindly gave them much valuable information, and the result of their visit would be embodied in a report and presented to the committee. Councillor A… thought that further expert assistance ought to be obtained.

Canterbury.—The new system of electric fire-alarms has been put to a test and pronounced a great success. It is said to be a great improvement upon the running about calling fire…

;, maroons, etc., of past times, which created just what required—viz., an impeding crowd. Those who watched al of the brigades were especially struck by this fact.

ield.—The Chairman of the Electric Lighting Committee the quarterly meeting of the Town Council that Messrs. nd Co., of Leeds, had delivered the two engines, and one fixed and was working to the entire satisfaction of the e, and the other was being fixed. Some connections were ake, but that was only a matter of two or three days'

rfield.—A committee of the whole Council have under ition the following resolution: "That this Council the advisability of applying mechanical traction on the ramways, and that it be an instruction to the Tramways ee to have estimates prepared for the work, and present uncil at the next monthly meeting, bearing in mind any nt additions, and the necessity of providing workmen's ; nominal rates."

—The convener of the Electric Lighting Committee of wn Council last week, in presence of a large company, began the work of introducing the electric light into the y picking out the first shovelful of earth at the foot of alk. Immediately after the ceremony work was at once ed, and by five o'clock about a hundred yards had been e Kirkgate below the channel at the footpath. The cost hole undertaking is estimated at about £30,000.

al. — Messrs. S. Z. de Ferranti, Limited, late of ouse-square, London, have now transferred the manu- f meters to their new works at Hollinwood, Lancashire. lon works are closed, but a depôt has been opened at 29, -square, Clerkenwell, for dealing with their meter busi- ondon and the South of England. All communications district should be addressed to St. John's-square. The g business will be dealt with from Hollinwood.

am.—The Works Committee of the District Board of ve under consideration a letter from the Board of Trade g a copy of a letter which they had received from the th and Greenwich District Electric Light Company asking ssion to supply energy on the alternating-current system portions of the area prescribed by the Blackheath and h District Electric Lighting Order, 1897, as lie outside supplied by the London Electric Supply Corporation.

-The Local Government Board have intimated their nction to the borrowing of the sum of £4 452 for electric purposes. The Board deducted from the amount of the tioned the items, £323. 0s. 10d. and £62. 3s. 9d., represent- ctively costs incurred in opposing the provisional order and tion of Prof. Kennedy's fee for report to the Board of on the company's undertaking, as it would be contrary actice of the Board. Altogether about £55,000 have now owed.

List.—The Edison and Swan United Electric Light , Limited, have forwarded to us a copy of their price- ews and terminals. This is a most useful one to all small uring electrical engineers or contractors for electric light ons. The various terminals and connectors illustrated ed, but the company are quite prepared to quote for ses. The screws, *per se*, are listed for both the British on and Whitworth standard threads in a great variety of nd shapes of head.

al.—We understand that Mr. Fred J. Satchwell has his position as manager to Messrs. Mackay and Mackay, mp makers, Bermondsey, having been appointed super- in Mr. Hiram S. Maxim's electrical laboratory.—Mr. dyer, traffic manager of the City of Birmingham Tram- pany, who has been appointed general traffic superinten- er the British Electric Traction Company, London, has ented with a handsome gold watch by the members and e Birmingham Company.

—At the monthly meeting of the Police Commissioners, tes of the sub-committee on electric lighting were of. The committee recommended the Board that the steps should be taken to put the powers possessed by to provide electric lighting and power in force, and that itted to the sub-committee to consider the matter and : with recommendations as to the system to be adopted, be chosen for the works, and all other matters necessary rying out of the scheme.

te-on-Sea.—A Board of Trade enquiry as to the of a provisional order to this seaside health resort is l at the end of the present week. The town is peculiar, as the majority of the streets are not maintained by uthority, but by a private firm, who also runs the gas- We understand that the gas engineer estimates that at electricity at 6d. per Board of Trade unit will be to gas at 16s. 8d. per 1,000 cubic feet. Mr. W. C. C. is advising the local authority.

m.—The Finance Committee have reported to the Town at, after considering the letter from the National Tele- pany suggesting that negotiations should be reopened e Corporation and the company with the view of afford- latter facilities for reconstructing its plant on the twin- n, and mostly underground, they did not see their way to l that negotiations should be reopened with this view. er of the National Telephone Company has requested w with the Council, which they have agreed to grant.

Glasgow.—The Electricity Committee have recommended the Town Council to appoint Mr. John Christie, of Londonderry, as station engineer, and Mr. J. C. A. Ward, of St. Pancras mains department, to the post of mains superintendent. The appointments will come up for confirmation on the 19th inst., but we are informed that the committee was unanimous in both cases, and so there is no reason to fear that the Council will do otherwise than confirm the appointments. The Board of Trade have refused to grant a provisional order to the North British Electricity Supply Company for the supply of Greenock, Port-Glasgow, and Gourock.

St. Marylebone.—At the meeting of the Vestry on the 12th inst., a report was received from the Electric Lighting Committee recommending, with regard to the Vestry's disapproval in respect of the laying of cast-iron conduit from the Metropolitan Electric Supply Company's Manchester-square station to Marylebone-passage, and thence to Rathbone-place station, that the Board of Trade be informed that the Vestry are now prepared to withdraw their opposition provided that the extreme outside width of the conduit at widest point does not exceed 16½in., and that the line of route thereof be as defined upon plan prepared by the Vestry's surveyor.

Montrose.—The Burgh Commissioners have decided to purchase an electric water-level for Kinnaber waterworks at a cost of £25. The Asylum House Committee have agreed upon the renewal of the electric lighting plant of the main building of the institution. The report of Mr. Young, engineer, Glasgow, has been considered, and on his suggestion it has been agreed that the type of engine should be the Belliss. The offer of Messrs. W. Dickson and Co., Glasgow, to carry out the installation, and that of Messrs. P. Bisset and Son, Aberdeen, for the supply of a new boiler to the institution have been accepted. The contract prices were not mentioned.

Rathmines.—A report of the Electric Lighting Committee, which was adopted by the Town Commissioners at their last meeting, stated that, referring to the extent of the obligation thrown on the tramway company by the fifteenth section of the Electric Power Act, 1897, to light the road, their solicitors were of opinion that that section required the company, where pillars are erected in the centre of the road, to light the whole width of the road to the satisfaction of the local authority. Mr. Hammond has been requested to furnish a supplementary report on his proposed scheme for the lighting of the township by electricity.

Dundee.—At the last meeting of the Town Council a discussion took place in reference to the question of the electric lighting of the public streets. It was stated that the committee had every disposition to extend both the public and private electric lamps. Some time ago, however, it was agreed by the Council to allow the matter to remain in abeyance until the question of tramway traction came up. It was proposed to instruct the engineer to prepare a comprehensive scheme for extending the electric lighting system in the public streets. Ultimately it was agreed to remit the whole question to the Gas Committee for further consideration.

St. Olave's.—The Board of Works has instructed the clerk to write to the Board of Trade informing them that the Board of Works would withdraw their opposition to the application of the County of London and Brush Provincial Electric Lighting Company if power was reserved to the Board of Works to control the position of the transformer sub-station chambers, and if it was provided that the chambers were to be moved at the company's expense if rendered necessary by any alteration of sewers or drains, and also subject to the company providing at the consumer's terminal pressure of 500 volts for continuous currents and 100 volts for alternating currents.

New General Traction Company, Limited.—The report states that the gross profits for the year amounted to £12,874, of which £2,983 was brought forward, making a total of £15,857. The sum of £2,231 the Board recommends shall be placed to a reserve account, and one half of the cost of the issue of the new capital, amounting to £2,122, is to be charged against the revenue of the year. This leaves a balance of £13,734, from which has to be deducted general expenses, salaries, etc., leaving £10,246. A dividend at the rate of 6 per cent. on the preference capital, calculated from the date of payment, amounts to about £6,500, and the directors recommend that this be paid and the balance carried forward

Leeds.—The Highways Committee on the 11th inst. confirmed the recommendations of the Management Committee to extend the electric tramway system along Dewsbury-road and on the Headingley and Chapeltown routes. The City Engineer (Mr. Hewson) reported that the city accountant's estimate respecting the cost of the electric tramways on the Kirkstall-Roundhay section had proved accurate, notwithstanding certain statements which had been made to the contrary. Mr. Derry's estimate per car mile was as follows: For repairs, $5\frac{3}{8}$d.; renewals, $1\frac{1}{10}$d.; interest and sinking fund, $2\frac{1}{2}$d—total, 9d. The actual expenditure had been $8\frac{7}{10}$d. per car mile. The committee resolved to erect a pay office and shelter at the Roundhay terminus.—*Leeds Mercury.*

Manchester.—At the last meeting of the City Council Mr. Alderman Higginbottom supplemented the reports which have appeared in the newspapers of his evidence before the joint committee of Parliament on electrical supply. The question raised before that committee, which should report to Parliament shortly, was whether private companies should be given the power to take up the streets of a city, lay down electric mains without the consent of the local authority, and compete with that authority in supplying electricity to the inhabitants. It had been stated

that the Manchester Carriage Company sought such powers. He gave evidence strongly in opposition to the granting of these powers to private companies, and against such companies being allowed to enter into competition with corporations.

Lancashire Orders.—At the last meeting of the County Council Mr. V. K. Armitage, in moving the adoption of the proceedings of the Parliamentary Committee, referred to the attitude of the Board of Trade concerning the amendments to be inserted in the electric provisional orders for the protection of the county and hundred bridges. He said the Board of Trade had prepared a model order, and was so well satisfied with it that apparently nothing on earth could induce it to alter a clause. With regard to Lancashire, the orders already before Parliament would affect no less than 24 of the county administrations. They thought it important to make a stand on this question, and see whether the Board of Trade was entitled to thrust upon them a model order whether it applied to their circumstances or not.

Legal.—Before Mr. Justice Bruce and a special jury at the Liverpool Assizes last week, Mrs. Betsy Myerscough, a widow, of Princess-street, Blackpool, recovered £290 damages from the Blackpool Corporation for injuries sustained through alleged negligence. Mr. McCall, Q.C., and Mr. Hodgson (instructed by Mr. W. J. Read, solicitor, Birley-street) were for the plaintiff, and Mr. Roe Rycroft (instructed by the Town Clerk) was for defendant. It was stated that the plaintiff had been strong and healthy, and had been earning her living since her husband's death by letting lodgings to working-men and taking in visitors during the summer season. On the evening of April 7, 1897, while walking along Foxhall-road, which was taken up for the laying of electricity mains, she fell into an excavation about 4ft. deep, which was unprotected, injuring herself so much that she was laid up for two or three months.

Barnsley.—The Corporation have decided to adopt the system of electrical supply for the borough recommended by Mr. Miller, electrical engineer, and to carry the system into execution, including the portion of the report referring to public lighting. A report has been received from the Streets, etc., Committee showing that the British Insulated Wire Company, Limited, had asked the consent of the Corporation to an application by a company to be formed by them for a provisional order to enable them to construct tramways in the borough; that Messrs. Newman and Bond had written in explanation of the proposals of such syndicate; and that Worsborough Urban District Council had written suggesting a conference on the subject of tramways in Barnsley and Worsborough. It has been agreed that a meeting of the committee, with representatives of the bodies concerned, should be held on the 19th inst.

St. Pancras.—At a general meeting on May 11, the following resolutions were considered: "That the resolution of the Vestry of Nov. 24, 1896, approving that consumers should have the option of being charged by means of the maximum demand indicator at the rate of 6d. per unit for the first three hours each day, and 3d. per unit thereafter, be and is hereby rescinded, any resolution or resolutions to the contrary notwithstanding; and that the foregoing charges be amended, and that after June quarter next the rate shall be for the first hour and half at 6d. per unit, and all after at 3d. per unit. That the resolution of the Vestry of May 23, 1894, fixing the price for public street-lighting at 5d. per unit be and is hereby rescinded, any resolution or resolutions to the contrary notwithstanding; and that the price for public street-lighting after June quarter next be reduced to 4d. per unit, which shall include the supply of carbons, labour of trimming the lamps, repairs, and maintenance."

Gloucester.—Representatives from the National Telephone Company, Limited, attended recently before the Street Committee of the City Council, and stated that in order to improve the telephone service the company desired to lay their main cables and wires in tubes underground, in which case only the service wires would be taken above ground from convenient distributing centres. It was explained that the course suggested would considerably lessen the number of overhead wires, and greatly improve the telephone service, as it was proposed to provide each customer with a return wire service which would prevent messages being overheard on other wires, and the interruption frequently caused by electricity works or cables near the telephone wires. It was stated that the system was being carried out at Bath and Bristol, and that the company were negotiating with Cheltenham, and a form of agreement was submitted under which the Corporation would themselves, or through a contractor, do and execute all excavations and works in the streets at the cost of the company. The committee promised that the matter should receive careful consideration.

Bermondsey.—At the last meeting of the Vestry the Electric Lighting Committee reported that they attended, in company with Mr. Manville (the expert), Mr. Sumner (the surveyor), and Mr. Ryall (the clerk), at the offices of the Board of Trade on the 27th ult., when the opposition of the London Electric Supply Corporation, Limited, and the County of London and Brush Provincial Electric Lighting Company to the Vestry's application for an electric lighting provisional order was heard by Sir Courtenay Boyle. Upon the question of whether the Vestry would be able to carry out the order at a profit, it being asserted by the opposing companies that the Vestry would not be able to do so, Sir C. Boyle was informed that the Vestry, before applying to the Board of Trade for an order, had obtained an exhaustive report from Messrs. Kincaid, Waller, and Manville, and were satisfied that an installation could be carried out for the benefit of the parish without any charge upon the rates. Sir C. Boyle advised the Vestry to again consider the financial aspect of the question, and stated that if within 14 days the Vestry decided to go on with the order, he would recommend that the same be granted. The committee's report was adopted.

A New Galvanometer.—The want of a dead-beat sensitive indicating galvanometer has for some time been felt, there being so many purposes to which it could be put, both in experimental and practical work, that the introduction of a cheap reliable instrument of this nature has become a necessity. Therefore, Messrs. Crompton, who have for some years past manufactured for use in their laboratory at Kensington Court, and to order, an instrument of the D'Arsonval or moving-coil type, have now decided to place it upon the market at a reasonable price. The instrument can be supplied to any reasonable degree of sensibility, that usual with an instrument of 200 to 300 ohms resistance being a deflection of 1·75mm. with $\frac{1}{1000}$th of a volt applied to its terminals. The same type of instrument can be divided off as a milli-voltmeter or ammeter, so that by means of suitable shunts the instrument becomes direct reading in the matter of amperes or volts, or it can be calibrated direct as a low-reading voltmeter or ampere-meter, its absolute dead-beatness enabling very fast work to be done. It is in this latter respect admirably suited as a cell volt tester, in which case the zero is placed in the centre of the scale, so that readings may be taken either side, so obviating the necessity of a reversing key.

Camberwell.—The Vestry have received a letter from the Board of Trade enclosing copy of a letter to the County of London and Brush Provincial Electric Lighting Company, stating that the Board consents to the supply of energy under the order on the alternating-current system on condition that the continuous-current mains for the supply of power are laid simultaneously with those for an alternating-current supply. The Vestry approved of the system for the supply of energy, subject to the usual regulations for securing the safety of the public under the following conditions: that the transformers and all high-pressure apparatus on the consumer's premises shall be the property of and under the charge of the undertakers; also the Board's consent to an extra high pressure being given by the undertakers, together with the provisional approval of the Board given with the concurrence of the Postmaster-General to the use by the undertakers of an earth connection on their system of mains. Six new accumulators, to replace six now used up, estimated to cost £12, are to be ordered of the Chloride Electrical Syndicate, Limited. Notice has been received from the County of London and Brush Provincial Electric Lighting Company of its intention to lay electrical conduits in George-street, New Church-road, Blucher-road, Leipsic-road, Camberwell New-road, Flodden-road, and Knatchbull-road.

Stourport.—The electric tramway is nearing its completion. The construction of the tramway was carried out by Mr. Law, and the generating and other plant supplied by the Brush Electrical Engineering Company, of London. The trams will probably be ready to carry passengers by Whitsuntide. Nine of the cars are already in the sheds at the tramway depôt. Six of these are motorcars, and the others trailers. The motorcars will seat 24 passengers inside, there being no seats on the tops of the car. The cars are very handsomely appointed, the seats and panels being of Norwegian pine, with mahogany fittings. There is ample provision for proper ventilation, and at night the cars will be lighted by electricity by means of 12 c.p. and 16 c.p. incandescent lamps; oil lamps also being provided in case of necessity. Beneath the floor of the cars are two motors attached by gear wheels to the main axles. On small platforms at either end of the cars are the controllers and hand brakes. Mr. Mahood is the chief engineer, supervising all the electrical work, and having as his assistants Mr. Andrews and Mr. Nowell. A number of feeder boxes are placed at intervals along the line of route. In the power-house there are two high-speed Raworth Universal engines capable of developing 150 h.p. to work the six pole dynamo, the engines being duplicated in case of one failing. Adjoining the power house is the boiler-shed, in which are two Babcock and Wilcox boilers. A Green's economiser is also provided. It is intended to charge a through fare of 3d. from Kidderminster to Stourport, with 1d. sections.

Iron for Dynamos.—We have received from Messrs. Charles Jennings and Co. their list of specialities in the way of iron for dynamo purposes. This list includes both the iron forgings necessary for the field magnets and also the plates for dynamo cores or transformer plates. The magnet forgings are made of what is called Isotropic iron. The production of this material resulted from a close study of the physical and chemical properties necessary to a material for ensuring the highest degree of permeability. The iron forgings at one time generally used were dependent very largely for their electrical value on the degree of purity of the iron (mostly scrap) but also to the care necessary to ensure the fibre of the iron being laid in the direction of the magnetisation; whereas the Isotropic material, a specially manufactured quality of ingot iron, is equally magnetisable in all directions, hence its name. This was introduced by Mr. George Schultz about six years ago. The same iron is also rolled out into plates for core work, and can be obtained in sheets and in discs of all dimensions up to 60in. in diameter, with plain or notched edges, with or without central and ventilation holes, keyways, etc., as well as in segments of all designs. The firm are prepared to supply any shape or type of stamping without making special charges for dies. Over and above the iron mentioned above, the firm makes a speciality of cast steel for magnets, and from the illustrations in the catalogue have carried out many orders for such work. We note that permeability curves are freely given in the catalogue, which adds much to its value.

Salford.—The report of the special sub-committee of the Electric Light Committee of the Corporation appointed to visit certain cities and towns to enquire into systems for the supply of current for lighting and electric traction has been adopted. It contains the following conclusions: "Your sub-committee have mainly had in view the question of adopting the best system in connection with the provision of current for the proposed working of the tramcars by the Corporation, and from the information obtained they have no hesitation in recommending—(1) that the generating plant should be erected at one station with the employment of accumulator sub-stations, the latter being a satisfactory method of utilising the plant during the hours when it would be otherwise idle; (2) that in view of the prospective great demand for current the engines and dynamos at the new stations should be of large dimensions, to secure economy in capital and working expenses, as the current generated at one station would be sufficient for both purposes; (3) that what is known as the feeder system of supply should be adopted in connection with the proposed tramlines, so as to separate the same in small sections to receive such supply; (4) that in the matter of rearranging the proposed tramlines for the borough it would be desirable that the rails should not be less than 120lb. in weight per yard, and the width of the tread not less than 2in., and that the distance between the trolley posts to be erected should not be more than 40 yards; (5) that the method of jointing the tramlines adopted at Dover should be employed in Salford, so as to avoid the jolting in passing over the jointed portions of the lines. Your sub-committee have not entered into the question of the cost which will be incurred in so extensive an undertaking, which will, of course, be done when the plans are more matured. The details of the ground plan of the new generating station proposed to be erected in Strawberry-road was explained to the officials of the stations visited, and they expressed approval of the system proposed to be adopted."

Sheffield.—The Tramways Committee have received reports from the water engineer (Mr. Marsh) and the electrical engineer (Mr. Fell) as to the possibility of obtaining water power from the reservoirs of the Corporation for the purpose of generating electricity for tramway purposes. Mr. Fell, dealing with the "compensation water," according to the *Sheffield Daily Telegraph*, says the separate sources of supply are so small, and so far apart, that they would be useless unless they were centralised. The cost of doing this would be out of all proportion to the value of the power gained. Apparently, if the water were connected from all the available sources, only 438 h.p. could be obtained, for which no less than £116,600 would have to be paid (this sum would not include the cost of the power-house site, power-house buildings, turbines, dynamos, switchboards, etc.). The interest on this sum would be a fixed sum, whether the tramways were not running or were using the full available horse-power. A great point with regard to generating electricity cheaply for tramway purposes is to obtain a plant which will work economically when the load is very small; the average load on a tramway plant is about 50 to 60 per cent. of the maximum load during the 5,720 hours per annum the tramways might be run, so that during, say, 18 hours per day at least 40 per cent. of the water would be wasted, and during six hours per day the whole of the water would be wasted. Mr. Fell estimates the cost of producing electricity by water at £116,600. Mr. Marsh expresses a strong opinion that the supply to the town cannot be utilised as a generating power. With reference to the water power available immediately below the embankment of each reservoir, he says that as these reservoirs vary from top water to draw-off line at different seasons of the year, he fails to see how it can be expedient or economical to use such a variable motive power. The committee, having considered these reports, decided on a vote to call in Mr. Fredk. Nell as an expert to report on the question. The city surveyor has been authorised to proceed with the concrete foundations for the power station building at Kelham Island, at an estimated cost of £500, and to prepare estimates for the superstructure.

Birmingham.—The engineer of an important tramway company, carrying on operations principally on the cable traction system in a northern city, was recently in Birmingham making an inspection of the existing tramways, and of routes that at present are not supplied with the means of tramway locomotion. The *Birmingham Daily Post* learns on good authority that, as the result of his report, the company in question will shortly submit to the municipal authorities proposals which may materially influence the negotiations which are about to be resumed between the Public Works Committee and the City of Birmingham Tramways Company. The latter have already sent in a communication pointing to some fresh offer, and at the last meeting of the committee some members were anxious at once to go into the matter. The majority, however, insisted first upon a complete clearing up as to the facts concerning what has already taken place, and particularly as to the alleged "verbal permission" to proceed with certain works which was repudiated all round the table. The other company are stated to be ready with a scheme for providing tramways for a large mileage of streets not now covered with tramways. These would be worked by underground traction, either cable or electrical conduit, as may be considered best adapted to the particular routes. The company would take a 21 years' lease, and after payment of a dividend of 5 per cent. they would be willing to share remaining profits with the Corporation. The latter is a novel proposition, so far as Birmingham and the Midlands is concerned, and would commend itself to those members of the Corporation who while not prepared to follow some other places in their municipalisation of the tramway traffic, nevertheless consider that the tramways ought to yield some revenue to the rates, and not to be let at practically cost price. One of the routes indicated is the Pershore-road, where the growth of a large population at the Stirchley-street end calls urgently for something better than the present omnibus service. Apropos of cable traction, of which comparatively little has been heard in the recent controversy, it may be mentioned that the Handsworth cable line is the most remunerative of all the lines at present belonging to the City of Birmingham Tramways Company. A competitive offer, such as the one above referred to, would afford a very direct challenge as to the accuracy of the estimates of the cost of an underground conduit system, in relation to which the Public Works Committee and the tramway directors were so greatly at variance. Of course, that is a matter for experts, but most of the members of the Public Works Committee hold very strongly that the materially lower estimate of Mr. Edward Pritchard (who was the engineer of the Handsworth cable line), as compared with the company's estimate, will be found to be fully verified.

APPOINTMENTS VACANT.

Electric Clerk of Works.—The Stockport Gas and Electric Light Committee invite applications for the above position. Details in our advertising columns.

Electrical Improvers (Kingston-upon-Hull).—The Electric Lighting Committee of the Hull Corporation require the services of one or more improvers. Details in our advertising columns.

Electrical Engineer.—The Electric Lighting Committee of the Poplar Board of Works are prepared to receive applications for the position of resident electrical engineer. Details in our advertising columns.

Electrical Engineer.—The Redditch Urban District Council invite applications for the post of engineer to the electric lighting central station. Applications should be sent in before 14th inst. to Messrs. Browning and Hobson, clerks to the Council, Redditch.

Cable Jointer.—The Electric Supply Company, Verulam House, Bournemouth, require an experienced high-tension cable jointer, capable with rubber and paper cables, lead wiping, connecting up transformer sub-stations, and house service work. Wages 7½d. per hour.

City Engineer.—The Corporation of Wellington, New Zealand, require the services of a city engineer, at a salary of £800 per annum. All particulars may be obtained at the office of the Agent-General for New Zealand, London. Applications, marked as such, are to be sent in to Mr. J. E. Page, town clerk, by Aug. 31.

City Engineer.—The Corporation of the city of Cape Town invite applications in detail (stating age) for the appointment of city engineer from gentlemen qualified and experienced in the duties required to be discharged in the like office under a British corporation or local authority. The officer appointed will be required to devote the whole of his time to the duties of his office. Commencing salary, £800 per annum. Application, accompanied by copies of not more than six testimonials of recent date, must be deposited at the offices of the London agents, Messrs. Davis and Soper, 54, St. Mary-axe, London, E.C., by 4 p.m. on June 15, endorsed on the outside "Application for City Engineer."

PROVISIONAL PATENTS, 1898.

MAY 2.

10022. **Improvements in the manufacture of carbons and filaments for electric lamps.** Gustav Daubenspeck, 1, Queen Victoria-street, London.

10034. **A new or improved primary electrical battery.** Anthony Frazer and George Alexander Smith, 73, St. Stephen's-road, Upton Park, London.

MAY 3.

10065. **An electrical double-pole fuse plug and combination grid connection.** Austin Walters, 35, Dorset-street, Hulme, Manchester. (Complete specification.)

10089. **Improvements in electric telephony.** Charles Adams-Randall, 63, Chancery-lane, London.

10094. **Improvements in the art of making plates for electric battery purposes.** Alfred Careno Croftan, 62, St. Vincent-street, Glasgow. (Complete specification.)

10110. **Improvements in electric arc lamps.** Charles Oliver, 31, Southampton-buildings, Chancery-lane, London.

10121. **Improvements in and connected with arc lamps.** John Frederick Wakelin, 33, Robert-street, Regent's Park, London.

MAY 4.

10225. **An improved method of casting electric accumulator plates and apparatus therefor.** Josef Hesse and Josef Kernaul, 6, Lord-street, Liverpool. (Complete specification.)

10236. **Improvements in electric arc lamps.** Wallace James Lambert Sandy, Douglas Clavell Bate, and Thomas Geer, 24, Southampton-buildings, Chancery-lane, London.

MAY 5.

10245. **An improved automatic electric cut-in and cut-out.** Arthur Emilio Roles Bottone, 3, Melbourne-villas, Manor-road, Wallington, Surrey.

10291. **Rheostats for electric circuits.** Charles Wirt, 111, Hatton-garden, London.

10248. Improvements in electrical time checking and registering apparatus. Charles Miles, 31, Camden-road, Southville, Bristol.

10269. Improvements in alternating-current induction motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

10270. Improvements in alternating-current induction motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

10308. Improvements in appliances for automatically replacing fuses in electric installations for lighting or transmission of power. Samuel Harrison, 6, Lord-street, Liverpool.

10314. Improvements in or relating to electric motors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Ricardo Arno and Aristide Caramagna, Italy.)

10333. Improvements relating to electric signalling and similar apparatus. Lucien Stephen Crandall, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MAY 6.

10346. Improved apparatus for automatically cutting off current of electric overhead or other like wires. Ralph Bostock and Frank Arthur Cheetham, Penny Bank-chambers, Halifax.

10352. An improved magnetic motor-engine. Ezra James Knight, Lloyd's Bank-buildings, Bristol.

10437. Improvements relating to cut-outs and switches for electric motors and other electrical apparatus George Augustus Momer, 11, Southampton-buildings, Chancery-lane, London. (Henry H. Cutler, United States.) (Complete specification.)

MAY 7.

10440. An improved detachable ceiling rose for use with arc lamps and other electrical apparatus. Albert Lewis Davis, 68, Victoria-street, Westminster, London.

10450. Improvements in the construction of dynamo-electric machines and motors. Matthew William Walbank Mackie, 77, Turnmill-street, London.

10457. Improvements in galvanic batteries. Emil Habermann, 20, Bucklersbury, London.

10470. Improvements in or relating to electric arc lamps. John Henry Cox, 3, Crawford-street, Greenock, N.B.

10475. Improvement in electrical accumulators. William Peck, Calton-hill, Edinburgh.

10477. Improvements in quick-break switches or cut-outs for electric lines. George Jaeger, Cürt Jaeger, and Hermann Bender, 10, Friedrichstrasse, Berlin. (Complete specification.)

10483. Improvements in and relating to electrical switches. Fredrick William Abbott and Robert William Bill, 104, Colmore-row, Birmingham.

10496. A new or improved maximum electric current self-recording instrument. Francis Malger Staunton, 31, Southampton-buildings, Chancery-lane, London.

10511. Improvements in and apparatus for producing mechanical energy for alternating electric currents. Alexander Heyland, 47, Lincoln's-inn-fields, London.

10523. Improvements in apparatus for regulating electric arc lamps. Ignac Hippolyte Hegnar, 46, Lincoln's-inn-fields, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1897.

8691. Electric arc lamp mechanism. Percival.

9135. Electrical apparatus for automatically actuating ventilators, flue dampers, throttle valve; also for controlling and regulating sources of power. Yerbury.

9290. Acid-proof and electric insulating compositions. Morison.

9442. Pressing electric accumulator plates and other plastic articles. Von Berks and Renger.

12902. Series-parallel controllers for electric motors. McMahon.

13520. Pneumatically-worked electro switches. Siemens Bros. and Co., Limited, and Le Rossignol.

13532. Windings for the armatures of direct-current dynamo-electric machines. Fynn.

18838. Electrical switches. Page.

20865. Primary batteries for light motive power and like purposes. Decker and von Struve.

1898.

3123. Electric switches. Andersen.

3796. Means for displacing, dispersing, or extinguishing arcs formed in breaking electric circuits. Short.

4825. Electric accumulators. Junge. (Knöschke.)

5001. Controlling system for electric railway vehicles. Short.

5054. Current collectors for dynamo-electric machines. Nell.

5672. Electrical safety lamp for miners. Lake. (Siedentopf,)

TRAFFIC RECEIPTS.

Liverpool Overhead Railway.—The traffic receipts for the week ended May 9 were £1,504, as compared with £1,316 in same week of 1897, being an increase of £188.

Birmingham Tramways.—The traffic receipts for the week ending May 7 were £3,744. 1s. 9d., as compared with £3,489. 14s. 9d. for same week in 1897, being an increase of £254. 7s. 0d.

Dover Tramways.—The traffic receipts for the week ending May 7 were £130. 11s. 8d. The total receipts for the year 1898 are £2,082. 2s. 8d. The mileage open at present is 3 miles.

Bristol Tramways.—The traffic returns for the week ending May 6 were £2,478. 2s. 4d., compared with £2,271. 9s. 5d. for same period of last year, being an increase of £206. 12s. 11d.

South Staffordshire Tramways.—The traffic returns for the week ending May 6 were £577. 7s. 1d., as compared with £593. 8s. 1d. in same week of 1897. The aggregate receipts for the year are £10,661. 1s. 8d., as against £10,719. 18s. 1d. in the same period of the previous year.

City and South London Railway.—The returns for the week ended May 8 were £964, compared with £957 for same week of 1897, being an increase of £7. The total receipts for the half-year amount to £19,721, compared with £19,503 for the same period last year, being an increase of £218.

Dublin S.D. Tramways.—The traffic receipts for the week ending May 6 were £461. 0s. 2d., as compared with £511. 7s. 2d. in the corresponding week in the previous year, being a decrease of £50. 7s. 0d. The number of passengers carried was 76,828 in 1898 and 78,961 in 1897. The aggregate returns up to date are £7,829. 17s. 3d., as compared with £8,166. 11s. 0d. last year, being a decrease of £336. 13s. 9d. The mileage open is the same as last year—viz., 8 miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	[illegible]
British Electric Traction, Limited. Ordinary, Nos. 1-30,000	10	[illegible]
—— 6 p.c. Cm. Pf., 30,001-40,000 (iss at £2. 10s. pm., all pd.)	4	[illegible]
Brush Company, Ordinary	3	[illegible]
—— Non. Cum., 6 per cent. Pref.	2	[illegible]
—— 4½ per cent. Debenture Stock	100	[illegible]
—— 4½ per cent. 2nd Debenture Stock	100	[illegible]
Callender's Cable Company, Debentures	100	[illegible]
—— Ordinary	5	[illegible]
Central London Railway, Ordinary	10	[illegible]
——	6	[illegible]
—— Pref. Half-Shares	1	[illegible]
—— " "	5	[illegible]
Charing Cross and Strand	5	[illegible]
—— 4½ per cent. Cum. Pref.	5	[illegible]
Chelsea Electricity Company	5	[illegible]
—— 4½ per cent. Debentures	100	[illegible]
City of London, Ordinary	10	[illegible]
—— Prov. Cert. 90,001-100,000	5	18-19
—— 6 per cent. Cumulative Pref.	10	[illegible]
—— 5 per cent. Debenture Stock	100	[illegible]
City and South London Railway, Consolidated Ordinary	100	[illegible]
—— 4 per cent. Debenture Stock	100	[illegible]
—— 5 per cent. Pref. Shares	10	15-16
—— " " " '96	10	[illegible]
County of London and Brush Provincial Co., Ordinary	10	[illegible]
—— " " "	4	[illegible]
—— 6 per cent. Cum. Pref.	10	[illegible]
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	[illegible]
—— 5 per cent. Debentures	—	[illegible]
Crystal Palace District, Ordinary 5 per cent. Stock	100	[illegible]
—— Preference 5 per cent. Stock	100	[illegible]
Edison and Swan United Ordinary	3	[illegible]
—— 5 per cent. Debentures	5	[illegible]
—— 4 per cent. Deb. Stock, Red.	100	[illegible]
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	3	[illegible]
Electric Construction, Limited	2	[illegible]
—— 7 per cent. Cumulative Pref.	2	[illegible]
—— 4 per cent. Perp. 1st Mort. Deb.	100	[illegible]
Elmore's Copper Depositing	1	[illegible]
Elmore's Wire Company	2	[illegible]
W. T. Henley's Telegraph Works, Ordinary	10	[illegible]
—— 7 per cent. Preference	10	[illegible]
—— 4½ per cent. Debentures	100	[illegible]
House-to-House Company, Ordinary	5	[illegible]
—— 7 per cent. Preference	5	[illegible]
India Rubber and Gutta Percha Works	10	[illegible]
—— 4½ per cent. Debentures	100	[illegible]
Kensington and Knightsbridge Ordinary	5	[illegible]
—— 6 per cent. Pref.	5	[illegible]
London Electric Supply, Ordinary	5	[illegible]
Metropolitan Electric Supply, Limited, Ordinary	10	[illegible]
—— 4½ per cent. First Mortgage Debenture Stock	100	117-121
National Telephone, Ordinary	5	[illegible]
—— 6 per cent. Cum. First Pref.	10	[illegible]
—— 6 per cent. Cum. Second Pref.	10	[illegible]
—— 5 per cent. Non. Cum. Third Pref.	5	[illegible]
—— 3½ per cent. Deb. Stock, Red.	100	[illegible]
Notting Hill Company	10	[illegible]
Oriental, Limited, £1 shares	1	[illegible]
—— £5 Shares	5	[illegible]
—— £4½ shares	4½	7-7½
Oriental Telephone and Electric Company	[illegible]	[illegible]
Royal Electrical Company of Montreal	—	[illegible]
—— 4½ per cent. First Shares Mortgage Debentures	100	[illegible]
South London Electric Supply, Ordinary	2	[illegible]
St. James's and Pall Mall, Limited, Ordinary	4	[illegible]
—— 7 per cent. Pref.	5	[illegible]
—— 4 per cent. Deb. Stock, Red.	100	[illegible]
Telegraph Construction and Maintenance	12	[illegible]
—— 5 per cent. Bonds	100	[illegible]
Waterloo and City Railway, Ordinary	100	[illegible]
Westminster Electric Supply, Ordinary	5	[illegible]
Yorkshire House-to-House	5	[illegible]

NOTES.

Train-Lighting.—A trial order of 12 sets carriage electric lighting apparatus has been Messrs. J. Stone and Co., of Deptford, by the nment Railways, to be followed by the necessary general introduction of these fittings should ient prove successful.

ity on the Metropolitan.—Mr. J. S. ed on Tuesday at the special general meeting opolitan District Railway Company that they l Sir J. Wolfe Barry and Mr. W. H. Preece to in the matter of electric traction. It was also the results of the Central London line would be ore active steps were taken.

Received.—"The Direct-Current Motor," by ley Carus Wilson, M.A., professor of electrical at the McGill University, Montreal. Longman, Co.; 7s. 6d.—"Alternating Currents of Elec- the Theory of Transformers," by Alfred I.C.E. Whittaker and Co.; 5s.—"Industrial by A. G. Elliot. Whittaker and Co.; 2s. 6d.

re.—While every capital in the Far East is ectricity, Singapore, says *Indian Engineering*, y her old love, the dismal gas jet. The new en recognised as indispensable in Bangkok, in l in Manila, and is surely so in the greater The town authorities, like many in England, have the matter under discussion, but talk is come so far.

phs, Telephones, and Tramways.—We commission of experts has been appointed in to consider the best methods of preventing contacts between overhead electric tramway and wires used for telegraphic and telephonic ions. The commission is a large one, but ch well-known names as Dr. A. Beding, Dr. r, Dr. Hagenbach-Bischoff, Dr. Koepsel, Mr. R.

Lines in London.—The City and Brixton ll, which has already been sanctioned by the ommons, has been referred to the Unopposed tee of the House of Lords owing to the with- ne threatened opposition. By this Bill a new ll be incorporated, with a share and loan capital 0, for the purpose of constructing an electric n Brixton-hill to a junction with the City and on Railway at a point under the High-street,

eering Magazine."—The current number of magazine contains a departure in technical hich we wonder the editor does not call atten- nder the heading of "Mining of the Witwaters- eader is given portraits of the native miners' ughters in various states of dress—or, perhaps, ld be the more appropriate term. It is well ournal has recognised the fact that even in matters ladies have great influence, but fewer t be given.

ctro-Harmonic Society.—At the general d on Friday last the following resolution was Ir. Alabaster having stated, much to the regret ting, that he particularly desired not to be the office of honorary secretary, that he be d authorised to call a general meeting for the onsidering the election of some other gentleman ." In consequence a special general meeting on Friday, 27th inst., at 4.30 p.m., at 28, Victoria-street, Westminster, as the secretary of the Institution of Electrical Engineers has kindly promised the use of the Institution rooms for the purpose of the meeting.

Snow on Overhead Wires.—*La Nouvelle Gazette de Zürich* gives some interesting figures as to the weight of snow which a telegraph wire may hold under certain conditions. Taking the specific weight of wet snow as ·2 as observed at the meteorological station at Zürich on April 2 last, a wire 210 yards long was found to have carried 120lb. of snow, or 40 times its own weight. It was not to be wondered that this storm broke down some posts which had on them about 250 wires, as a rapid fall of temperature also contributed to the strain on the wires.

Auxiliary Plant in Central Stations.—Mr. C. Compère read a paper before the Société des Ingénieurs Civils de France on April 15 on the steam consumption of various engines and auxiliary steam plant. Speaking of the proportion of the total steam produced used in the feed pump, the author quoted two trials of other experts where this quantity rose to 27 and 45 per cent. Finally, he gave figures for a private plant in Paris equipped with four Willans engines, of which three were of 100 h.p. and the fourth of 75 h.p. The steam consumption of these was found to be up to guarantee by trials, which also revealed the fact that about 75 per cent. as much steam was used for the feed pump as for one of the larger engines.

Prize Competition.—The Société d'Encouragement pour l'Industrie Nationale of France is offering the following prizes. It seems to us that the society might be better advised as to the relative value of the subjects for which they offer prizes. The first announcement is a prize of £120 for the best essay on the methods of making permanent magnets with a view to great permanency and high magnetisation. The second prize of £80 is offered for an incandescent lamp giving two bougies decimale (roughly 2 c.p.) with a tenth of an ampere at 100 volts. This means about five watts per candle. The text explains that a number of these small lamps will be better for the eyes than an equivalent candle-power in larger units. Both these prizes are to be awarded in 1899.

Electrical Engineers (R.E.) Volunteers.—The War Office have made an important change in the regulations for efficiency of the Electrical Engineers Volunteers. By the regulations originally proposed recruits were required, in addition to military drills and eight days' training in camp, to attend 78 technical drills. By the modified regulations the 78 technical drills are reduced to 12. Whilst this will make the work of recruits living in London much easier, it will also make it quite practicable for men residing at a distance from London to join the corps; they will obtain their purely military training with any volunteer corps in their own neighbourhood, and will complete their technical training by attending in camp two additional days, making with the eight days' training required from all a total of 10 days.

Chemical Society.—A meeting of the Research Fund Committee of this society will be held in June. Applications for grants from this fund should be accompanied by full particulars, and should be sent to the secretaries on or before June 6. We would also remind our readers that it has been arranged by the council that the society shall entertain at a banquet at the Hôtel Métropole, on June 9, the following past-presidents who have completed a period of 50 years' fellowship of the society: Lord Playfair, Sir J. H. Gilbert, Sir E. Frankland, Prof. Odling, Sir F. A. Abel, Bart., Dr. A. W. Williamson, and Dr. J. H. Gladstone. The secretaries will be glad to hear as soon as possible from those Fellows who intend to be present, and

also if they desire to bring guests. The price of tickets will be one guinea each, including wine.

The Barcelona Riot.—Our readers will remember that before the outbreak of the war the Spanish mob stormed round the United States Embassy at Barcelona and endeavoured to get at the consulate eagle and shield. It seems that the Consul (Mr. Bowen) confronted the crowd, and that an electrical engineer, Mr. Norman Harrington, who was in Barcelona on business, went to the rescue. It did not come to fighting, but the risk was there all the same, and the electrical papers from across the water are congratulating Mr. Harrington on his action. It seems the self-introduction when he came on the scene was as follows: "I am Norman Harrington, of Chicago. This is my first day in Barcelona. It seemed to me as if there would be some trouble for the eagle up there, and I thought I'd take a bit of it." Such are our competitors as tramway engineers.

Heat.—The first of Lord Rayleigh's lectures on "Heat" was delivered last week. The nature of heat was the backbone of the lecture, although Lord Rayleigh gave many illustrations of the effects produced by heat. The old theory that heat was an independent substance called "caloric" was not cared for by such experts as Newton, Rumford, Young, and Davy. Thus while for many problems it made no difference which theory was adopted, the theory that heat was not a material, but consisted in the invisible motion of the small particles composing a body, gained ground. The evidence in favour of this view was indirect, but its substantial accuracy was proved. The lecturer remarked that the theory had been applied with considerable success to the investigation of matter in the gaseous condition, and concluded with a brief outline of the kinetic theory of gases.

Nyassa Rubber.—The district of Lake Nyassa is now a source of African rubber, which is said to be of excellent quality. A considerable quantity from this region was recently offered at the inscription sales in Antwerp. This rubber is from the new protectorate of British Central Africa, and according to the *British Central African Gazette*, published at Zomba, this may become an article of extensive export from the protectorate. It is being sent down from Bandawe at the rate of about two tons per month at present. It is collected from the Landolphia vine. This creeper does not grow all over the country, but is found solely along the banks of streams. In the country west of Nkata and Bandawe all the numerous stream valleys contain Landolphia. The rubber is shipped by the steamers of the African lakes, across Lake Nyassa, down the River Shire to the Zambesi, and thence to the mouth of the latter on the East African coast.

Cleaning the Globes of Enclosed Arc Lamps.—Mr. J. H. Hallberg writes a short article to the *Electrical World* on the above subject. He comments on the fact that the trimming and cleaning of the inner globes on enclosed arc lamps is of the utmost importance, as the efficiency and candle-power depend to a large extent on the transparency of the inner globes. It will be found that most of them are covered inside with a grey-white dust or film, which comes off if the globe is washed in clean water; but some, even after they are washed in water, show a brown-black stain around the top of the globe which apparently will not come off, no matter how much it is washed; in fact, it appears as though it were a natural colour in the glass itself. The author advises the use of hydrofluoric acid to remove these stains, and that it should be used very strong. He thinks that a two-second immersion in strong acid is better than 10 minutes in weak acid, as it reduces the risk of breakage.

Electric Lighting at Colombo.—The Chai
the Colombo Corporation, speaking of the contrac
for lighting the fort portion of the municipality
tricity, said that the figures were much the sa
London, but it was not a contract to be compared
contract which was shortly to be submitted for ra
for the lighting of the rest of the municipal str
buildings, by which they would get their street-lig
about 2d. per unit. Its execution meant that th
abreast of the times, and that they had secured
illuminant at a reasonable figure. The contracts
the same, the period of the contract was made co-t
with that of the tramway concession. It will te
on Nov. 25, 1922, when the Council will have the
of renewing the contract or taking it at a valuatio
are indebted to our contemporary *Indian Engine*
the above news.

Regular Inspection.—The Association Sui
Electriciens has inaugurated a new departure wh
our most cordial approval. The association in
meeting on Aug. 10, 1896, passed a number of
rules dealing with high-tension installations, an
rules are now to be supplemented by a technical
inspectors. This office will be supported by the
generally, and will superintend all new works and r
inspect old installations to see that the public are pr
and that all reasonable protection is also given to e
We are glad to gather from the *Revue de l'Electricit*
is published at Berne, that many of the governing
of the various cantons are supporting this new
organised by a trade really for the advantage of the
as the inspectors may have to impose onerous condi
times. At present the advantages of this new depa
which has its offices at Weinbergstrasse 20, Zürich,
fined to subscribers and to members of the above as

Vacuum-Tube Lighting.—Our New York
porary *Electricity*, speaking of the exhibition, sa
probably one of the most interesting features is the
tube lighting invented by D. Macfarlane Moore. A
of these tubes are located in a specially designed
and are so arranged as to conform to the groin
arches. The light diffused is unquestionably won
soft and pleasant. Mr. Moore's system of vacu
lighting has been perfected since the Electrical Ex
of 1896. The tubes used in the illuminating of th
are the first designed for such work, and it is saf
dict that the chapel will be the centre of attraction
out the month, especially as it is equipped with an
church organ, and the management intend to have i
upon by some well-known artist. Perhaps in the
the spectacular the eight historical wax tableaux, illu
the successive developments in electrical science,
take first place. These tableaux are located in eigh
in what is known as the Concert Hall, and around
is proposed to group the old electrical books and
that relate to the subjects touched on.

Too Much Light.—An amusing complaint h
made before the Norman Cross District Council co
the electric light at the London Brick Company's
The following letter was read at the recent meeting
Council from the manager, Mr. C. J. Hill: "I
acknowledge receipt of your letter of the 12th inst.
that complaints had been made by the public th
passing my works the electric light shines so str
the road as to dazzle the eyes of persons u
thoroughfare. I regret this very much, and
anything I can to prevent any annoyance which
may have. I have been up and down this road
many times when the electric light was on, and I

never yet noticed any objection to the light shining ghting up the district; in fact, quite the contrary, as ared to me to be quite a feature in lighting up the rom the London corner to past my works. I will, er, give the matter my attention with a view to g some shades where we can possibly put them to at any objection being raised."

bles in Time of War.—The *Daily Chronicle* has ed a large amount of attention to this subject, which viewed in the leader of our issue of April 29. Thus menced by the following query: "When the victory nila was won the Spaniards refused Dewey the use e cable, so it was cut, and, as we foresaw, the admiral ot any instruments enabling him to use the submarine . Are our ships supplied with mirrors and scales or n recorders in view of a similar case, with some officers een instructed in the use of them?" In the next issue it was announced that "many of our men-of-ave been fitted with the Sullivan galvanometer for work in case of necessity. The editor of the *Daily icle* knows nothing, save by general repute, of this ment, but it is said to be steady even on a torpedo n a rough sea. The point is that the matter has not d the attention of the Admiralty." So far so good, t is difficult to imagine that even then permanent ction could be maintained in a fighting centre between and a cable end. The question of compensation for ables is getting serious, and the difficulty in many will be to fix which is the offending nation.

Large Business.—The balance-sheet of the General ic Company of America is now to hand. This com-has not paid any dividends for some years, in spite creased volume of business. The returns show a revenue from sales of about £2,477,000, and a total of production of £2,179,000, which shows a gross facturing profit of only 12 per cent. on the sales. iture interest takes a considerable part of this profit, he remainder does not get through to the share-s. The work done during the year may be arised as follows: Dynamos of an aggregate output ,826 kw. have been delivered for lighting purposes, for traction purposes generators of over 60,000 kw. apacity have been turned out. The average size of ilway motor has increased to 34·7 h.p., while the ge generator for 1897 was 484·3 h.p., as against h.p. in 1896. Orders for direct-current and induc-motors for power transmission purposes aggregated 1 h.p., and orders for multiphase generators aggregating 2 h.p. were also fulfilled. Other totals of goods d read as follows: wattmeters, 36,874; other ring instruments, 3,369; transformers, 11,499; arc s, 24,158; incandescent lamps, 6,857,239.

e Royal Society Soiree.—Lord Lister received a gathering of gentlemen only at the Royal Society's s at Burlington House on Wednesday week. The ific attractions in the way of exhibits were too rous for general mention, but they included several of ical interest. Thus the most recent forms of apparatus d for space telegraphy by Prof. Oliver Lodge and Dr. ead were much noticed. The system was fitted up e two extreme ends of the edifice. The message r at either end is an automatic transmitter, with a lly-punched tape, and is thrown in or out of action pecial switch. The receiving apparatus at one end iphon recorder in direct circuit with a tapped-back r. At the other end is a telephone wherein the ations of current are distinctly audible. Mr. A. A. bell Swinton had an interesting exhibit of X-ray appa-including a pinhole camera for taking a photograph of a Crookes bulb when emitting the questionable rays. The rays appear to be emitted from a small hollow ring. Prof. Ewing exhibited a magnetic balance for permeability tests of iron. It is a new apparatus designed to afford an easy means of judging of the magnetic quality of iron or steel, with special reference to its suitability for use in dynamo magnets.

The New York Electrical Exhibition.—The President of the United States opened this exhibition on May 2 by electricity. He was in the White House at Washington and the exhibition at New York, so that the formality of the opening was spared some of the usual speechmaking. We understand from the electrical Press of America that the exhibition is really first rate, although the use of the future tense in some descriptive matter reveals the fact that the arrangements were not complete at the opening. Another editor goes so far as to admit that the novelties and improvements exhibited surprised him, and hence "the average engineer may expect to find much of interest." The *Electrical World* says that a striking illustration of the possibilities of the rapid installation of heavy machinery has been shown in the preparation for the exhibition. The building to be occupied was turned over to the officers of the exposition at midnight on April 23, and between that time and May 2 it was necessary to put in many complete power plants and installations of the most intricate kind, including every detail from a 5ft. stack, 100ft. in height, a battery of boilers, engines, dynamos, piping, wiring, etc., to all the auxiliary apparatus and the tremendous multiplicity of small features needed to make the exhibits operative and sightly. Although the work was far from complete at the time of opening, an enormous amount of work had been done in the eight days available.

Underground Telephone Wires.—The London County Council are proposing not to proceed further in the matter of requiring a reduced tariff from the National Telephone Company until the report of the Select Committee appointed by the Government has been received. They wish, however, to bind the company to clauses to the following effect with respect to their underground system of mains: (*a*) That if and whenever the Council or road authority have power in any way to alter or widen any street in which any line of the company is laid, or have power to place any rest, shelter, or convenience in any such street, the Council or road authority may require the company to alter any such line, or to remove the same to such position as may be required, and the company shall, with all reasonable dispatch, at its own expense and without any claim for compensation, proceed to alter or remove such line or portion of line as may be required. (*b*) That if the Council desire to adopt electric traction on any tramway under the control of the Council which passes along any street in which any line of the company is laid, the Council may, if they think fit, require the company to alter any such line or to remove the same to such position as the Council may require, and the company shall with all reasonable dispatch, at its own expense and without any claim for compensation against the Council or its lessees, proceed to make such alteration, and so long as no earth return but a complete metallic circuit is provided and used, the Council or its lessees shall not be liable to the company for any interference with, or prejudicial effects produced upon, the cables or wires or the working of the same, or upon the operations of the company, by reason of such use of electricity upon such tramway.

Patin's New Flywheel Alternator.—The craze for new types was at its worst some 15 years ago, when the most extravagant forms of field magnets were adopted by

certain firms. We remember one machine, which had not even a complete magnetic circuit through the armature, which was puffed up to a great extent. These monstrosities naturally fell out of the market as firms began to realise that efficiency rather than a distinctive type was wanted. The Patin alternator described in the *Electrical Review* of New York reminds us of these old steps in the path of evolution. The alternator is certainly of the flywheel type, but the arrangements of the armature and field show a modification of old arrangements, without advantage being derived from the change. We should describe the design as a variation of the Siemens type in which the disc armature is converted into a cylinder. The magnet system consists of two concentric rings with projecting poles. The inner ring is the flywheel, and it is connected to the outer cast-iron ring by radial yokes. The thin cylindrical armature does not revolve, but is inserted between the two sets of pole-faces. The coils are supported at one end only, and are replaceable. This fact, coupled with arrangement of a number of parts to make a true cylinder, raises many difficulties which do not exist with the revolving-disc types. With the disc the centrifugal force does tend to keep the armature segment in a vertical plane. In the description referred to above of the Patin alternator the absence of collecting gear is praised, but the exciting circuit revolves, and has to be fed by rings and brushes. This inductor type is the only one which really has no collecting gear. Efficiencies of 96 and 94 per cent. are claimed for the 120-kw. and 40-kw. machines respectively, but we gather that these figures do not include the excitation, or "excitement," as the author calls it, and also that they are not obtained from actual tests.

As Others See Us.—Mr. Claude P. D'Oyly concludes, in our New York namesake of May 5, his articles on "Statistics on English Electric Lighting Plant." This last attempt is much better than the previous ones. We are told that our electrical machinery is more efficient than the American. Mr. D'Oyly admits that "our engineers are constantly on the alert for improvements looking to a gain of efficiency in the different parts of the system. The money necessary is a very secondary consideration, and consequently manufacturers in England make a very high-efficiency machine—a great deal higher than is ordinarily made on the Continent of Europe or as standard machines in the United States. This makes the machines heavy, and they do not look symmetrical, and they require movement of the brushes with the variations of load, a point which would instantly condemn them in America. English manufacturers have not made many 550-volt generators of any considerable size, and consequently have not had any experience with "bucking." When they have experienced this they may aim at machines with a larger air-gap and a lower efficiency, more after American practice, but which machines will take care of themselves." Perhaps the author would expect the large 500-volt dynamo at Manchester to buck, and we have yet to learn that good efficiency is the cause of this fault in American dynamos. Finally, the author says that "the electric lighting art has not been developed to the same extent in England as it has in the United States, and although they are making some headway now, and are doing it in a thoroughly systematic way, it will be a long while before they can catch up with us, as after all the larger towns are lighted up then the question comes up, which was tackled here years ago, of the small towns which are too small for gasworks, and which were equipped with overhead wires in America, but which cannot be done in England unless new Board of Trade regulations are passed." Once again, the fact that our gas industry is miles ahead of that in America has to be considered, and we again see an instance of how diffic
for a traveller to realise that the home conditions
apply in a foreign country. Our small towns have
supply, and in our large towns the price of gas i
than anywhere abroad.

Water Gas.—Prof. Vivian B. Lewes's lect
"Water Gas and its Application" before the So
Arts last week was well attended, and also well
reading. The subject is a broad one, and one wh
had some disastrous failures as well as successe
author described the various steps in the develop
the use of water gas. He gives as an approxi
from the results of several years' working, t
average of 34,000 cubic feet of water gas may be o
from a ton of coke. Speaking of a new method
Lewes explains that in all the attempts to make wa
which had seen the light up to last year, the raising
fuel to incandescence has practically always been o
by using the air blast in so deep a bed of fuel t
carbon monoxide and residual nitrogen of the air
the chief resultant products; and it must be reme
that when 1lb. of carbon combines with oxygen t
carbon monoxide, as when forming producer gas, onl
heat units are developed, whilst if air be present in su
quantity to burn the carbon direct to carbon dioxi
amount of heat which is evolved is 3·47 times as g
that is, 1lb. of carbon gives 8,080 heat unit
process for making water gas has been devis
Mr. Carl Dellwik, in which this fact is utilised
adjustment of the air supply, and by keeping th
of the incandescent fuel in the generator at a c
height. Under these conditions the producer gas ce
exist as a by-product, and the products of the blow
merely of the ordinary non-combustible products o
plete combustion, carbon dioxide and nitrogen, the
being that double the quantity of water gas can b
per pound of fuel than was before possible, and th
heat generated minimises the period of blowing, and
runs or time of steaming to be continued far longe
has been possible before. By this method the gas
to cost about 3d. per 1,000 cubic feet. Where corpo
have the control both of the gasworks and also the
lighting of a town, the generation of current by m
water gas generated from their coke by means of a I
plant would, the author says, not only give ele
power at a price far below that at which it is obtaina
other means, but would also keep up the price of th

Liquid Hydrogen.—The *Times* on Friday las
the following details of Prof. Dewar's latest trium
explained by him before the Royal Society: "Prof.
said that in 1895 he described apparatus for the prod
of a jet of hydrogen containing liquid, and showe
such a jet could be used to cool bodies below the te
ture that could be reached with liquid air, thou
attempts to collect the liquid hydrogen failed. So
investigator had improved on the results described in
and as the type of apparatus employed in those
ments worked well it was resolved to construct a
larger liquid-air plant, and to combine with it circu
arrangements for the liquefaction of hydrogen. The
ratus took a year to build up, and many month
occupied in testing and in making preliminary trials
many failures and defeats need not be detaile
May 10 an experiment was started with hydrogen co
– 205deg. C., and escaping continuously under a pres
180 atmospheres from the nozzle of a coil of pipe at t
of 10 to 15 cubic feet a minute, in a vacuum vessel
silvered, and of special construction, surrounded with
kept below – 200deg. C. With these arrangements

ydrogen began to drop from this vacuum vessel into other, doubly isolated by being enclosed within a third, nd in five minutes 20 cubic centimetres of liquid were ollected. The hydrogen jet then froze up from the solidication of air in the pipes of the apparatus. The yield of iquid was about 1 per cent. of the gas. In the liquid condition the hydrogen was clear and colourless, showing no absorption spectrum, and the meniscus was as well defined s in the case of liquid air. The liquid must have a relatively high refractive index and dispersion, and the density must be in excess of the theoretical values—viz., 0·18 to 0·12—deduced respectively from the atomic volume of organic compounds and the limiting density found by Amagat for hydrogen gas under infinite compression. Prof. Dewar's old experiments on the density of hydrogen n palladium gave a value for the combined body of 0·62, nd it would be interesting to find the real density of the iquid substance at its boiling point. No arrangements eing at hand to determine the boiling point, two experiments were made to prove the excessively low temperature f the boiling fluid. In the first place, when a long piece f glass tubing, sealed at one end and open to the air at he other, was cooled by immersing the closed end in the iquid hydrogen the tube immediately filled, where it was ooled, with solid air. The second experiment was with a tube ontaining helium. Having a specimen of purified helium, tracted from Bath gas, sealed up in a bulb with a arrow tube attached, he placed the latter in the liquid ydrogen, whereupon a distinct liquid was seen to condense. rom this result it would appear that there could not be y great difference in the boiling points of hydrogen and elium. In conclusion, Prof. Dewar pointed out that all nown gases had now been condensed into liquids which ould be manipulated at their boiling points under atmospheric pressure in suitably arranged vacuum vessels, ough even so great a man as Clerk Maxwell had doubts to the possibility of ever liquefying hydrogen. With quid hydrogen as the cooling agent a temperature could reached within 20deg. or 30deg. of the zero of absolute temperature, and its use would open up an entirely w field of scientific enquiry. No one could predict e properties of matter near that zero. Faraday quefied chlorine in the year 1823. Sixty years afterards, Wroblewski and Olszewski produced liquid air, and w, after an interval of 15 years, the remaining gases—ydrogen and helium—were obtained as static liquids. nsidering the step from the liquefaction of air to that f hydrogen was relatively as great in a thermo-dynamic nse as that from liquid chlorine to liquid air, the fact at the former had been achieved in one-fourth the time eded to accomplish the latter proved the greatly celerated rate of scientific progress in the present age. e paper ended with an acknowledgment of the aid ndered by Mr. Robert Lennox, without whose engineering skill, manipulative ability, and loyal perseverance e present successful issue might have been indefinitely layed.

Electric Horses.—The following extracts from a ader of the *Financial Times* on "Electric Horses and ectric Globes," are too good to be missed. The editor arks that the joint-stock atmosphere appears to be rged with an undue amount of electricity at the present e. Electric cabs are whizzing along the streets of ndon, and motor enthusiasts are predicting that before ny years are over the skeleton of the noble quadruped l stand side by side with those of other extinct animals zoological museums. To our intense surprise, the latest posal concerning the application of electricity consists only of depriving the horse of his occupation, but of assuming his form, and this really involves the addition of insult to injury. The idea is owned by a company called the Electric Horse Promotion Syndicate, whose object is not to promote horses by electricity, as some might imagine, but to exploit patents relating to "an absolutely original form of recreation, combining the pleasure of equestrian exercise with the charm of novelty." The syndicate is capitalised—or over-capitalised—at £5,000, and is merely the forerunner of a more ambitious venture, which is to have a capital of £80,000. The promoters, therefore, appear to be people with very small resources, or else they have extremely little faith in their enterprise. Judging from the prospectus, we should think the former alternative is correct. The enthusiastic pioneers have so much confidence in the future of the electric horse that they have conjured up a vision—it might almost be called a nightmare—of its exploits. The result lies before us in the shape of a somewhat crude illustration, in which 30 or 40 mechanical steeds are shown disporting themselves in an extensive arena. Hundreds of spectators are watching the proceedings from grand stands and pavilions, and all are displaying the greatest excitement, with the exception of two or three couples in the foreground who are carrying on mild flirtations. The up-to-date quadrupeds—mounted apparently on rods attached to rails—enter the arena on a series of tracks that almost puts Clapham Junction in the shade. If they pass this point without sustaining a violent collision they pursue a labyrinthine course, which combines the intricacy of Hampton Court maze with the curvatures of a mountain road in Switzerland. When these evolutions have been accomplished the intrepid riders take a final gallop round the arena, make their exit by the up lines at Clapham Junction, and, panting no doubt from their violent exercise, dizzy in brain and shaken in nerve, they probably make their way to the nearest bar for a brandy-and-soda. An outer ring affords an opportunity to the more adventurous to indulge in an electric horse race, the apparatus being arranged in such a manner that "the race is a genuine one, and the selection of the winner is purely a matter of chance." As the course is over real turf, the illusion must be well-nigh perfect, and the Derby may now be regarded as an effete institution, quite devoid of interest except from the antiquarian point of view. If we were at all sceptical concerning the virtues of the electric horse we should be converted at once by the assurance that the new equine machine will trot, walk, canter, or gallop at the wish of the rider. This is where art triumphs over nature. Further, it is impossible even for the most timid to fall or lose their balance when once seated upon the saddle, so that when this initial performance has been accomplished the equestrian will feel far more at home than he would on a safety bicycle. "Every motion of the genuine quadruped," we read, "is counterfeited by means of this ingenious contrivance"; but this is where, in our judgment, the inventor has made a mistake. We have heard of cab horses dropping at the rank from sheer exhaustion. We have seen the friend of man jibbing, suffering from staggers, and running amok, to the great danger of life and property. It was unwise to copy nature so slavishly as to reproduce these obvious failings, and we can only assume that the idea was to minister to the love of sport, which, as the prospectus very truly remarks, is inherent in every Englishman. "The present invention, which is one of the mechanical triumphs of the nineteenth century, will provide a simple and inexpensive means of recreation which is probably more dear to the average man than any other." The inexpensive horse ought not to be more dear than any other; but then we must bear in mind that it is electric, and has been promoted.

THE KIDDERMINSTER AND STOURPORT ELECTRIC TRAMWAY.

This is a line for which the British Electric Traction (Pioneer) Company, Limited, obtained parliamentary power in 1896, and is to be worked throughout on the Dickinson overhead electric side-wire system. The line commences at Somerleyton-avenue (Fig. 1), about half a mile in an easterly direction from the Great Western Railway Station at Kidderminster, and passes through the principal streets of Kidderminster, thence along the Stourport-road, across the level crossing of the Great Western Railway, terminating in Bridge-street, Stourport, on the banks of the River Severn. It is a single line with passing places,

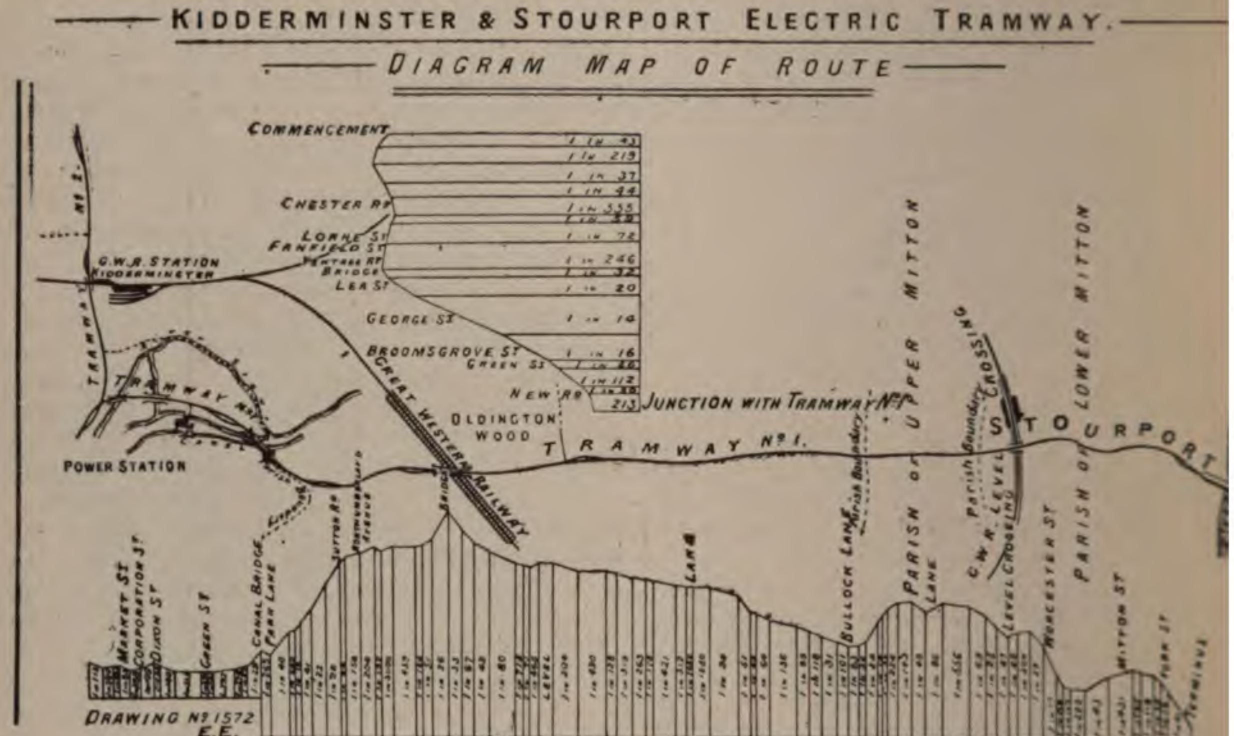


FIG. 1.

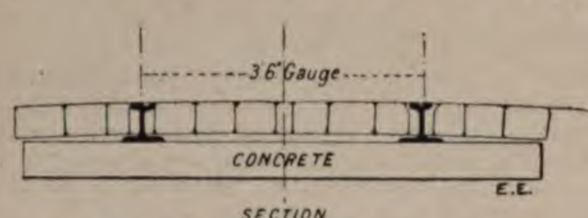


FIG. 2.—Section of the Track in the Streets of the Town.

3ft. 6in. gauge, and constructed throughout with girder rails 75lb. to the yard. All the grades on the lines are shown in Fig. 1.

In the borough of Kidderminster the rail is laid as an ordinary tramway (Fig. 2) upon a bed of concrete 6in. in thickness between the rails, and for 18in. on either side is

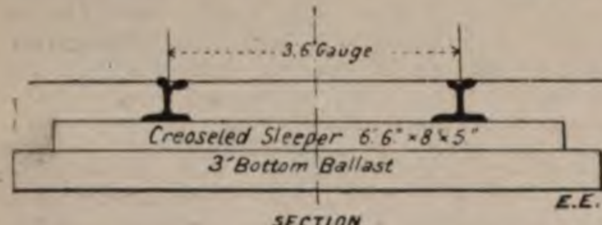


FIG. 3.—Section of the Track as laid on Sleepers in the Country.

paved with 3in. by 5in. Clee Hill granite setts. Along the Stourport-road to the level crossing of the Great Western Railway, the line, with the exception of one short length, is laid along the northerly side of the road. The rails are laid on sleepers (Fig. 3) between the rails, and on each side is made up with macadam. The section of th showing fishplates and bond is given in Fig. 4.

Very considerable road improvements have been As the line runs mostly alongside the road, and as a carriageway had to be left for the ordinary tra necessitated widening the roadway, also three bridges of these, being a double bridge spanning both the Stour and the Worcestershire Canal, presented consid difficulty, as the sides of the original bridge did n straight, but in a double "S" bend, and the arch spa the canal was skewed. This bridge had to be wide both sides and made straight throughout its entire l of about 180ft. The arch spanning the river was wi on both sides by building brick arches alongside, th work being tied into the old by means of tie-bolts c right through from side to side. The skew arch coul be widened in the same manner owing to the pe shape of the old bridge, but was effected by steel g construction, the longest span being 38ft. 6in.

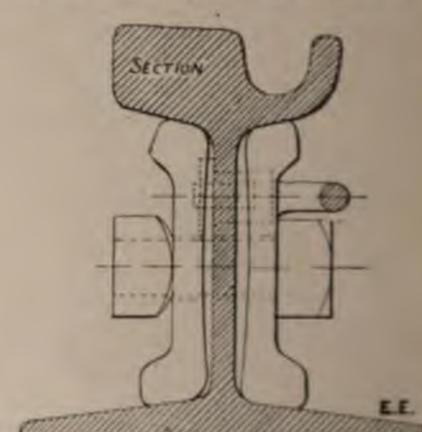


FIG. 4.—Section of 75lb. Rail.

Owing to various obstacles it has been necessary less than three instances to place the poles on opposite of the road—that is, the poles and wires for some con able distance are on one side of the road only, and th some distance on the other side of the road, when again cross, so that in this installation there is a example of the adaptability of the Dickinson running trolley to the wire in varying position in it tion to the tramway. Fig. 5 shows an average sect the track and overhead construction.

Tapered steel poles 6in. and 7in. diameter are fixed

ı distance apart of 50 yards. They stand 22ft. above und, and are bedded in concrete to a depth of 6in. the surface of the road. Two trolley wires are ɪd, one for up-line and the other for down-line g, the necessity for overhead switches at the passing

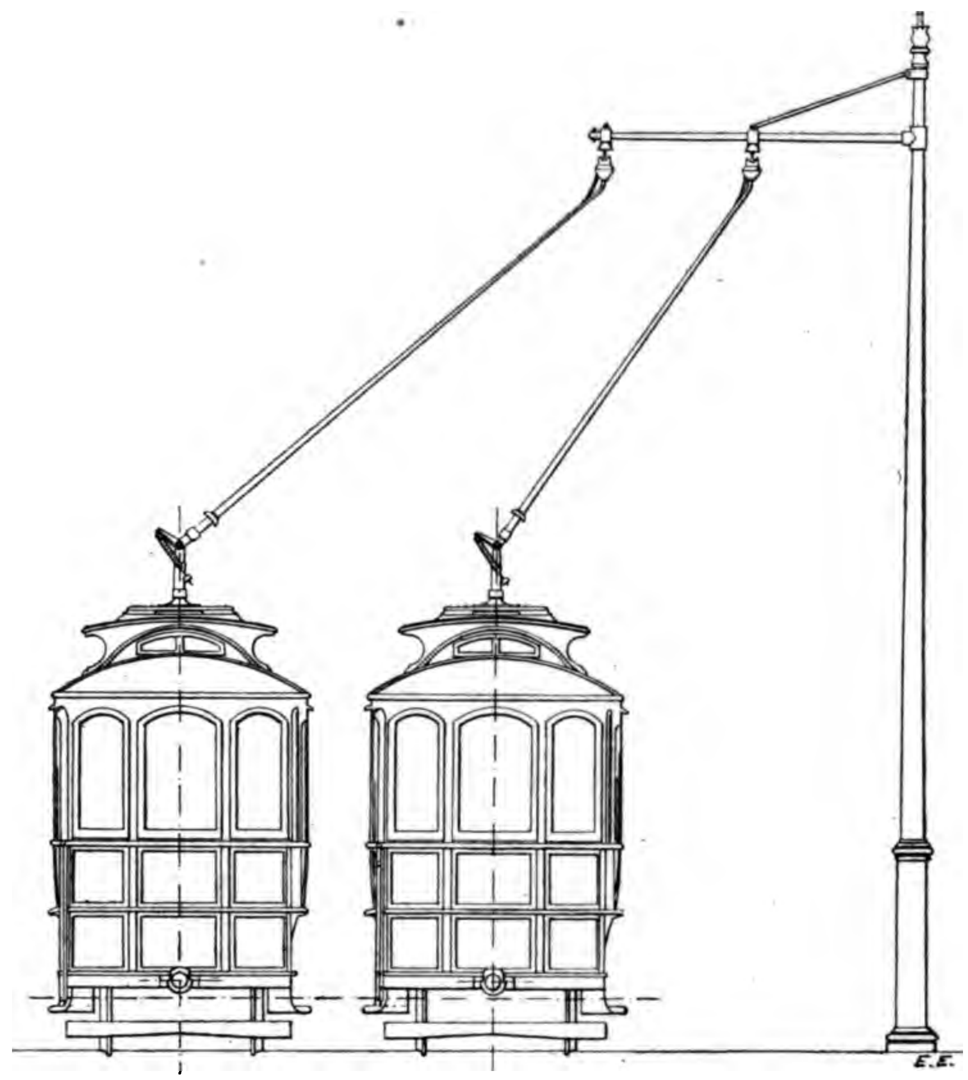


FIG. 5.—End Elevation of Cars and Overhead Construction.

being thus avoided. The height from the rail to ɔlley wire is 21ft. The lengths of the bracket arms which the trolley wire is suspended vary considerably, ngest being 8ft. 6in. and the shortest 2ft. 6in., the r number being of the latter length. The trolley ı suspended by riveted gunmetal ears, which are in

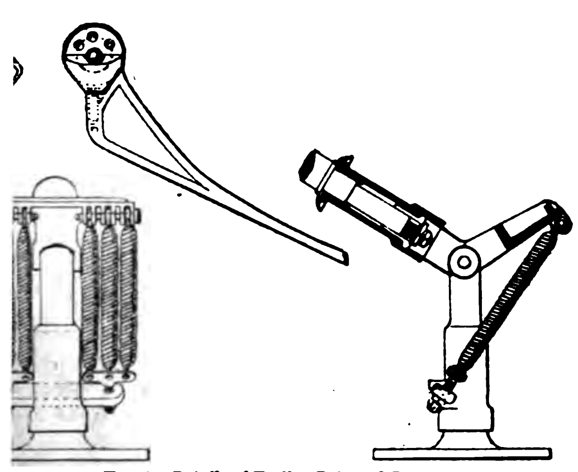


FIG. 8.—Details of Trolley Pole and Base.

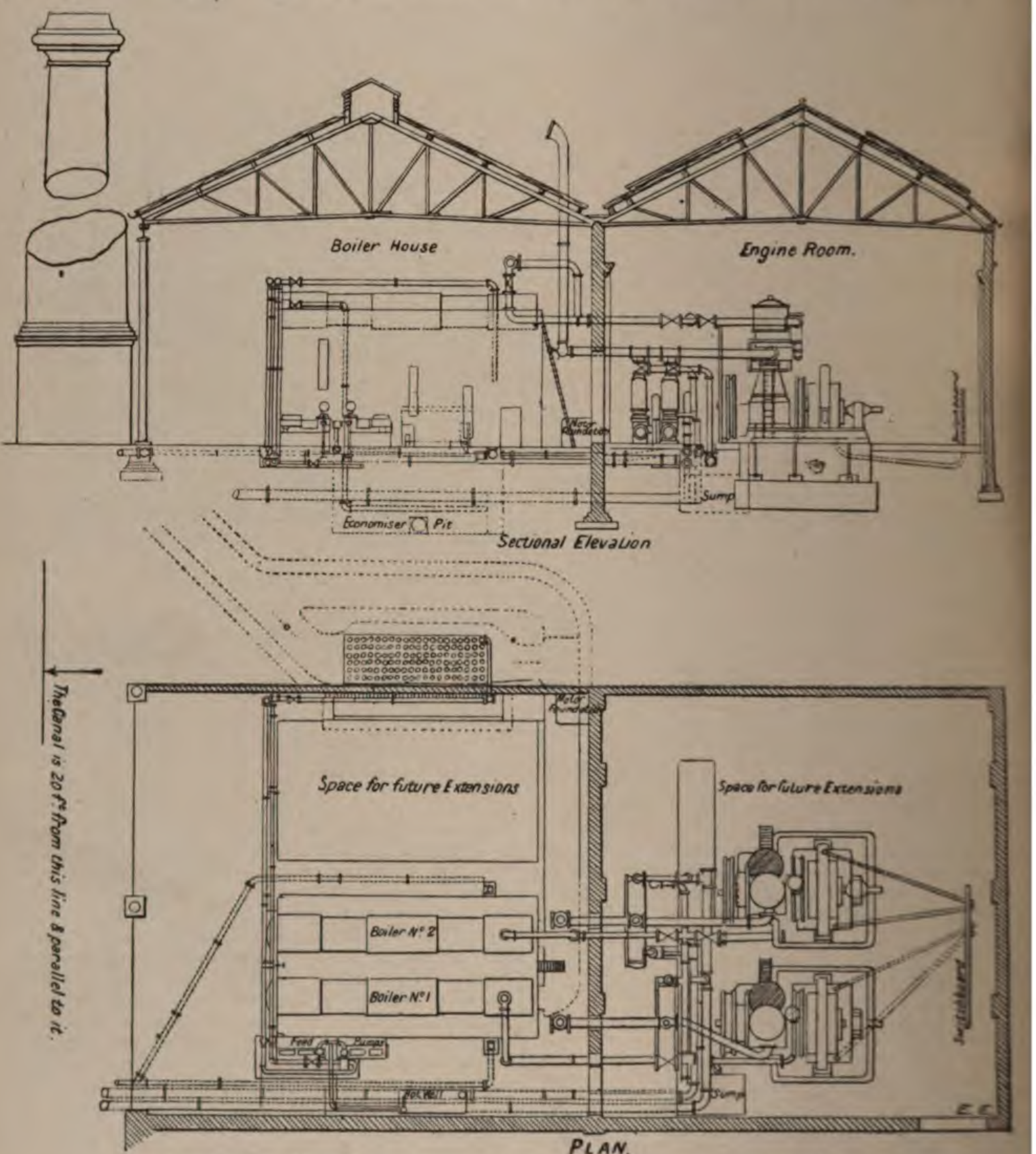
uspended from bell insulators fixed to the bracket y wrought-iron clips.

power station and car depôt are built together upon nirable site (Fig. 1), situated between the River Stour e Worcestershire Canal, which is a little over a mile from the Kidderminster terminus, and 3½ miles from Stourport. There is shedding room provided for 10 cars. The generating plant consists of two Babcock and Wilcox boilers, each of 1,218 square feet heating surface, and capable of evaporating 3,500 gallons of water per hour; a Green's economiser of 120 pipes; two Raworth "Universal" compound engines, developing 150 b.h.p. at normal and 200 b.h.p. at a maximum load with 130lb. steam pressure, each coupled direct to a multipolar compound-wound generator, to be run at a speed of 235 revolutions per minute. The generators are wound to give a constant E.M.F. of 550 volts, with a full normal load of 190 amperes and a maximum load of 250 amperes. The arrangement of this plant is given in Figs. 6 and 7. There are also two Wheeler surface condensers of the Admiralty type, one for each steam plant; the exhaust-pipes are arranged so that either engine can exhaust to either of the condensers, or direct to atmosphere automatically should the condenser fail through any cause. An amply supply of water for the condensers can be obtained from the canal. The steam-piping, which is arranged in duplicate, is of mild steel. The valves are manufactured by Messrs. Winn and Co., of Birmingham. The water supply is taken from the town mains.

The switchboard is divided into six panels—main station, generator, feeder, and Board of Trade. The main station panel is fitted with an ammeter showing total output of station, recording volt and watt meters, an equalising switch, and a station clock. The generator panels are each fitted with a magnetic quick-break cut-out switch, an ammeter, shunt-regulating switch, and plugboard for station voltmeters. The feeder panels are each fitted with a quick-break cut-out switch, ammeter, and lightning arrester. The Board of Trade panel contains all the instruments necessary to comply with the Board of Trade regulations. All the voltmeters and ammeters have illuminated dials. There are two main feeder cables from the power station,

one going east towards Kidderminster and the other west towards Stourport. At every half-mile the trolley wire is divided by section insulators, at which points the feeder boxes are located. These feeder boxes contain two main knife switches feeding on to an omnibus bar, from which bar there are four cut-out fuses, which can feed both ways on to the double trolley wire. Any section can thus be easily disconnected for testing, etc. The east-going feeder is a $^{19}/_{14}$ stranded cable, and extends to within half a mile of the terminus. The west-going feeder consists of a $^{37}/_{11}$ cable as far as the third feeder box, from which point

no top seats provided. The trucks are of the Brill cantilev type, with a wheel base of 6ft. 5in., the wheels bein 2ft. 6in. diameter. The bottom framing of the cars is co structed of teak, the body of teak and English ash, a the panels of Honduras mahogany. Each of the motorca is equipped with two 15-b.h.p. four-pole motors of the ir clad type, with spring suspension, and geared to the axl with spur gearing with a ratio of 4 to 1. The armatur are of the drum type, slot wound, with symmetric renewable coils. The armatures are cross connected so to have only two points of commutation. Carbon brush



FIGS. 6 AND 7.—Details of Power-House and Generating Plant of the Kidderminster and Stourport Electric Tramway.

and on as far as the next two boxes it is reduced to $^{37}/_{12}$, and from thence to the last feeder box it is reduced again to $^{19}/_{14}$, finishing up within half a mile of the terminus. A $^{7}/_{22}$ cable is connected to the rails at the extreme ends, and brought back to the switchboard for testing the drop in the return circuit. The feeder cables are lead sheathed and armoured. They are buried in the ground at a depth of 18in.

There are 10 cars—six closed motorcars 27ft. 6in. in length over all, and 6ft. 4in. in breadth. They have a carrying capacity of 24 passengers, and three open trailer cars with a carrying capacity of 40 passengers. There are

are employed. The controllers, which are fixed one at e end of the car, are of the series-parallel type, one contro handle being supplied with each pair of controllers, wh are so arranged that it is impossible to detach it except when the controller is in the "off" position. Each ca lighted with ten 16-c.p. lamps, arranged in two circuits five lamps in series. The interior of the car is lighted three clusters of lamps, one containing four and two c taining two lamps, and a headlight, which also lights t vestibule, arranged at each end over platform. The troll pole (Fig. 8) is a light steel tube, 15ft. long, tapering fr $2\frac{3}{4}$in. to $\frac{3}{4}$in. outside diameter, and fitted with swivel h

ow the wheel to turn and adapt itself to any the trolley wire. The base of the trolley pole ɪd on four insulators, as the whole of the pole of the electrical circuit. Each car is provided ıtning arrester.

tractors for the complete electrical installation 3rush Electrical Engineering Company. This line :ceedingly interesting, because not only has the :k been installed, but manufactured, by the Brush The contractor for the permanent way and was Mr. George Law, Kidderminster. The poles ufactured by Messrs. James Russell and Sons, Crown Tube Works, Wednesbury. Messrs. Alfred and Co., 120, Colmore-row, Birmingham, were ers for the whole undertaking, Mr. G. B. Parlett, ., being resident engineer and their representative t the work.

we were going to press we received a teleing that the Board of Trade had passed the , which will hence be opened for traffic at once.

[I]ON OF ELECTRICAL ENGINEERS, May 12.

[Mag]netic Balance for Workshop Tests of Permeability.

[B]Y PROF. J. A. EWING, F.R.S., MEMBER.

hor believes that the want is felt of a workshop for making tests, in an easy and rapid fashion, of ic permeability of cast and forged metal for dynamo His own permeability bridge,* introduced two years ɔw somewhat extensively used, allows the B-H curve bar to be determined with very much less trouble ded to carry out ballistic tests. For the accurate of one bar with another, throughout a wide range of g forces, the permeability bridge is entirely suitable, ishes as simple a means of performing that operation be had. The author uses it systematically in his ;, and is thoroughly satisfied with it as a means of g the B-H curve. But the complete B-H curve is e than the dynamo-builder or the steel founder wants to know. For his purpose it would often nd the induction produced by some one (fairly high) ıe magnetising force. That information is a suffiof the character of the specimen to allow judgment d on its suitability for use in the field magnets of a

nsiderations have led the author to develop another rument, which, while it tells less about the specimen ı learnt by means of the permeability bridge, gives ıeful information in a still more easy way. To use no knowledge of electrical testing, and the results orking out. The value of the magnetic induction l units, corresponding to a single stated magnetising :ectly read off on a divided scale. The instrument etic balance of the traction type, making use of le already applied in magnetic testing in apparatus y Prof. S. P. Thompson, Mr. Gisbert Kapp, and Du Bois. In most apparatus of this kind the as taken the form of a turned bar with a faced end ıe pull due to magnetisation was exerted. In the ılance this facing of the end is not required, the ɪull being exerted between the side of the turned ɪagnet pole which it touches, and from which it is 7. The specimen is a turned rod ¼in. in diameter ɪng. It lies across the two poles of a U-shaped net, which is excited by a constant current of such to produce a magnetising force in the rod of about ınits. In one of the poles there is a V notch for the in, and the other pole has a slightly convex surface, ed to form a portion of a cylinder with its axis lar to the direction of the length of the rod. The ı rod touches this pole at one point only, and the rce at this point of contact is the force which is A lever or weigh-beam is applied to pull the rod this pole, while the other end of the rod remains in h in the other pole, forming what may be called a inge. The tractive force is measured by means of a ch slides along the graduated weigh-beam. When ɪt in place, the current is reversed once or twice, ɪt any residual effects of previous magnetisation. ; is then moved along the beam until the beam just drops each time it is raised, so as to bring the side of the rod into contact with the pole. The rod requires no preparation beyond turning it to the proper diameter. Its cylindrically turned side touches the convex pole-face in a perfectly definite manner, and the rod may be taken out and put back without altering the character of the contact. The lever is arranged in such a way that the rod always touches the same point of the pole-face.

The value of the magnetising force to be brought to bear on the rods under test was fixed at about 20 C.G.S. units for the following reasons: At forces much weaker than this the B-H curves of different specimens often cross; in other words, the order of merit often changes when the force is varied. But the author's experience in testing dynamo steel leads him to the conclusion that with forces of 20 units and over there is no serious change in the order of merit of various specimens. If a piece is good when $H=20$, it remains good under stronger forces; if it is only fair when $H=20$, it remains only fair; and a specimen that has relatively low permeability under this force does not take a materially better place when the force is increased. On the other hand, any considerably stronger force would be less convenient for testing, especially because the difference between good and bad specimens would become less well marked, and the sensitiveness of the test would consequently be reduced. The author has selected 20 as a force, which on the one hand is sufficiently low to make the distinction wide between bad and good specimens, and on the other hand is sufficiently high to make the order of merit substantially the same as is maintained under stronger forces. From the measured induction at $H=20$, the probable induction at higher forces can be inferred with some confidence. By examination of the results of tests of a very large number of samples of dynamo steel, including the published tests of Mr. Parshall,* as well as his own tests, the author has prepared the following table, to show the probable approximate values of B at forces of 25, 30, 40, and 50 C.G.S. units, when the value of B at a force of 20 is known. The values of B found for $H=20$ range, in dynamo steel, from 16,000 in the very best specimens down to 12,000 in specimens of decidedly low permeability. About 15,000 is representative of good dynamo-steel castings, and anything below 14,000 may be pronounced poor.

TABLE I.—Probable Values of Magnetic Induction, B, for Various Amounts of Magnetising Force, H.

Magnetising force, H.	Magnetic induction, B.				
20	12,000	13,000	14,000	15,000	16,000
25	12,700	13,700	14 600	15,500	16,350
30	13,300	14,200	15,100	15,900	16,600
40	14,200	15,000	15,700	16,400	17,000
50	14,900	15,600	16,300	16,900	17,400

The range of the new magnetic balance extends (for $H=20$) from 12,000 up to something over 16,000. It will test at the top of its range the very best samples that are found, and at the bottom of the range it will test steel of poorer quality than would be accepted for use in dynamo magnets.

The scale is a linear one, in which equal divisions correspond to equal differences in B, for a constant value of H. It is graduated to give by direct reading the values of B for $H=20$. This uniform graduation is arrived at in consequence of the fact that with different specimens the magnetising force is not quite constant, although the current in the electromagnet is constant. A specimen of high permeability increases the induction in the magnetic circuit, and consequently causes a larger share of the magneto-motive force to be used in that portion of the circuit which lies outside of the specimen itself. Hence the induction in the specimen is less high than its greater permeability would imply; in other words, the better specimen is exposed to a somewhat less magnetising force than the worst specimen is exposed to. The tractive force increases more rapidly than in simple proportion to the actual induction; but matters are so arranged that the lessening of the induction which comes about in the way just stated compensates for this, and the observed differences of tractive force, as measured throughout the range of the scale, stand in simple proportion to the differences in the values of B which the various specimens would exhibit if the force H were constant. In other words, a scale of equal parts on the weigh-beam corresponds to equal differences of B under a constant magnetising force, and the weigh-beam is accordingly lettered to read B directly in equal divisions. The readings give B for $H=20$, although, in consequence of the action just explained, the actual magnetising force is barely 20 for rods of very good quality, and somewhat exceeds 20 for rods of lesser permeability. The scale is adjusted by the maker by selecting values of the sliding weight and of a fixed weight on the weigh-beam which will bring the readings into agreement with the known values of B in certain standard rods.

ɪd in the author's paper on "The Magnetic Testing [of] Steel," *Minutes of Proceedings*, Institution of Civil May, 1896.

* *Minutes of Proceedings*, Institution of Civil Engineers, May, 1896

A single standard rod is supplied with each instrument, and the observer adjusts his current until the tractive force on that rod is such that the sliding weight stands at the place on the beam corresponding to the known value of B which a force of 20 C.G.S. units produces in that standard. The standard rod consequently serves instead of an ampere gauge, and no other current measurer is required. A rheostat is provided in the instrument for regulating the current, and a single small storage cell forms the necessary battery. The observer puts in the standard rod, and turns the rheostat until he finds that the weigh-beam just drops each time it is lifted, while the sliding weight indicates the known value of B. He then puts in the rod which is to be tested, and finds the position which the sliding weight has to take for it, no change being made in the current. The constancy of the current is checked at the end of the tests by again putting in the standard rod.

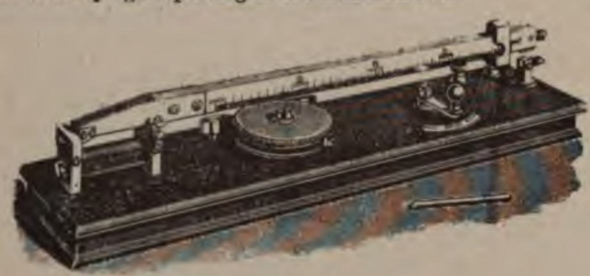


Fig. 1.

The complete instrument is shown in Fig. 1. The weigh-beam lifts the rod by means of a V-shaped stirrup close to the pole-piece, from which it is to be pulled away. When the rod is pulled away the beam comes immediately against a stop which limits the motion. A hinged piece is provided under the far end of the weigh-beam, to hold it up while a rod is being taken out or put in. The weigh-beam can readily be lifted out of the way when it is desired to clean the pole-faces, and care has to be taken to keep them, as well as the side of the rod where it touches them, free of dust and rust.

In the following table a comparison is made for a number of rods of different qualities of the value of B known to be produced by a magnetising force of 20 units with the values as measured by this magnetic balance. The known values of B were determined by means of the permeability bridge by comparing each rod with a standard whose B-H curve had been found in the first instance by ballistic tests. The range covered

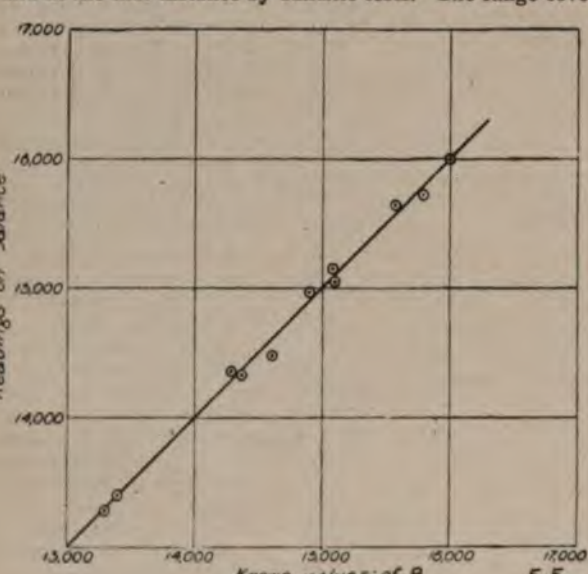


Fig. 2.

by these examples is as wide as is likely to be met with in the practical testing of dynamo steel.

Table II.—Calibration of the Balance.

Induction, B, at H=20 determined from independent measurements.		Induction, B, read from balance.
13,300	....	13,280
13,400	....	13,400
14,340	....	14,360
14,350	....	14,290
14,600	....	14,470
14,900	....	14,960
15,100	....	15,060
15,080	....	15,150
15,570	....	15,650
15,800	....	15,720
16,000	....	16,000

These tests relate to different specimens, all tested wi
constant current in the magnet of the balance. The agr
between the scale readings and the known values of B i
factory. Fig. 2 exhibits the same tests graphically, the r
of the balance being plotted against the known values o
H=20. They show that within this range of B the va
the induction (under constant H) are fairly represented
readings on the uniformly divided scale of the balance.
irregularities as occur lie equally, so far as can be jud
both sides of the straight line. The readings of the
may be accepted as giving values of B for H=20, at le
accurately as these are required in the uses which the
is meant to serve.

Discussion.

Before the discussion on the paper presented to the Ins
by Prof. Ewing, the **President** said he was glad to an
that Mr. Henry Wilde had been elected an honorary mem
the Institution. Mr. Wilde was well known in electrical
all over the world, and the Institution was greatly hono
having another such distinguished man on their roll of h
members.

Prof. W. E. Ayrton said he wished to congratulate Prof.
on his invention. What surprised him was the clearness
scale. He should not have thought it possible to obtain
open scale, where one would have expected it to have bee
crowded. He should like to ask what was the actual m
force employed and how the magnetic element was divided
fear was from the possibility of error creeping in in th
tests. How far was it necessary to clean the specimens
were to be tested from oil, rust, etc., before testing so as to
correct results?

Prof. J. Perry said that when Prof. Ewing stated that the
ment worked well, he knew nothing more was required to
regarding it. He should like to make some experiments w
instrument.

Prof. S. P. Thompson said he also had to congratulat
Ewing on the success of his invention, and quite agree
Prof. Perry's opinion. It was now nearly 10 years since h
speaker) had constructed a crude instrument for the same p
which worked on the tractive system. He was glad to s
Prof. Ewing had become a convert to this system. He d
think that it was a good thing to have so small a point of
and should imagine some error would be caused at thi
through the gathering of the lines of force. In his own instr
he had used a flat surface and found it answer very well.
were probably good reasons for taking 20 as a stand
magnetising force, but how would the results stand if he
to know the values of a specimen with a different magn
force? The machine did not in his opinion have a large
range, the induction used in multipolar machines runni
siderably below 13,000, and some for small machines even
up to 20,000.

Mr. W. M. Mordey said he would ask the author to dir
attention to another sort of testing—namely, an instrument
would test the iron in bulk. It was sometimes impossible
off a piece for the purpose of testing, and also very oft
results from the piece cut off would differ altogether from th
of the iron. If the author made an instrument which wo
this, he would greatly increase his indebtedness to them.
need of such an instrument was very apparent, when, as in
he (the speaker) knew, two machines supplied from the sam
of iron varied as much as 70 per cent. He would like
whether the testing should be done quickly or slowly? An
ment was wanted by which dynamo makers could know wh
wanted when orders were sent in for iron which had a
magnetic quality.

Mr. James Swinburne said he thought there was a
possibility of error owing to the smallness of the point of c
He thought there was sure to be some variation at that point
to the "gathering" of the magnetism.

The **President** said, before asking Prof. Ewing to reply,
would like to join in the general chorus, and say that the
had done good service in making such a reliable w
instrument.

Prof. Ewing, in reply, said that he thanked the membe
much for the cordial reception his paper had met with.
Ayrton had remarked as to the large scale, and he would
that the beam on which the scale was carried was a very
one. The tractive force was more used up in overcomi
weight than in magnetic induction. He thought it would
much good for measuring specimens of very low or ve
magnetic force. He was just as surprised as they were w
found to what a degree of accuracy it attained. His idea
first been to use it by comparison with several specimens
had been tested ballistically. The specimens should be fr
rust or oil when tested, but it did not matter whether th
polished or not. With regard to what Prof. Thompson h
about his conversion to tractive methods, he confessed hi
convert to some degree, but did not agree with it, however,
some reference to ballistic tests. He took as his standard
men which had been tested by ballistic methods. He sh
sorry to think that this instrument would cut out the perm
bridge. Mr. Mordey had suggested he should construct an
ment for measuring iron in bulk. The problem had been
mind for some time, but at present he did not see his way t
anything in the matter. The day previous he had received

from Mr. Gisbert Kapp, saying, "Your invention is a most useful instrument, and I shall not be at all surprised to see it largely taken up over here" (Germany).

The Registration of Small Currents Used for Electric Lighting or other Purposes.

BY ALFRED H. GIBBINGS, MEMBER.

The subject which I have the honour of bringing before your attention this evening is one which is becoming of considerable importance to the suppliers of electrical energy from central stations. This arises chiefly from the fact that several of the electricity supply concerns have recently increased the pressure at which they supply current to the consumer, or, in other words, they have raised the voltage on the distributing mains. One of the most important reasons, however, which has brought about this change—viz., the economy effected in distributing mains through the halving of the current hitherto required—is in itself responsible for the imperative necessity of greater accuracy in the registration of the smaller current consumed. I refer, of course, to the change from a supply pressure of 100 volts to that of 200 volts, and to the proportionately less current required for lamps in connection therewith.

In looking through the list of consumers of any undertaking for the public supply of electricity it will be found, if the business has been carried on for more than two years, that the maximum demand for current by the great majority is considerably below 10 amperes. If, however, we include all those consumers who would come within a 20-ampere maximum demand limit, there will remain but a very small percentage requiring more than that amount. If these facts be true for supply at 100 volts, it is evident that at 200 volts pressure the 10-ampere limit will practically include all consumers.

The question, however, with which we are more concerned is the registration of the minimum current which the consumer uses when he has only one or two lights in circuit, and also that this registration should be accurately proportionate throughout the capacity and range of the instrument. There is, moreover, the consumer whose demand does not exceed three amperes—say, 10 16-c.p. 60-watt lamps—and who probably does not, as a rule, have more than half that number in use at one time. The revenue derived from such a consumer is small, and the net profit does not permit of providing him free of charge with an expensive meter. The consumer on his part either strongly protests against, or is unable to afford, a heavy meter rent. In a recent discussion on meters at the last annual convention of the Municipal Electrical Association, the following remarks were made by Mr. Evershed: "As regarded energy meters as against quantity meters, the quantity meter was cheaper to make, and therefore for small consumers it seemed to him to be greatly desired. He agreed that the small consumer must have a meter to cost less than £5, but where it was to come from he did not know. There would always be a large demand for meters for big consumers, and meters which must have a very long range, and it appeared to him to be folly on the part of engineers to expect a meter of that kind to be made at a low cost. They could not have them cheap and with a long range. But the small consumer did not want a long range. If the price was to come down to the lowest level, good work would have to go, and he was afraid they would find themselves very much mistaken if they thought that good meters would become very much cheaper than they are now. It was true the workmen were getting more skilled, but the rate at which wages were rising entirely wiped out the advantage that was gained by that fact, and even the labour-saving appliances were hardly sufficient to atone for the rise of wages. He had no hope of the price coming down to 50s. or 40s., as he had heard suggested." We are, therefore, confronted with these two desiderata—viz.: (1) a meter that will register accurately at all atmospheric temperatures and at all loads, from one-tenth ampere to its range limit; (2) a considerable reduction in the capital cost of the meter. Such a meter I propose to bring before your notice to-night. I shall endeavour to show, by reference to certain tests, etc., which I have carried out, that this meter fulfils the conditions I have just mentioned. In order to make the description as clear as possible, and to do justice to the consideration of every point, it will be best to treat each feature under a distinct and separate heading. I will, therefore, deal with the subject in the following order: (1) principle of action and registration; (2) construction and probable cost; (3) tests; (4) summary.

I.—Principle of Action and Registration.

The principle which has been applied to the registration of the electric current in this meter is that of electrolysis, or the decomposition of a liquid. This effect of the electric current has not only been known from almost the inception of the science, but it has been applied to the purposes of registration in many cases, and forms the subject of many patents, as I will presently describe. The method of registration is that of the difference of level of the electrolyte due to electrolysis and observed by a graduated reading of the tube containing the liquid. My object this evening will be to show that the application and method of registration, however, which has been adopted in this meter is novel, and that as an ampere-hour meter it has advantages over those in which other principles are utilised. Let me say at once (though, indeed, this is scarcely necessary) that it is only applicable to the registration of continuous currents; but even as such, and notwithstanding its confined scope, it is still an advance upon present methods. We have at the present time meters which employ those effects of the electric current which render them equally available for use with either continuous or alternating currents; and we have, moreover, various forms of wattmeters. All these perform their functions sufficiently accurately to be articles of commercial value. With these aspects of the case, therefore, the present paper has nothing whatever to do, and hence the following remarks should not be criticised from such standpoints. In making a comparison between this meter and other types of ampere-hour meters, as far as the restricted points of consideration admit, I will, at the outset, state concisely the characteristics which are claimed for it—viz.: (1) starting with an infinitely small current, and stopping immediately current is switched off; (2) accurate at all temperatures and at all loads; (3) no periodical testing required for starting current; (4) independent of direction of current; (5) no mechanism; (6) no permanent magnets; (7) no shunt currents; (8) cheap in initial cost; (9) cheap in maintenance; (10) no special adjustment for different lamp voltages, except on calibration of scale; (11) accuracy unaffected by temporary excess current; (12) unaffected by local short-circuits; (13) unaffected by outside influence; (14) not susceptible within wide limits to vibration, temperature, or barometric changes.

In support of some of the foregoing features, evidence will be forthcoming in the portions of this paper devoted to "Construction" and "Tests" respectively. For the moment I will deal with those which require little or no proof in support of the claim, and which are numbered 1 to 7 inclusive in the preceding list. The first four claims are indisputable, as they arise out of the fundamental laws of electrolysis. The one fact alone that no periodical testing is required for starting current is of immense importance itself, as the necessity of the inspection which exists at present forms a considerable item in the costs of the meter department. Further, the result of this inspection is often enough the removal and recalibration of the meter, and on this matter I shall have more to say when I deal with the question generally. With regard to items 5, 6, and 7, it is apparent at a glance that the removal of all mechanism, and the absence of permanent magnets and shunt currents, render the meter free from many errors which arise from those causes in most of the existing types.

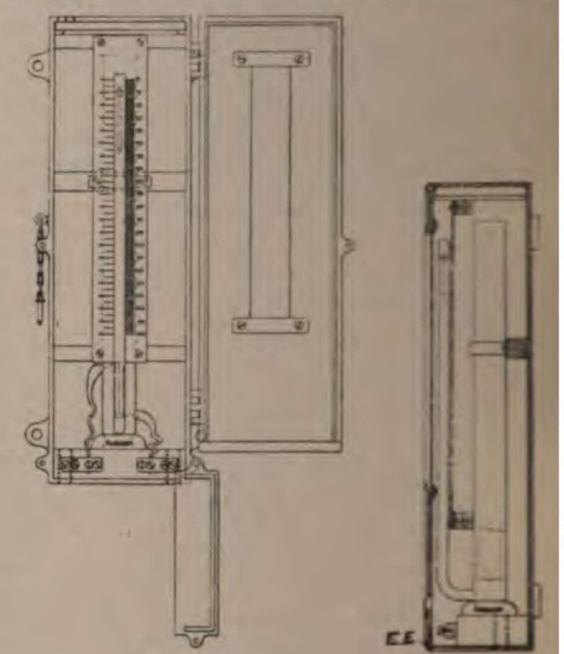
Before proceeding with the second division of my paper, I propose to give herewith a list of all those electrolytic meters which have been invented since the beginning of the year 1883. Many of these applications of electrolysis are characterised by the unique and ingenious nature of their construction and their registering devices, as will be seen from the extracts which are given below: (Butler)—Acidulated water is electrolysed, and the pressure of the gas generated is caused to actuate the counting mechanism. Arrangements are also made for periodically exploding the gases. (Boucher)—Acidulated water is electrolysed, and the gases given off are caused to pass up into an inverted funnel which is placed under the water in a tank. This funnel is connected to a lever which swings loosely upon a pivot. When the funnel becomes filled with gas, the lightness of the gases causes it to tip up so that the lower end of the funnel comes above water and allows the gases to escape, and simultaneously the movement of the lever attached to the funnel actuates the counting mechanism, either mechanically or by the agency of an electromagnet. (Wright)—An electromagnet is wound with a very fine coil, which is connected with a shunt across one parallel or set of parallels, and an electrolytic cell is placed in the circuit, the plates of which are removable and can be weighed, so as to obtain a measure of the energy absorbed by the circuit. Used with high-tension incandescent lighting when the lamps are arranged in multiple series. (Greenhalgh)—Two electrodes are placed in an electrolytic cell, of which one is fixed and the other movable. The weight of the metal deposited upon this latter electrode is caused to actuate the registering mechanism. This is effected by the agency of a ratchet wheel and pawl, which in its turn controls a train of wheels. (Shippey)—Acidulated water is electrolysed, and the pressure of the gas generated is caused to move an indicator. It is mentioned that a pencil may be used to trace a line on a paper mounted upon a drum, and thus obtain a register. It is also stated that the gas generated may be measured by passing through a gasmeter. (J. Swinburne)—Relates to arrangements of meters for direct or alternating currents. The meter consists of a voltameter or copper deposition apparatus, the current through which traverses a variable resistance, which is controlled by the core of a solenoid, or by the expansion of a wire heated by the current passing through it; or the meter may be operated by

the secondary circuit of a small transformer which traverses the voltameter, and is made and broken by a suitable contact-breaker. (Fairfax and Wetter)—Refers to electrolytic meters used for measuring alternating currents. Metal is precipitated from one or both of the electrodes, and any convenient method of indicating the loss of weight in the electrodes may be employed, such as attaching a delicate spring balance to the plates, or connecting the plates to a system of counterweighted levers. (Lowrie and Hall)—Also refers to alternating-current meters. This specification deals chiefly with means of differentiating the wave of potential of an alternating current, so that the quantity of current flowing in opposite directions is unequal, and to utilise this difference to measure the amount of the total current flowing. The specification states that an electrolytic cell may in some cases be employed in order that the gain or waste in weight of an electrode may measure the amount of current. (Sellow and Jackson)—A liquid, such as acidulated water, is electrolysed within a U-shaped tube which is closed at both ends. At one end of the tube is fitted an arrangement for causing the pressure of gas to actuate any suitable registering device, and at the other an arrangement for periodically exploding the gases which are generated. It is mentioned that the pressure of gas may be used to give motion to float or piston, or, by closing electric circuits, to actuate electromagnetic devices. (W. Emmott)—The gas or gases liberated by means of electrolysing a fluid are caused to turn a sort of waterwheel which actuates the registering mechanism. (C. S. Forbes)—One or more secondary batteries are so arranged that either the whole or a part of the main current passes through them, a proportional part of the current being stored by these batteries. (C. P. Elieson)—Water or other liquid is electrolysed, and the amount of current which has passed is ascertained by metering the gas generated. (Dr. Smelles)—This meter deposits metal upon the electrodes alternately, and is fitted with a commutator arrangement which changes the relative position of the anode and cathode. One of the electrodes is movable, and the changes of weight of this electrode actuates the registering mechanism. (H. W. Miller)—Between the electrodes (in an electrolytic bath) is placed a balanced metallic cylindrical wheel. When the current passes it deposits metal upon one side of the cylinder and dissolves it from the other side, thus causing the cylinder to slowly revolve by upsetting its equilibrium. The motion of the cylinder is used to actuate the registering dials. (Grassot, Paris)—The tip of the lower end of a straight vertical wire, placed within a tube, dips into an electrolytic bath and forms one of the electrodes (the anode). The above-mentioned tip is provided with an insulating support to rest on in the electrolyte, the lower end of the wire being slowly dissolved by electrolytic action. The wire descends by gravity, and this motion is caused to register on dials. (A. E. Waterhouse, U.S.A.)—This meter electrolyses fluids, and the gas decomposed is caused to actuate registering apparatus. Arrangements are included for automatically discharging the gas after a certain amount has been collected. (McKenna, U.S.A.)—This meter consists of an electrolytic cell containing a mercury salt, from which mercury is caused to be deposited upon an electrode composed of carbon (the other electrode consisting of mercury), and in the form of a round rod placed vertically, and terminating in a point at its lower end. Beneath this carbon electrode is placed a graduated glass tube into which the mercury drops, the amount of mercury in the tube showing the quantity of current which has passed. (Alders and Hottgen, London)—This meter is almost precisely similar to McKenna's, but instead of an electrode of carbon for the mercury to deposit upon, a platinum electrode is substituted, conically shaped, and with the pointed end downwards over the indicating tube. (Naber, Amsterdam)—Water is electrolysed, and the gas collected and measured. A thermometer is mentioned, also table, as being used in reading the meter (probably for correcting temperature errors).

The foregoing details show very clearly the importance in which the electrolytic action of the current has been held as a principle of registration. The application, however, has been entirely confined either to electro-deposition of metal, or to the measurement of the gases given off in the process of decomposition of the liquid. In the first case so many difficulties arise that only one type has been adapted commercially as an ampere-hour meter for electric lighting purposes, and that with very indifferent success. In the second instance, even greater disadvantages have to be considered owing to the large errors introduced due to variations of temperature and complicated and delicate mechanism.

II.—Construction and Probable Cost.

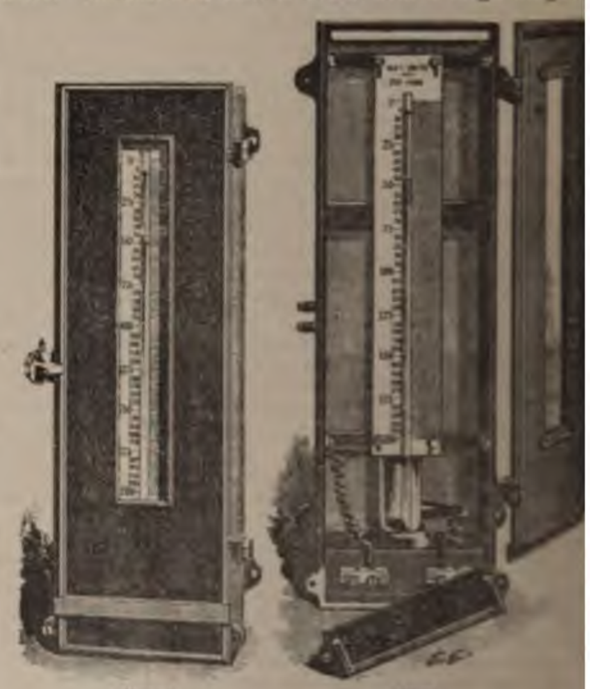
Construction.—The general construction and arrangement of this meter are shown in section in Fig. 1 and from photographs in Fig. 2. There is also on the table before you a skeleton meter consisting only of the electrolytic portion, which I have arranged so as to demonstrate, as far as practicable at the present time, one or two of the principal features of the instrument which I have already enumerated. There are also a few samples of the commercial article before you which have been calibrated in Board of Trade units at 115 and 230 volts r tively, and which I will now briefly describe. The elect apparatus consists of the usual platinum electrodes moun a glass tube of true bore throughout the range of the The lower end of the tube is sealed, the top remaining op the purposes of refilling with water and the escape of the On the top of the liquid is poured a thin film of oil to p atmospheric evaporation. The liquid is composed chi water, rendered non-freezing to within 24deg. F. belo ordinary freezing point of water by the addition of sul



Front Elevation. Section.

FIG. 1.

acid, upon which, however, the electric current has no a ciable effect. The entire electrolytic apparatus, which is contained, is mounted in a cast-iron case, as shown in F and 2. The terminals of the electrolytic apparatus are manently connected to two other main terminals, whic mounted on a porcelain or ebonite block at the base of meter. The cast-iron case is fitted with a large hinged



Closed. Open.

FIG. 2.

and a terminal door, which are provided with the nece sealing arrangements. In the large door a slot is arranged which glass is fitted, and through which the scale may be The scale which is placed on each side of the tube is ma enamelled sheet metal or other suitable metal. It can be adj up or down to the extent of $\frac{3}{8}$in. by means of an adjustin and thread at the lower end for the purpose of obtainin accurate zero every time the tube is refilled with the electr thus avoiding the otherwise necessity of extreme care in th

and the use of a syringe if filled slightly too high. ıg apparatus (as shown in Fig. 3) consists of a long ich is provided with a cock in the stem, so that the he electrolyte may be instantly stopped when it rises on the scale. As, however, in the action of the meter is decomposed, thereby leaving the specific gravity trolyte much greater at the bottom of the scale than tube is full, it is clear that in periodically filling the r only need be used. The entire meter is fixed on on a meter bracket in the usual way.

Cost.—It will easily be seen from the foregoing the meter is inexpensive in construction, the chief the platinum and the glass tube. I may state at he meter can be supplied at 50s. up to 10 amperes This fact should be reassuring to Mr. Evershed, arks on this point at the Municipal Electrical Associa- ıg I quoted in the previous part of this paper, and less at the time accurately represented the opinions ectrical engineers.

III.—Tests.

on.—In commencing the test of a meter with new through which no current has been previously passed action occurs. The liquid first of all becomes slightly for the first three or four minutes the voltage across als rises about one-fifth of a volt, and then gradually to the normal in from 36 to 60 minutes. This does ubsequently with the same electrolyte. The zero of should be obtained after the electrolyte has been he meter for a few hours in an average temperature.

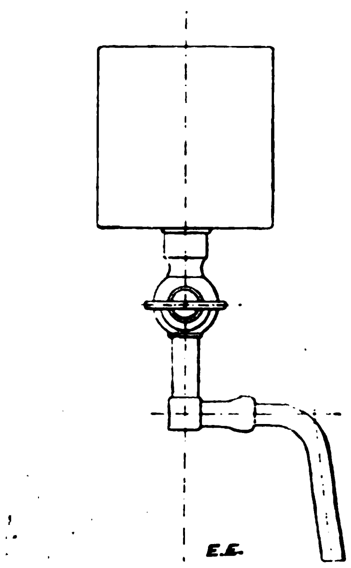


Fig. 3.

the entire scale is made adjustable to zero without calibration, readings must be taken only after the allowed for fully an hour, for the following reason: the meter throughout its range of capacity, the expands, and consequently rises in the tube to an responding to the size of meter, being about 2mm. capacity. Hence, if a reading is taken with an error is introduced, but the electrolyte correct level in about an hour after current has off. On a range of 250 units at 200 volts cali- error would be 0·5 per cent. on the calibration. ration of this meter which is necessary is at the its capacity, and this may be effected in the usual connecting up a number in series. The calibration and to half the range of the meter, and the scales are ed off mathematically accurate for each meter respec- he scales are thus not interchangeable.

y.—Tests have been taken throughout the ranges of ters, at varying loads, at the respective temperatures F. and 100deg. F. The greatest variation from uracy which occurred was about 2 per cent. between temperatures, after allowing the liquid to settle to its nperature before and after readings were taken.

ture.—The temperature of the electrolyte rises with e of current from minimum load to its range limit. own as a curve in Fig. 4. As the conductivity of reases with the rise of temperature, this point is an in contradistinction to its usual effect in other types

ing and Excess Current.—This is one of the most es of trouble with meters of the ampere-hour type. ed to excess currents, with which we may include short-circuit which blows a main or subsidiary fuse, upon ampere-hour meters which employ permanent magnets is of such a nature as to render them quite unreliable, and their recalibration a matter of necessity. In one type the effect of overloading leaves the meter permanently high in calibration; while in another type the effect is the very reverse

Rise in Temperature in relation to Current.

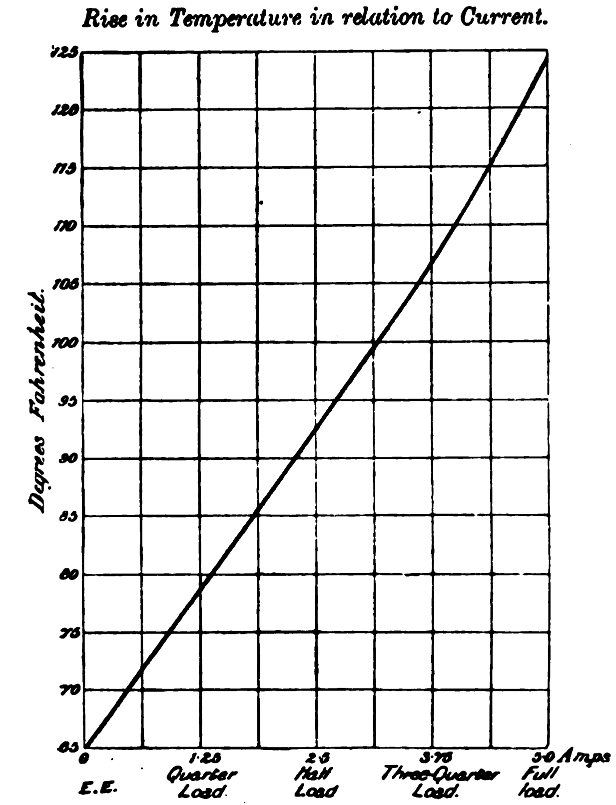


Fig. 4.

of this. These inaccuracies are quite unable to be discovered readily, and are frequently not discovered at all until the consumer complains of an abnormal increase upon his usual consumption. The error will, of course, vary in extent, but I

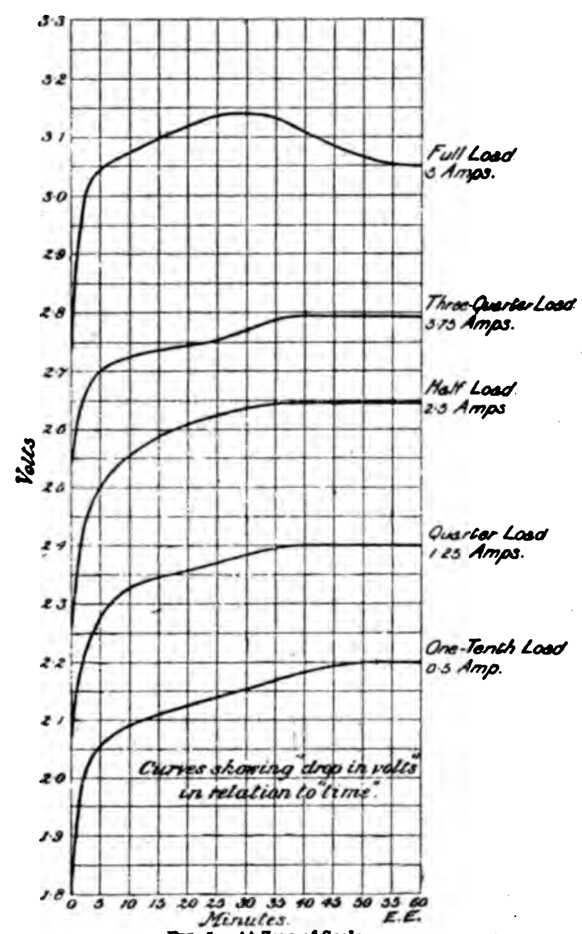


Fig. 5.—At Zero of Scale.

have found several to be from 17 to 25 per cent. During the year 1897 the Bradford Corporation have removed 28 meters which were found to be out of order from the above causes.

Watt Loss.—Referring again to meters of the motor or pendulum types, we find that the watt loss ranges from two to twelve watts. In this respect they show a slight advantage over the electrolytic meter, in which, at all loads, over two volts are lost through the action of the meter. Against this one defect, however, must be set several compensating advantages, such as greater accuracy at light loads and no shunt-coil losses, which in some cases is a never-ending loss. The curves of fall of potential across meter terminals have been taken when the electrolyte has been at zero on the scale and at end of range, showing that the meter has a maximum loss at the zero end of the scale (see Figs. 5 and 6).

Summary.

I have just described in the foregoing tests the range of accuracy of the meter as far as the registration, efficiency, and general reliability are concerned. You will have seen, however, that the results which have been obtained are not only satisfactory in themselves, but that they also have a most important bearing upon the whole question of meter troubles, and that in this respect these results cannot be too highly appreciated. I shall proceed to consider them in detail in the light of the influence which they have on the costs of the meter department, and will briefly deal with these under three heads—viz.: (1) calibration, (2) periodical inspection, (3) repairs and maintenance.

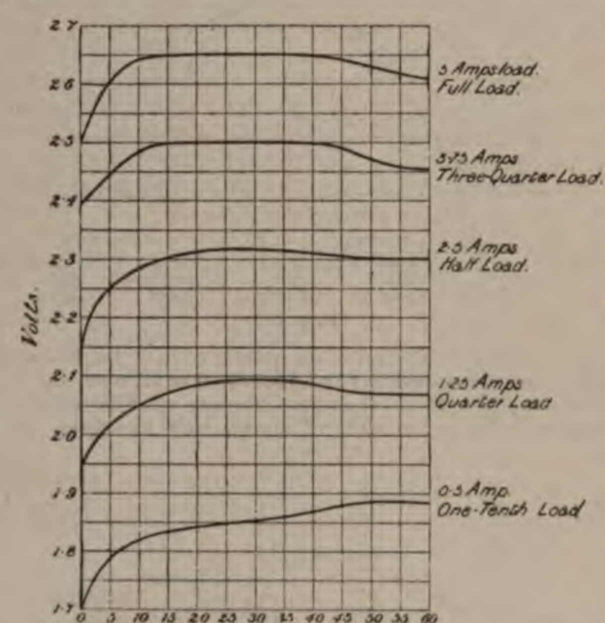


FIG. 6.—At End of Range

Calibration.—By calibration I mean the actual first test to which a meter is subjected as it is received from the maker's hands, and by means of which its accuracy of registration is ascertained. The mean percentage error which I believe is usually allowed is 3 per cent., and those which do not come within that limit are rejected. Also, with most of the existing types, calibrations have to be made at one-tenth, one-quarter, one-half, and full load. The question, then, becomes, How much does a meter actually cost before it is ready for the consumer? Meters which are returned to the makers after a first test involve a second, and frequently a third test, so enormously adding to the cost. I give herewith a list of meters ordered by the Bradford Corporation in 1897, with the percentage rejected.

1897. Months.	Meters tested.		Meters sent back to makers.		Meters accepted.		Percentage rejected.	
	W.	A.H.	W.	A.H.	W.	A.H.	W.	A.H.
Jan.	—	31	—	10	—	21	—	32·3
Feb.	12	6	4	2	8	4	33·3	33·3
March	—	38	—	13	—	25	—	34·2
April	—	34	—	14	—	20	—	41·2
May	18	20	—	8	18	12	—	40·0
June	—	24	—	13	—	11	—	54·2
July	—	44	—	25	—	19	—	56·8
Aug.	—	42	—	25	—	17	—	59·5
Sept.	5	68	—	44	5	24	—	64·7
Oct.	—	60	—	20	—	40	—	33·3
Nov.	—	58	—	27	—	31	—	46·6
Dec.	—	36	—	18	—	18	—	50·0
Total	35	461	4	219	31	242	11·4	47·5

W. Watt. A.H. Ampere-hour.

Invoice cost of above accepted meters.................. £1,
Cost of testing all meters ....

Total cost of meters.. £1,

Hence average cost of accepted meters, £5. 3s. 5d. we compare this figure with the cost of making one c of scale at full load only, and add to that the cost of trolytic meter—viz., £2. 10s.—a more accurate a comparison will be made with present methods and m

Periodical Inspection.—The argument which I forward above is equally applicable to the cost of inspection, though in a slightly different sense. In towns the meters are usually inspected once a mo where any pretence whatever is made to really try t for starting current and to keep up their efficiency, absorbs the constant services of a certain number inspectors. But it is evident that inspection once months, instead of once a month, would entail only of the cost; and it must further be borne in mind tha for starting current are necessary, and that the ope refilling with water is a matter which takes but a few

Repairs and Maintenance.—In the course of inspection throughout the year many meters are fou defective, and these have to be removed and others sub Here again the cost of retesting and recalibration is as well as the cost of carriage to and from the work maker. The actual cost depends, of course, upon the of the meters in circuit, but the average cost forms n siderable item in the cost of the department. In thi also the electrolytic meter compares most favourably when repairs are necessary—such, for instance, as the ment of a broken tube—it can readily be accomplished and without even removing the meter case from the wa

Discussion.

Before the discussion on Mr. Gibbings's paper took **President** announced that the conversazione would be June 16 at the Natural History Museum.

Mr. Evershed said he was in rather a peculiar positi could not very well praise Mr. Gibbings's meter whe interested in one of his own. The question was, had Mr. made what was wanted, and, if so, how long was it goin Some years ago he had tried putting oil on top of the a accumulators to stop spraying, but not with any very goo The most serious difficulty was the drop in volts thr action of the meter. Instead of getting 200 volts, only was obtained. Though not perhaps so great a disadv lamps, it might be serious in other cases. The absence of m was certainly an advantage in its favour. One of the making a meter cheap was that it could not be made He had from curiosity tested his own meter, and fo one-five-thousandth of the power was spent in turning th all the rest went in heating the conductors. Electric me never so good as gasmeters, and not nearly so cheap. G also might be taken straight away from the manufactory in the house. This was very seldom the case with electri only about one in twenty behaving properly and not req be sent back to the workshop again. There was not a s of meter now to his knowledge in which less than five used. He should like to know how Mr. Gibbings's in would stand a railway journey. A gasmeter which wa 1872 had been taken to pieces by him, and he had f various parts to be as good now as when first put in.

Mr. J. Swinburne said that such inventions as Mr. G were not inventions, but merely improvements on someb ideas. He thought that any fool could make an inventi required a clever man to perfect it, and a perfect genius

Mr. H. Hirst said he classed himself as a genius, as took the selling of the meters. One reason why gasme cheaper than electric meters was because the Board required much more from electricians than from the gas

The **President** said he had to congratulate Mr. Gib having brought forward such a useful machine, and he had a brilliant future before it. He saw no reason why t with proper care and attention, should not work very 20-ampere circuit was outside the limit, but it should do g with about five amperes. The lowering of the volta serious item, especially when it had to compete with so meters which did not cause a drop. He would like to experience Mr. Gibbings had had with this meter. meter had been in use some time did the cathode show disintegration?

Mr. Gibbings, in reply, said he had only had six experience with the meter. The cathode did not seem to upon. With regard to putting oil on accumulators, it w different thing owing to the much greater surface of a cells. The meter might not stand a railway journey some others. The 40 volts 5 amperes mentioned by Mr. about the usual current used, and the meters worked very this quantity.

The Metropolitan Electric Supply Company, Limite company held its annual general meeting yesterday wi doors. No reporters were admitted, but we shall not be to see full reports in spite of this.

[MERCIAL METHODS OF UTILISING BLAST-ACE GASES FOR POWER PRODUCTION, THEIR POSSIBLE EFFECTS ON THE PIG-INDUSTRY.*

BY B. H. THWAITE, A.M.I.C.E.

(Concluded from page 596.)

:tual cost of electrical energy per Board of Trade :he electric light and power central stations in the ;raphical centres of ironmaking in Great Britain, as l from official statistics, and comprising the coal, waste, water and stores, the wages of workmen, airs and maintenance, are as under :

	Present cost for B.T.U. at electrical stations.
nd and Staffordshire district	1·86d.
Wales	1·24d.
shire, North and South	1·43d.
-East Coast	2·00d.
nd	1·32d.

be possible in most cases to supply these stations rgy at a very considerable reduction on the prices If we assume a profit value of 0·50d. for each Trade unit, then the sale value of this factor on a ll output would be equal to £1. 17s. 6d. per ton of produced per annum. The table subjoined shows of the power reckoned in 5, 10, and 24 hours' blast furnace of 100 tons weekly output.

Annual Profit Value of Blast-Furnace Power.

hours per diem at 0·75d. per B.T.U. =	£3,046 17 6
0 hours per diem at 0·6d. per B.T.U. =	4,875 0 0
4 hours per diem at 0·5d. per B.T.U. =	9,750 0 0

assuming that the whole of the effluent gases were producing motive power. But as the ordinary furnace process, with all the Thwaite-Gardner nents employed, would involve the absorption of ls of the gas energy in providing and heating the l to satisfy the internal power requirements of the the remaining one-third being available for external , so the above figures divided by three would be ible output value for blast-furnace power. The oportion of the sale value will, of course, depend distance that the power has to be transmitted, e maximum distance of transmission—or 30 miles ironworks—there would be still left a satisfactory n of profit after full allowance is made to cover sion costs. The establishment of a plant, to com- two objects of providing the highest quality of and cheap motive power, can be shown to be a and economic move wherever there is an adequate for power. The author has designed such a plant ench district, and careful calculations show that bility of effecting handsome profit returns is well

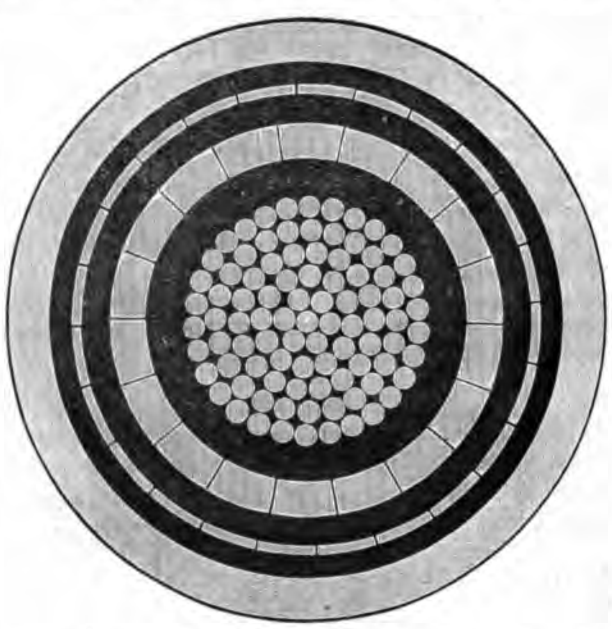
ernative method of utilising the available power ply it for the purpose of obtaining an increased pressure. The economic advantages of increased pressures have been adequately demonstrated by st American practice — unfortunately, in the of blast furnaces it would be impossible with our steam-boiler plants to increase the present range ures, but the new system, in one of its patented ons, permits the existing blowing engines to t a higher speed with very little alteration, so only is a startling economy possible, but this is nied with an increased iron output by reason of er air-blast pressures. The existing boilers are afe under pressures exceeding 30lb.—this means last engines, in all probability no greater average ressure than 25lb.—whereas the average pressure piston by the new system will not be less than nearly three times the average pressure in existing steam practice. The regularity of in the new system is remarkable, and the fact piston speed of the gas-engine runs four times than that of the ordinary steam-engine is some explanation of this fact. The author's method of applying the new system to the driving of existing blowing engines is simplicity itself; and very little alteration is necessary; so that from this standpoint of increased blast pressure and consequent increased iron output, the new system is worthy of the serious consideration of the iron-master. Where a steelworks is associated with iron blast furnaces the charity of economic saving should begin at home, and the application of the system of electric driving would immediately secure a great reduction in cost of fuel per ton of steel output. Taking the production of a ton of steel rails to involve the expenditure of 8cwt. of fuel, and allowing for the absorption of thermo-dynamic energy in transformation and transmission of power, this fuel consumption might be reduced to at least one-half.

One great advantage of the new system is the fact that ironworks, and especially in this country, are generally situated in the centre of industrial areas, and therefore are in the best positions for the economic as well as the profitable disposal of power. It will be seen that the new system enlarges the profit-making scope of the blast furnace, and curiously, in this respect, it provides a barrier for the defence of the small furnace owner against the otherwise irresistible competition that the enormous output capacity of the modern blast furnace provides, this progress meaning the wiping out of the profit-making margin of the smaller but well-distributed furnaces, and in this respect the new system commands the appreciative consideration of the iron-master. Pioneer work is ever difficult, and in the development of the new system, which has included the removal of difficulties always set up by the conservatism of well-established practice, the development work has been no exception to the general rule, and it remains for the British ironmaster to recompense this British and original pioneer work by the serious consideration of the system as applied to his furnaces. The result, the author believes, would ultimately prove advantageous both to the individual, the country, and the State.

* read before the conference of British Iron Trade Associa- 5, 1898.

A LARGE CABLE.

The British Insulated Wire Company have kindly sent us the following details of a cable recently supplied by them to the



Glasgow Corporation. The cross-section of this triple cable is represented exactly full size in the illustration. This cable has a sectional area on each of the inner conductors of one square inch, the neutral or outer conductor having an area of ·3 square inch. The net weight of the cable, exclusive of drums, is 45 tons per mile, and we believe this to be the largest insulated cable that has yet been built. The whole of it was tested at a pressure of 2,500 volts for 15 minutes before leaving the factory, and a sample of the cable was, in Mr. Chamen's presence, bent six times in opposite directions round a 3ft. barrel, and the insulation afterwards withstood successfully a pressure of 30,000 volts alternating for 10 minutes.

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TO CORRESPONDENTS.

 Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

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WILDE.

It is a pity that we have nothing in E
analogous to the eulogies published by the S
sonian Institution, or which emanate fro
Academy in Paris. Few of the existing n
electrical engineers know the part played by
of a preceding era in the development of ele
matters. We absolutely traverse Mr. Swinb
dictum, "that any fool can make an inventio
that it takes a clever man to perfect it, and a p
genius to sell it." Our view of the case i
any fool can sell anything that goes by the
of an electrical invention, and that mone
been and is readily forthcoming at the comm
hundreds of plausible men who claim to be inve
and perhaps who have invented by a proc
copying. There are inventors who never inv
their own initiative, who couldn't if they trie
upon their attention being turned into any dir
by a real inventor, manage in some hocus-pocu
to get a patent and take money from a cre
public. There are men now living whose
are household words as inventors, but whos
inventions are of little account. Faraday inv
but he left commercial men to make the h
He was content with putting others on the
instead of travelling further along it himsel
doubt many of the men who have traversed th
opened up by Faraday have been wise men, and
wise men have left mark-stones at the foot of
new gradient in the road. Wilde, among o
made a definite step in advance, hence the h
paid him by the Institution in electing h
honorary member. For the past twenty yea
have been engaged in calling attention
gradual extinction of all the men who were earl
minent workers in the development of applie
tricity. We have suggested that those men
are still living should be urged by some soc
influence and authority to write memoirs,
would thus be authentic, and probably lead
definite solution of many little points whic
and which will be obscure. Consider the im
labours of Mr. Fahie in trying to make
certain credits to telegraphic improvement.
people, however, are still doubtful as to the v
of Mr. Fahie's contention. Then there are
unsettled credits in every branch of applied
tricity. It is certain that in a number of ins
credit must be given to two or more perso
improvements or discoveries which were made
pendently. There are cases, too, as certain in
independence is claimed, but in which, i
truth was known, it would be found tha
telegraph and the "root of all evil" shin
spicuous in such so-called independence. I
are somewhat wandering from our subject, wh
to again suggest the making much of the old-
still among us, the ascertaining from the
definite facts and dates, so that credit can be g
history where credit is due. The Institution ha
ferred honorary membership in two or three
upon such men, but there are still a few others
it might with advantage and honour to itself i
within the bounds of its membership. Scie

cosmopolitan, and the honour roll might well include the names of men from other lands. It is too much the fashion to be fashionable, and to neglect anything that for the moment loses prominence. Our scientific institutions are not fashionable assemblies, nor are they mutual admiration societies, though it is difficult at times to see that they have other aims. A cynical man it was who said that "you should believe very little of what you heard, and not half of what you saw," but he said it because of the substratum of truth underlying his remark. Again, Froude and other historians have argued from the doctrine of probabilities against the certainty of any so-called historical fact being correct. It seems to us that one of the aims of a scientific society should be to help to make accurate history. How this is to be done is a matter of detail, and may be attempting the impossible, but we are sure the recollections of pioneers would be valuable to future scientific men as well as to their colleagues.

SELECT COMMITTEE ON ELECTRICAL ENERGY.

Generating Stations and Supply.

(Continued from page 584.)

Sir Samuel Johnson, town clerk of Nottingham, gave its area as 17 square miles, population at 230,000, and ratable value £900,000. They owned the gasworks, tramways, and electric light station. The latter was started that they might keep authority over the streets. The gas, water, and electric undertakings have been profitable. In order not to have the streets disturbed they have constructed subways at a cost of £60,000, and had a strong feeling about the breaking-up of the streets, that should not be in the hands of any dividend-seeking company, and that the authority should have an absolute veto. They also anticipated damage to gas and water pipes from electrolytic action, for which the protection in the Board of Trade order does not extend far enough. They agreed with the Manchester evidence. There should be a certain area where notices should be served of an intention to apply for a provisional order or an Act of Parliament, and then there should be an exemption from liability for nuisance where the works are carried on with due care, but where the land is acquired by voluntary agreement they thought there should be a difference, because the neighbours in that case have no opportunity of being heard, and then the present practice of the Board of Trade should prevail—namely, that persons should not be exempted from nuisances.

Mr. George Franklin, Lord Mayor of Sheffield, stated that the authority had taken over the electric lighting, and they were opposing the General Power Distributing Company, and objected to any interference in the streets.

Dr. John Hopkinson thought that, under certain conditions, authorities and companies should have compulsory powers to purchase lands, and that a company should have power to break up streets with the consent of the local authority or by reference to the Board of Trade. The reason why the charge for power is usually less than the charge for light simply arises from this, that as a rule the people who use a supply of current for power, use it for a very much longer time than those who use it for light. A large part of the cost for effecting a supply whether for power or light consists of dead charges; it consists of interest on capital, sinking fund, office expenses, expenses and management, and it even goes further, the cost of coal that is required for keeping up steam to effect a supply if it is wanted. The result of that is, that a considerable part of the cost is the same whether a supply is given for the whole of the 24 hours or for only a single hour. Consequently, if you are supplying for the whole 24 hours, the actual cost of effecting that supply will be enormously less than if that supply is being effected for a single hour. Tramways use power on a large scale, and could easily be supplied at 1d per unit or ¾d. per horse-power. The witness did not agree with Mr. Swinburne or Mr. Harris that Great Britain was behindhand. He thought the installation at Niagara had in it the elements of success, but had had to pay heavily for its experience. In a case like London, if he had to start again, he should put probably two or three stations outside London, and have none of the trouble with litigation which there has been as to annoyance.

Mr. Alfred H. Gibbings thought compulsory powers should be given to authorities and companies for the purchase of land, but that companies should first obtain the consent of the authority, and that streets should not be broken up without the consent of the authority.

Mr. William Ashcombe Chamen agreed with the memorandum put in by Manchester.

Sir Alexander Richardson Binnie, Mr. John Williams Benn, and **Earl Russell** practically agreed with the evidence previously given on behalf of authorities.

Mr. William Henry Preece had to approve of schemes submitted to Parliament so far as they affected the interests of the Postmaster-General. Perhaps it will be as well to give some of the questions to and answers of this witness more at length, as they embody the views of the Department.

1977. Power-houses are required for generating electrical energy to supply certain matters, are they not?—Yes. I want, my Lord, to call the attention of the committee to the fact that electrical energy for which generating stations are acquired are used for several other purposes beyond those that have been brought before the committee up to the present moment. We have principally dealt with the supply of electrical energy for electric light purposes and for power purposes, but there are other purposes for which these generating stations are acquired that are growing at a considerable rate, the working of tramways, the supply of current to batteries for cabs in London, and for vans and also generally for traction purposes. Then, again, there is a very important field which has been opened, and that is the working of existing railways by electricity. The Metropolitan District Railway have obtained a Bill and the Metropolitan Railway have passed one House, and I think they are before the other House for a Bill to enable them to work their railway by electricity. Again, in addition to all these in the future—and we must look to the future—electrical energy will be used very largely for electrolytic purposes for chemical manufacture and also for the production of heat for certain operations like electric welding or things of that kind where you require the sudden application of an intense heat. A large flow of electric current may come in and be very handy indeed. I think all these points show that the construction of these central stations and their disposition is an extremely important question that requires legislation in the future.

1978. Then do you think that the erection of power-houses and the distribution of electrical currents for these purposes are to be watched with very great care?—Yes, we have been obliged now for many years to watch the progress of this new industry, for these electric currents are apt, unless under very strong control, to create electrical disturbances which injuriously affect telegraphs. It was in the first place their influence on telephones that attracted our attention to the matter, but I do not pay very much heed to telephones, because in the present day the telephones are quite competent to take care of themselves, and your Lordship will remember at the committee over which you presided dealing with this question before I pointed out that the only reason why telephones suffered at all was because at that time the telephone was an imperfect apparatus. The Telephone Company only used one wire and they employed the earth; by that means they admitted into their circuits all these disturbing elements. But now they have learnt wisdom and are following the example of the Post Office. Now the practice is invariably to make a circuit, a metallic circuit, free from the earth and free from all disturbance. But with telegraphs it is quite

a different thing; we must use the earth. A question was asked me whether it would not be possible to use the same system of metallic circuit for telegraphs, but this is quite impracticable and quite impossible in the present day, for the whole of the roads of this country are covered with wires, and to duplicate those wires would make the whole question impossible, besides adding an unnecessary and frightful expense to the maintenance of the system. The next point is where these disturbances have created annoyance in our observatories, at Greenwich and at Liverpool. At Greenwich, in particular, the disturbances arising from the City and South London Railway have stopped entirely certain very valuable observations made at Greenwich, and they have rendered very difficult the magnetic observations for which that observatory is so celebrated. Then, again, it may be, and it has happened in America, particularly at colleges and other places, experimental laboratories have been seriously affected, but that does not at present come before us here. I could, if necessary, give the illustrations.

1979. Can all these disturbances be remedied under control ?—Yes.

1980. Are you satisfied with the clause which the last Joint Committee put in ?—Yes, and it has been carried out in all subsequent Acts. We are quite satisfied with its working, and the only case where we suffer at all is in the case of the City and South London Railway, and the Liverpool Railway, which were exempt from that clause, because they were constructed prior to the meeting of your committee.

1981. Do you think that that clause ought to be introduced in all Bills ?—Yes, certainly.

1982. Would that clause protect all that is necessary as to water and gas pipes ?—Yes, to a certain extent. There is one very serious difficulty that has not up to the present moment been entirely removed, and that is in the working of the tramways by the trolley wires, as they are called. There are those loose currents running about wildly, affecting water-pipes and gas-pipes, and they have in three or four instances affected very seriously the lead-covered cables, which we are using so much in England now for telegraphic and telephonic purposes. But still the remedy has not been applied yet. There is no doubt whatever, when a stringent clause appointing proper control, with the inspection of the Board of Trade, and the attention which has been given to it by their expert is inserted. I think we may say that those disturbances will ultimately be removed also.

Sir Courtenay Boyle, recalled, among other views, suggested that as the increase of term from 21 to 42 years aided the progress of electric lighting, further stimulus would be obtained by lengthening the term from 42 to 60 years.

(To be continued.)

FORTHCOMING EVENTS.

SATURDAY, MAY 21.

Institution of Electrical Engineers.—At 11 a.m., students' visit to the works of the Electric Welding Company.

MONDAY, MAY 23.

Society of Arts.—At 8 p.m., last of a series of four Cantor lectures on "The Electric Locomotive," by Prof. Carus Wilson.

TUESDAY, MAY 24.

Self-Propelled Traffic Association. — The four-day trials of Motor Vehicles for Heavy Traffic begin at Liverpool.

THURSDAY, MAY 26.

Institution of Electrical Engineers.—At the Society of Arts, at 8 p.m., "The Design of Electric Railway Motors for Rapid Acceleration," by Prof. Charles A. Carus-Wilson.

Royal Institution, Albemarle-street.—At 3 p.m., the Right Hon. Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S., on "Heat." Last lecture.

Self-Propelled Traffic Association.—Dinner at the Adelphi Hotel, Liverpool.

FRIDAY, MAY 27.

Physical Society.—At the Chemical Society's rooms, at Burlington House, at 5 p.m., "A Simple Interference Method of Reducing Prismatic Spectra," by Mr. Edser and Mr. Butler. "Some Further Experiments on the Circulation of the Residual Gaseous Matter in Crookes Tubes," by Mr. Campbell Swinton.

CITY AND GUILDS OF LONDON INSTITUTE.

ELECTRIC LIGHTING AND POWER TRANSMISSION.

ORDINARY GRADE.

The following are the questions set by the Examinations Department of the City and Guilds of London Institute, 1898 :

1. Describe, with sketches, two well-known types of secondary cells, one suitable for central-station work and one for traction, and point out in what respects they differ. (20 marks.)

2. With several direct-current dynamos running in parallel, how would you determine if one was running as a motor ? (10.)

3. Distinguish between indicated horse-power, brake horse-power, effective horse-power, nominal horse-power, and electrical horse-power. An engine coupled direct to a dynamo is indicating 100 h.p. What would you expect the values of the other quantities to be ? How many amperes would you expect to get at 100 volts ? (15.)

4. Describe a simple form of brake suitable for testing the power given out by a motor up to, say, 10 h.p., and give sketches showing the principal dimensions. (20.)

5. A building of four floors has 100 8-c.p. lamps on each floor; the height of each floor is 18ft., and the mains run straight up in the middle of the building. On each floor is a passage extending 100ft. each way from the middle, and in the passage on each side of the middle are five lamps. Opening out of the passage, on each floor, there are 20 rooms to the front and 20 rooms to the back, each room containing two lamps. Calculate the size of the mains going from the bottom to the top of the building, of the sub-mains in the passages, and of the lamp leads, on the supposition that when all the lamps are turned on the drop in pressure from the basement to the farthest lamp does not exceed two volts, and that the pressure supplied is 100 volts. (25.)

6. Give the particulars of a resistance frame of two ohms to carry 10 amperes, with sketches of the principal dimensions. (15.)

7. A compound-wound dynamo when running at 1,200 revolutions maintains a potential difference of 100 volts when the current produced is 50 amperes. If you desired to run it as motor, would you alter the machine in any way ? What speed would it run at if joined up to 100 volts constant-pressure mains, and what horse-power would it give out ? (12.)

8. A dynamo sparks badly at a particular point of the commutator. What is its probable cause, and how could you remove it ? (10.)

9. One coil of a drum armature gets very hot when the machine is running unloaded. What is the cause, and what is the cure ? (10.)

10. Calculate the resistance of a Gramme armature wound with 144 turns of rectangular wire 0·2in. × 0·21in., length of armature core without insulation 12in., radial depth 2·5in. The resistance of 100 yards of copper rod, one square inch in cross-section, is 0 0025 ohm. How would you measure the resistance of such an armature ? (20.)

11. Calculate the size, resistance, and weight of copper wire such that, if wound on a magnet core 7in. by 3½in., and having a potential difference of 25 volts maintained between the terminals, 5,000 ampere-turns will be produced. Length inside former is 8in. (15.)

12. What difficulties are likely to occur in charging batteries with a compound-wound machine, and what precautions would you take to avoid them ? (12.)

13. Sketch some form of multipolar field magnet which is excited by a single coil. (12.)

14. Describe, with sketches, some form of moving-coil voltmeter. What are the advantages of this type ? (10.)

15. You are required to charge 50 accumulators in series from 100 volts constant-pressure mains. Describe and sketch the kind of apparatus you would employ to do this. (12.)

16. Give sketches of a "controller" on an electric tramcar, and explain exactly how it acts. (28.)

17. Describe the best safety devices for protecting the

62·5 kw. at 250 volts. These different machines are utilised in charging accumulators. The works also include two batteries of accumulators, consisting of 250 of the cells of the Société des Métaux, yielding 2,100 ampere-hours, and one battery of 260 Tudor elements, yielding 3,000 ampere-hours. The distribution is wholly effected by lead-covered and armoured cables, placed directly in the earth in a layer of fine sand. The junctions of the cables, the tee-joints, and the connections for subscribers are all made in special boxes, hermetically closed, and on a level with the pavement. Some interesting trials have been made at the Clichy sector in the burning of anthracite for the purpose of avoiding smoke. These trials have been made comparatively with Saint-Charles of Charleroi coal burned in smoke-consuming Langer furnaces. The anthracite was burned on Richards firebars. The following gives respectively the consumption per kilowatt-hour :

St. Charles Coal.	Anthracite.
5·5lb.	5·1lb.
6·1lb.	5·5lb.
5·8lb.	4·65lb.

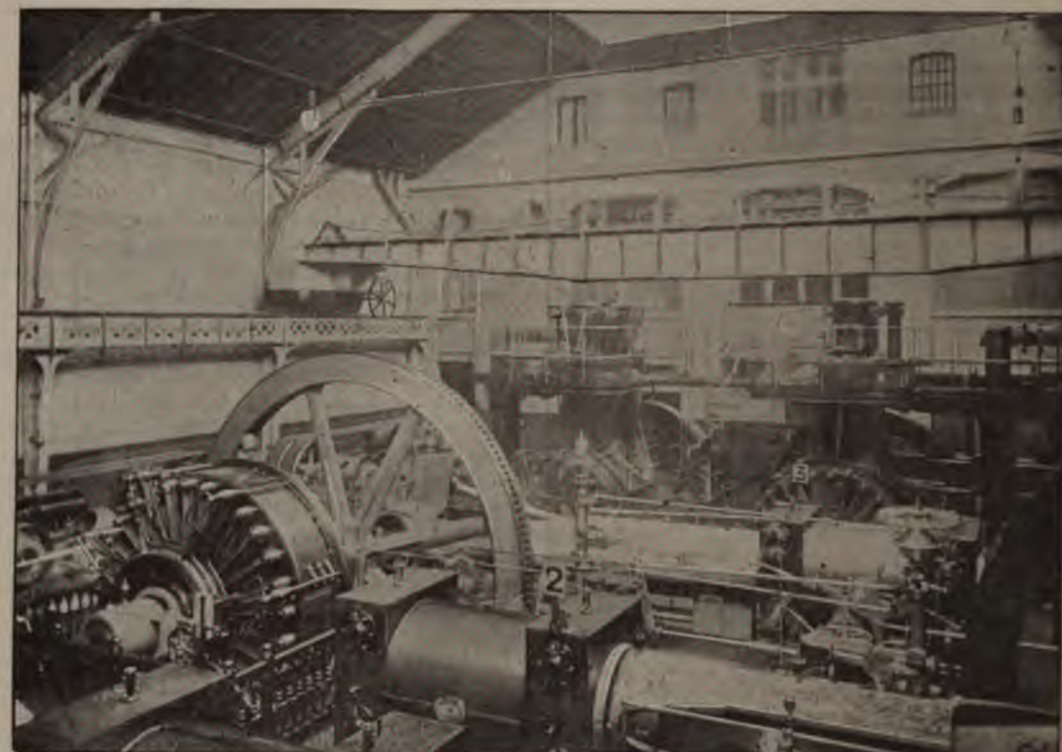


FIG. 7.—Electricity Works, Secteur de Clichy.

Special trials of St.-Charles coal on Richards firebars gave a consumption of 5·8 and 5·9 kilos per kilowatt-hour. Taking anthracite at 27s. 3d. per ton, and St.-Charles coal at 22s. 6d., the mean cost respectively would be 0·748d. and 0·71d. per kilowatt-hour. By the use of anthracite, absolute smoke consumption is assured. On July 30, 1897, the number of subscribers supplied was 2,864, taking the equivalent of 152,846 lamps of 10 candles, of which 136,471 were for lighting, 14,622 for motive power, 603

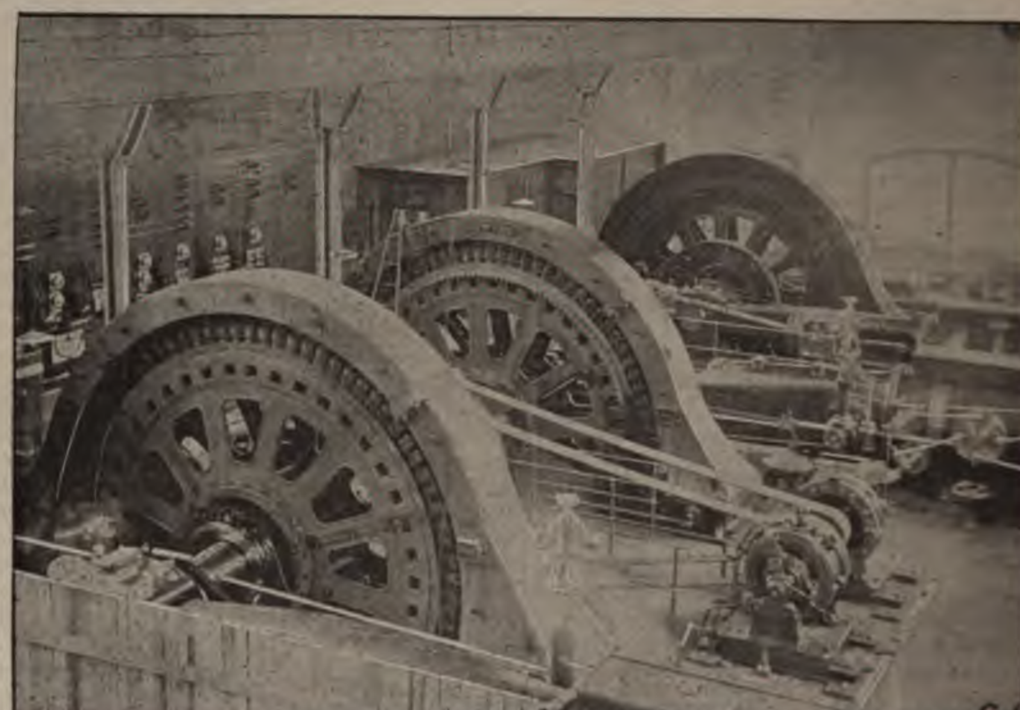
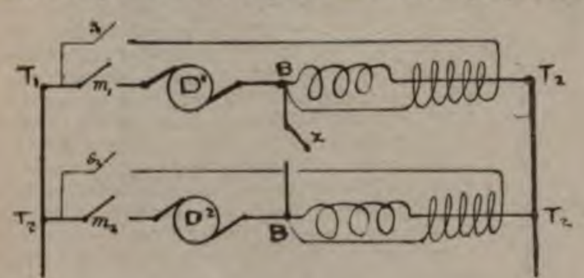


FIG. 8.—Secteur des Champs Elysees (Old Alternators).

becomes a motor working in the external circuit of the former. To get over the difficulty, a method (described by Prof. Silvanus P. Thompson in his book on "Dynamo-Electric Machinery") has been suggested by Mr. Mordey. It consists in connecting the shunt windings of the machines in parallel, and the series windings as a shunt on one another by connecting the brushes, B B, of the two machines; then, if the engine of one lags and the E.M.F. of the dynamo begin to drop slightly, current will flow between the brushes, B B, and lighten the load of the lagging engine and throw more on the other, so that one tends to race and the other to slow down; in this way the two machines will exercise a mutual adjustment. The connection between the brushes must be of the same section as the mains, and provided with a switch, Z; switches should also be fixed in the shunt winding circuits, as at s^1, s^2, and in the main circuit between the armature and the connecting point of the shunt winding, as at m^1, m^2. In switching in a machine the following would be the order. Suppose that D^1 is already running on the load, and it is required to throw D^2 into circuit, then D^2 is run up to speed, the shunt switch, s^2 closed, then Z. The machine is now fully excited, and main circuit switch, m^2, is closed; in switching out, this order is reversed. A combination switch could be constructed to perform these operations in their proper order.



When large and small machines are connected in this manner, as would have to be the case in central stations, they must be so constructed that the respective resistances of the series coils are inversely proportional to the full current to be generated by each dynamo, so that with variations in the resistance of the external circuit the fall of potential in all the series coils may be the same. Very few stations can obtain this similarity in their machines, especially when the time comes for extensions to the plant and the extra switching gear and complications to the switchboard connections are undesirable. But even though some such method as the above can be employed to give perfect paralleling of compound-wound machines, there are stronger reasons in favour of the use of shunt machines. Constant voltage is not required at the station, but at the consumer's premises, and the volts must rise and fall with the load to balance the drop in the feeders. For instance, with a 110-volt supply during the times of light load the voltage at the omnibus bars is about 112 volts, while in the evening, at the time of maximum load, when the feeders are nearly fully loaded, it must be increased to 116 or 117 volts; and the machines must be capable of giving these extra volts whatever their load, so that as many of them as possible can be fully loaded instead of the load being evenly distributed, as would be the case with compound-wound machines, and the engines running at half or three-quarter full load, with a consequently increased consumption of steam. This has a marked effect on the economy of the station, especially when machines of different sizes are installed, as it enables the large units to be fully loaded during nearly the whole of the time of their run, and only the small units need be run light. Hence it has become general to employ shunt-wound machines excited from the omnibus bars, so that their excitation, and consequently their voltage, depends directly on the voltage at the station. Of course, where a battery of accumulators forms part of the plant shunt-wound machines are absolutely necessary.—F. T. H.

Answer to No. 59 (*awarded* 7s. 6d.).—The reasons why compound machines are not used in central stations will be seen from the following: Dynamos in central lighting stations must be capable of running in parallel, and shunt machines are the best machines for parallel running, the shunts being put into circuit exciting the fields, and the armature is run up to speed, and when the voltmeter shows the desired pressure the dynamo is switched into circuit, and perfect parallel running is the result. If a compound-wound machine is used expensive switch-gear must be provided, and great care is required in switching the machines in circuit or a general burn-up is the result. In central stations using direct-current machines, accumulators are generally used as a stand-by in case of a breakdown, and the dynamos are used for charging the accumulators in the daytime during light load; and here again we find that compound-wound dynamos are entirely unsuitable, for with this class of machine the current of the secondary cells may flow into the machine and change the polarity of the magnets. To prevent this, the series windings must be cut out of circuit, and then, if the current from the battery should flow into the machine, the reversed magnetisation of the magnets is avoided. The machine with the series cut out is a shunt machine; and as compound machines are more expensive than shunt machines, it will be obvious that a shunt machine is preferred. The great convenience of compound-wound machines is, in single machines, the series turns can be made to compensate for the drop of pressure in the wires between the dynamo and outside circuit. When, however, compound dynamos are run in parallel, this effect cannot be produced, as the rise in pressure is caused by the individual dynamos, and not the sum. To get over this difficulty requires two series windings on each machine, one to balance the action of the machine itself—that is, the fall in voltage; the other to effect the over-compounding, and thereby balance the drop of pressure in the feeder and distribution system—that is, one winding carries the whole current output of the station, and the other the current generated by the individual machine. This method means complicating the field windings of the machines, and this complication the engineers must guard against, as it means extra first cost and more care in working. It will be seen from the above that compound machines are unsuitable for following reasons: (1) they are not easy to parallel; (2) accumulators cannot be charged unless the compound—that is, the series—is cut out of circuit; (3) they are imperfect regulators when working in parallel; (4) they are more expensive than shunt machines.—F. M. M.

[N.B.—We have divided the amount between these two competitors, as their answers are practically equal, each excelling in a special direction.—ED. *E. E.*]

Question No. 60.—What are the relative advantages and disadvantages of an electric and steam driven feed pump respectively? Give figures.

Best Answer to No. 60 (*awarded* 10s.)—The principal reason which warrants the adoption of electrically-driven feed pumps is their superior efficiency, small steam-driven pumps being generally most inefficient. There are several reasons which account for this, one of the principal being that they do not realise the benefits of expansion, as the full pressure is maintained in the cylinder till the end of the stroke; and, secondly, there are all the losses incidental to small auxiliary engines, such as they cannot utilise the advantages of compounding, and, as a rule, work non-condensing. Probably the average consumption in a small steam pump will be about 100lb. per indicated horse-power per hour.

Steam Pump.

100lb. per indicated horse-power per hour, taking an efficiency of about 70 per cent. = 140lb. of steam per effective horse-power per hour.

Taking 10 per cent. condensation in pipes = 155lb. of water evaporated per effective horse-power per hour, ∴ 155lb. per hour ditto 33,000 foot-pounds of work per minute. Taking a boiler pressure of 140lb. per square inch, this corresponds to a head of 320ft.

∴ 155lb. of water will pump $\frac{33,000}{320} = 103$lb. per minute, or 6,180lb. per hour.

∴ percentage of water used in pump to amount pumped into boiler $= \frac{155}{6,180} = 2{\cdot}5$ per cent.

Electric Pump.

To pump 100lb. of water into boiler per hour requires an expenditure of $100 \times 320 = 32,000$ foot-pounds of work $= 727$ watt-hours.

Taking efficiency of the steam dynamo at 80 per cent. and the motor at 85 per cent. $= 1,070$ watt-hours.

Say engine averages 30lb. of steam per electrical horse-power per hour, 100lb. water = 90lb. will give 3 h.p. $= 135,000$ watt-hours.

$\therefore$ percentage of energy used in pump, etc., to amount pumped $= \frac{1,070}{135,000} = \cdot 9$ per cent., thus showing a saving of about 1 to 2 per cent. of the total steam consumption.

The next principal point in favour of electric pumps is, n the event of none of the boilers being under steam they an still be pumped up; this, of course, only applies in the ase of stations employing accumulators, but as these latter re becoming the rule in most direct-current stations, and ven in some alternating stations, such as Blackburn, this a matter of comparatively little moment. With steam umps of the Worthington pattern, in the smaller sizes iere is sometimes provision made for doing this by hand, ut the process is necessarily both slow and laborious. In ternating-current stations in which the machinery is kept ontinuously running, it would be necessary, unless low-nsion direct current was available from the exciter 'bus ar, to employ alternating-current motors to drive the umps, which seem up to the present to be only compara-vely self-starting or reliable. There certainly are monophase iduction motors to be obtained which are said to fulfil iese conditions; and in one or two instances, notably Vorcester, they are employed for pumping purposes, but the great majority of instances they have not been an nqualified success. Again, the conditions which exist in ost boiler-houses are hardly suitable for a totally unpro-ected motor, so that it is usual to employ the enclosed or emi-enclosed type. With the employment of steam umps it has been found convenient to use their exhaust or heating the feed for a few degrees preparatory o its going into an economiser, if the latter is sed, and thus preventing sweating and corrosion. If lectric pumps are used, then probably live steam will iave to be used for this purpose. As far as maintenance s concerned there will be very little difference between the wo systems, the repacking of glands, cylinder lubrication, tc., being counterbalanced by depreciation of gearing, wear of brushes, commutator, etc. In price the steam pump has a decided advantage, being probably only about 50 to 70 per cent. of the electrically-driven type. The steam pump has a slight advantage in the amount of floor space required, though this in a great measure will depend on the pattern adopted. From the above it will be seen that both types have a number of features to recommend them, and it is only by studying the existing conditions in each individual case that a decision can be arrived at as to which type to adopt.—H. BELL.

Answer to Question No. 60 (awarded 5s.).—It is well known that the usual boiler feed pumps are wasteful. Let us take an example, assuming that the steam required to drive a boiler feed pump is 3 per cent. of the feed water pumped. Suppose we deliver 6,377lb. of water against a boiler pressure of 135lb. Then expenditure in foot-pounds $= (135 \times 2\cdot 3) \times 6,377 = 1,980,058 = 1$ horse-power hour (nearly). The number of pounds of steam to do this $= 3$ per cent. of $6,377 = 191$.

Now, taking the case of an electrically-driven pump, assuming 32lb. of steam per electrical horse-power and efficiency of electromotor pump (including transmission losses, etc.) to be 60 per cent., the number of pounds of steam per indicated horse-power hour $= \frac{32 \times 100}{60} = 53$, or a saving of 191lb. $-$ 53lb. of steam per horse-power hour by adopting an electrically-driven pump.

The first cost of a steam-driven pump is less than one driven electrically, and it also has an advantage in reliability, which is an important factor. The absence of gearing is also another point in its favour. In direct-current stations with accumulators, motor-driven pumps, however, have the great advantage of enabling the boilers to be filled up, say, on a Sunday (and other such times when steam is not required on the steam-pipes), without having to turn on steam; this, however, does not apply to stations where a battery is not installed.—J. F. M.

INSTITUTION OF JUNIOR ENGINEERS.

A numerously attended meeting of this institution was held at the Westminster Palace Hotel on Friday, May 6, when a paper on "Evaporative Condensers, and Independent Air-Pumps for Same" was read by Mr. Harry Fraser, of Millwall, member. The chairman, Mr. H. Bloomfield Vorley, presided.

In introducing the subject, the author alluded to the increasing field which was opening up for the use of the evaporative form of condenser through the establishment of electric central stations for power and illumination purposes. These stations generally being placed in crowded districts so as to be convenient for distributing the current, difficulties in obtaining an adequate water supply usually arose where surface condensers were employed. The evaporative condenser, if properly designed, would do its work with a water supply equal to three-fourths of the weight of steam which it condensed, and descriptions of such condensers producing vacuums up to 26in. were given. In designing the apparatus, it was necessary to bear in mind the boiling points of water at various pressures less than that of the atmosphere, as should the water trickling over the outside of the tubes become too hot when nearing the bottom, the condensed water inside would be re-evaporated and the vacuum destroyed. An arrangement of compound condenser, in which the coldest water was first brought in contact with the coldest part of the condenser, and the hottest water against the hottest part, thereby obtaining the greatest possible exchange of temperature between the inside and outside surfaces, was described, and tabulated figures given showing its advantages. It was of great importance to have all the joints well made, and easily accessible; a very small air leak would seriously affect the working of the apparatus, and the average deposit on the outside of the tubes left by the evaporating water amounting to 25oz. per square foot per annum, provision for cleaning was most essential. Specimens of the author's devices for cleaning the outside of the tubes and distributing the steam through the condenser, were exhibited. No fixed condition as to design could be determined, as the spaces available for the erection of the condensers varied through such wide limits. It had been found that horizontal tubes were more advantageous than vertical, but that the space occupied by a condenser with horizontal tubes was larger than that necessary for the erection of a vertical-tube condenser. The distance between the condenser and steam-engine was of no consequence, provided that due area was allowed in the exhaust pipe and in the air-pump suction pipes. Most of the inventions in connection with evaporative condensers simply dealt with various arrangements for the distribution of the cooling water over the outer surface of the tubes, it being difficult to direct water to flow with an even film over a hot tube. Illustrated descriptions of some of these arrangements were given. It being necessary that the evaporative condenser should have a much larger surface to do a given amount of work than an ordinary surface condenser, the cost of construction per square foot of surface was an important consideration. As indicating the effect of improvements in construction, it was stated that some of the latest-designed apparatus cost about one-half per square foot of surface as compared with earlier ones, without the efficiency of the condenser being impaired. By experiment it had been found that artificial fan-draught improved the efficiency of the apparatus by about 50 per cent., and a fan-draught was recommended when the load varied to any considerable extent, as then the fan need only be run during the heaviest load. With a properly designed condenser the proportions of air-pump used for a surface-condensing apparatus would be found equally satisfactory with an evaporative plant. The idea that it was requisite to have a much larger air-pump for the latter probably arose from some of the earlier condensers having been put up with not sufficient surface to fully deal with the volume of exhaust steam entering them. If the condenser were not large enough, putting in a bigger air-pump would not prove a remedy. Models and designs of the various air-pumps constructed by the Worthington Company, Blake and Knowles Company, Browett and Lindley Company, and others were exhibited, all of them being of the balanced-beam system, which arrangement largely helped to overcome the natural inequality of the turning moment of an independent air-pump. With reference to the increasing popularity of air-pumps having one set of valves only, and that set being above the piston, the author pointed out that while such an arrangement might work satisfactorily with marine-type surface condensers, it was not certain that they would be equally favourable with evaporative condensers, but as his firm were now building two sets on this principle for a 1,500-h.p. plant, he hoped later on to be able to give some more reliable information on this single-valve pump question.

COMPANIES' MEETINGS AND REPORTS.

DISTRICT RAILWAY COMPANY.

A special general meeting of the proprietors of the Metropolitan District Railway Company was held on the 17th inst. at the Westminster Palace Hotel, S.W., Mr. James Staats Forbes presiding, for the purpose of submitting certain Bills now pending in Parliament.

The **Chairman** said, according to the *Financial News*, the first Bill referred to in the notice convening the meeting was entitled "A Bill for conferring further powers upon the Metropolitan Railway Company in relation to their own undertaking, and for the ventilation of their railway, and upon that company and the Metropolitan District Railway Company in relation to the working of their undertakings by electrical power, and upon those companies and the South-Eastern Railway Company with respect to certain lands at Cannon-street; and for other purposes." This Bill contained clauses which affected the District Railway, and it could not pass through Parliament until the proprietors had sanctioned it in respect of those particular clauses. In the early part of last year they passed two or three Bills, which were subsequently submitted to Parliament and approved. One of these gave them power, whenever the time was convenient, and the method sufficiently developed, to apply certain funds of the Company for the purpose of working by electricity the railways of the Inner Circle. The Metropolitan Railway Company was applying for similar power, and, of course, the District Company could not dissociate itself from that company in respect to electrical communication—they were bound to work in harmony. The clauses in the Bill affecting the District Company were Nos. 24 and 38. The former empowered the Metropolitan and District Companies to enter into agreements as to working of traffic by and supply of electrical power, and the latter empowered the South-Eastern Railway Company to grant and the Metropolitan and District Companies to hold a lease of the portion of the forecourt of the Cannon-street Station of the South-Eastern Company, which was occupied by so much of the stations and works of the Metropolitan and District Companies as was above or upon the surface of the forecourt. As the result of much negotiation and the award of an eminent judge, the claims of the South-Eastern Company had been settled, and would take the form of a lease of the land upon which the station stood, in respect of certain financial payments by the two underground companies. Of course the adoption of electricity was a matter they could not go into with absolute indifference as to the question of cost. A good deal, however, was now known about this form of traction. It had its advantages and disadvantages, but the proprietors decided as far back as February last year that it was a matter they ought to be prepared to face at the right moment. Their idea was that £500,000 would be extremely well spent in adapting their railway to electrical traction over that particular part of it which he had mentioned, which was crowded with traffic, and so much of which was incapable of anything but very imperfect ventilation. They were instructed by very eminent authorities that the financial burden cost on the two companies would be extremely moderate in comparison with the great advantages to be secured, not only by getting rid of many of the offensive qualities of the air in the tunnels, but also in the saving in the cost of traction, which they were advised would be considerable. The matter was one demanding some care, and they naturally wished to be in the hands of perfectly responsible engineers of eminence In Sir J. Wolfe Barry, a man of considerable experience, who had advised the Company almost from its inception, and Mr. Preece, the electrician of the Post Office, and one of the most distinguished members of his profession, they had thought well to vest the preliminary enquiries. Those gentlemen were now concerned in the matter, and the directors would not proceed until they were assured by the report and recommendations of those gentlemen that it was safe to do so. They were gradually gaining experience in the matter of electrical traction. The greatest enterprise of the kind yet approaching to anything like development was the Central London Railway. They knew a little about the question from what had been done on the City and South London line and the Liverpool Overhead Railway, but the Central London Railway, which would be running by the end of this year or the beginning of next year, would doubtless open their eyes to a good many things. The experience of that company would be very useful to the District and Metropolitan Companies. The Chairman then moved the approval of the Bill in so far as it affected the Company.

Lord Gort seconded the motion, and it was agreed to.

The consideration of the Whitechapel and Bow Railway Bill was postponed until June 9.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.

The ordinary meeting of this Company was held on Wednesday at Winchester House.

Mr. W. Andrews, who presided, moved the adoption of the report (already published by us). He said the shareholders were informed at the last meeting that the necessity would probably arise to renew or partially renew the Chord line which affected the duplication between Trinidad and one of the northern islands. The Board believed they had succeeded in saving a portion of the old cable, which would be joined to the new one. The falling off of revenue in the West Indies was much less than he anticipated; latterly it had even increased, probably owing to the large number of messages sent in connection with the war.

NEW GENERAL TRACTION COMPANY, LIMITED.

The annual general meeting of the New General Traction Company, Limited, was held on the 11th inst. at the Cannon-street Hotel, Captain F. Pavy presiding.

The **Chairman**, in moving the adoption of the report, said they had obtained Acts of Parliament for Norwich and an extension at Coventry, and had raised £100,000 additional preference capital at a small premium, and were thus able to make the necessary contracts, their capital being now £270,000. This country was behind others in the matter of electric traction, and there must be continuous progress in this direction, so that he had no fear for the future. The report (already published by us) was adopted.

MOTOR MANUFACTURING COMPANY, LIMITED.

The first ordinary general meeting of this Company was held on the 16th inst. at Winchester House.

Mr. John H. Gretton, who presided, stated that the meeting was only the statutory one, and that he had no resolution to submit. They had laid the foundation of a business which he believed would become extensive and profitable. The present Company were entitled to use various improved patents, and they could make Daimler motors and motor bicycles and tricyles, as well as the various other vehicles which were in use. They also had the right to use any improvements which the British Motor Company might acquire in the future.

MIX AND GENEST, LIMITED.

The annual general meeting of the shareholders of this Company was held at their Board-room at 67, Bulowstrasse, Berlin, on May 16. The directors submitted their report, recommending a 10 per cent. dividend for the year 1897. The gross profit earned amounts to £25,000, which, after deducting expenses and writing off £3,200 on tools and machinery, leaves a net profit of £13,570. The directors state that the number and amount of Government and trade orders generally in hand are again in excess of last year's figures, and a further development can be prognosticated.

The **Chairman** informed the shareholders that business had been very brisk during the past year, necessitating a further extension of their newly-built factory, which up to now accommodated 1,000 hands, and which, with the additional premises, would allow of the employment of 1,500 hands.

HOBART ELECTRIC TRAMWAY COMPANY.

The report of the directors of the Hobart Electric Tramway Company, Limited, for the year 1897, which was submitted to the annual general meeting held at the registered offices on Friday, states that the gross takings amounted to £12,380, and the working expenses to £8,853, and after deduction of debenture interest, administration, and other expenses in Hobart and London, the Company has made a net profit of £301 for the year. The directors continue to receive assurances that the service provided by the line is much appreciated. The number of passengers carried by the tramway since the opening of the line in September, 1893, to Sept. 30 last is 5,349,450, and the total number of car miles run is 1,336,157. The directors continue to receive from Mr. Parker, the Company's general manager in Hobart, very complete weekly and monthly reports as to the working of the Company's business, and are glad to be assured by him that the plant and rolling-stock remains in an efficient condition.—*Financial Times.*

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bray.—The Commissioners invite tenders for the supply of the materials required at their electricity works for the ensuing year. Tenders by June 6.

Hammersmith.—The Vestry invite tenders for the supply and erection of additional plant. Tenders by June 8. Full particulars appear in our advertising columns.

Sunderland.—The Corporation invite tenders for the supply of piping, water-softener, etc Tenders by May 27. Full particulars appear in our advertising columns.

Bury St. Edmunds.—The Town Council invite tenders for the supply and erection of plant. Tenders by June 13. Full particulars appear in our advertising columns.

London.—Tenders are invited for the supply of calcium carbide, delivered free in London, 10 tons or more weekly. Apply to Carbide, care of Bates, Hendy, and Co., 81, Cannon-street, London.

Salford.—The Electric Light Committee of the county borough invite tenders for accumulators; motor-generators, balancing machinery, and boosters; switchboards; cables; alternating current transformers. Tenders by June 6.

Madras.—The Secretary of State for India in Council announces that the time allowed for the receipt of tenders by the Chief Engineer for Irrigation, Madras, for the utilisation of water power of the Periyar Lake has been extended from Oct. 31, 1897, to July 1, 1898.

St. Helens (Lancs.).—The Health Committee invite tenders for the erection of destructor shed, new pail shed, electric light

engine-house, chimney, weigh-house, offices, etc. Plans, etc., may be obtained on and after May 6 on application to Mr. Geo. J. C. Broom, M.I.C.E., the borough engineer, on payment of £1. 1s., which will be returned on receipt of bona fide tender. Tenders by May 25.

Watford.—The Council invite tenders for the erection of an electric light station adjoining the new sewage works at Watford. Specifications, etc., may be obtained from the architects, Messrs. Gordon, Lowther, and Gunton, Finsbury House, Blomfield-street, E.C. Tenders by June 8.

Coventry.—The Electric Lighting Committee invite tenders for the electric mains, switchboards, arc lamps, posts, and apparatus: (Section A) high-tension feeders on a solid system, and low-tension armoured distributors, laid and jointed complete (indiarubber-covered cables will not be considered); (B) supply and erection of switch-gear, etc., in sub-stations; (C) public arc lighting (about 40 alternating arc lamps, posts, transformers, etc.); the whole bound up in one specification. Tenderers are at liberty to tender for the whole or for either section separately. Specification, etc., may be obtained from Mr. Gilbert S. Ram, city electrical engineer, Coventry. Tenders by June 7.

Darwen (Lancs.).—The Corporation invite tenders for the erection and construction of the various buildings comprised in the new electricity supply works, and also for the tall chimney to be used in connection with the proposed refuse destructor and works, in Robin Bank-road, Darwen: (Contract No. 1) buildings, etc.; (2) chimney shaft. Specifications, etc., may be obtained at the offices of the Borough and Electrical Engineers, where also plans of the site, buildings, and chimney may be seen during ordinary office hours on payment of £2, which sum will be returned on receipt of a bona fide tender. A separate tender must be sent in for each contract. Tenders must be delivered at the Town Clerk's Office by 12 noon on 26th inst.

Victoria (Australia).—Tenders are invited by the Council of the city of Hawthorn for the supply and erection, or for the supply only, of: (Section A) buildings only; (B) boilers, water-heater, pumps; (C) engines, dynamos, switchboard, mains, sub-mains, transformers, meters, arc lamps, insulators, testing instruments; (D) supply of poles and their erection; running of the plant for three years. Specifications and forms of tender can be obtained at the office of the Agent-General for Victoria, Lieut.-General Sir Andrew Clarke, G.C.C.M., Victoria Office 15, Victoria-street, Westminster, London, S.W., on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Tender for Electric Lighting," and addressed to the Mayor of Hawthorn, Victoria, Australia, on June 24, at 5 p.m.

Dublin.—The Corporation of Dublin invite tenders for the supply of the following electric mains and apparatus: (1) high-tension feeders and low-tension distributors, laid and jointed complete on a solid system, not including roadwork, but including the connecting-up of existing consumers to the new system of mains; (2) transformers (20 kw. to 50 kw., about 700 kw. in all), with instruments and apparatus in sub-stations erected and fitted complete. Specifications, etc., can be obtained of the City Engineer, City Hall, Dublin, on payment of a deposit of £1. 1s. for each specification, which will be returnable on receipt of specification, accompanied by bona fide tender. Drawings can be inspected and other information obtained either at the office of the City Engineer or at that of Dr. A. B. W. Kennedy, 17, Victoria-street, Westminster. Tenders are to be sent to the Town Clerk by 10 a.m. on 23rd inst. Tenders will only be considered which are sent in by firms who have already carried out the class of work required upon a large scale.

RESULTS OF TENDERS.

Bisley.—The London County Council have accepted the tender of Edmundsons' Electricity Corporation, Limited, Westminster, £16,665, for the lighting of the Heath Asylum.

Colwyn Bay.—The tender of B. Thomas, Manchester, at £1,469, has been accepted by the Urban District Council for gas plant. A full list of tenders appeared in our last issue.

Liverpool.—The City Council have accepted the tender of Manlove, Alliott, and Co., Nottingham, at £572, for inlet fan and silent engines at Smithdown-road refuse destructor.

London, S.W.—The following tenders have been received for sundry decorations, hot-water fittings, and electric light installations at 63, Earl's Court-square, S.W.:

Lole and Lightfoot	£356
F. Holdstock	318
H. Smith and Son	289
J. Whitaker, Earl's Court (accepted)	275

Aberdeen (N.B.).—The Town Council have received the following tenders for the supplying and laying of about 10 miles of ·67 single-core feeder cable, about 5 miles of ·2 three-core network cable, and about 3¾ miles of arc lamp series cable:

Siemens Bros. and Co., 12, Queen Anne's-gate, Westminster, London (accepted)	£12,138	1	0
British Insulated Wire Company, Prescot	12,405	11	10
Callender's Cable and Construction Company, Limited, 90, Cannon-street, London	12,642	4	6
Glover and Co., Salford, Manchester	13,113	10	10
Western Electric Company (late Fowler-Waring), North Woolwich, E.	14,318	10	1

Note.—These tenders do not include cable work, and arc lamp tenders not settled.

Bethnal Green.—The following tenders have been received by the Guardians for the installation of the electric system in their new infirmary:

Cox and Walker	£9,920	0	0
Thames Ironworks	9,321	0	0
Private Wire and Telephone Installation Company	8,919	0	0
G. E. Cockburn	8 741	0	0
W. B. Scott and Co.	8,671	8	5
Crompton and Co.	8,223	0	0
Cash, Robinson, and Co.	8 100	0	0
Nicholson and Tyler	7,921	6	7
H. F. Joel and Co.	7,920	14	0
H. C. Keen and Co.	7,775	0	0
National Electric Free Wiring Company	7,631	0	0
Laing, Wharton, and Down	7,272	0	0
Troup, Curtis, and Co.	7,142	0	0
H. J. Rogers and Co.	7,125	0	0
Paterson and Cooper	6,992	0	0
Brush Electrical Engineering Company	6,958	10	0
Hampton and Sons	6,837	0	0
Speedy and Co.	6,659	0	0
Sharp and Piper	6,460	0	0
Richmond Engineering Works	5,840	10	0
Calvert and Co. (accepted)	4,965	0	0

BUSINESS NOTES.

Morecambe.—The electric lighting of the Front is to be started at Whitsuntide.

Hessle.—The Council objects to the landscape being disfigured with telephone poles.

Stafford.—The gross profit of the working of the electric lighting department for the year is stated as £527.

Ealing.—The District Council by a majority of one have come to a decision to oppose the electric tramways scheme.

Prestwich. — The Council have resolved to apply for a provisional order for the electric lighting of the district.

Burton.—The question of electric lighting is still under the consideration of the Gas and Electric Light Committee of the Town Council.

Lyndhurst.—Messrs. Warburg, Dymond, and Co. are about to ask for a provisional order to enable them to supply the electric light at Lyndhurst.

Saltburn.—The Urban Council have decided to consult an expert about the introduction of the electric light for public and private lighting purposes.

Taunton.—The total new connections during the month have been equivalent to 512 8-c.p. lamps, making a total of 541 8-c.p. for the past three months.

Glasgow.—The Tramways Committee have agreed to recommend that the salary of Mr. John Young, manager of the Corporation tramways, should be raised by £250 per annum.

Llandudno.—A report by Mr. Preece, in which he recommended the adoption of the overhead system for the proposed light railway in the district under the control of the Council, has been adopted.

Bromley.—The plans for the electric lighting station are now ready. The prospect of a 120ft. chimney in the centre of the town has called forth several remonstrating letters to the Council.

Stirling.—Efforts are being made to ascertain whether, in the event of the electric lighting scheme proposed by Mr. Yorke being adopted, the necessary consent and wayleaves can be obtained.

Hackney.—The report of the committee recommending increases of salaries of the engineer and electrician, assistant engineer and assistant electrician, adjourned from last week, came before the Vestry last Wednesday.

Buxton.—Mr. Salt has been appointed chairman of the Electric Lighting Committee. A deputation is to confer with Prof. Kennedy on the question of gas or steam engines being adopted and as to site for station and other details.

Western and Brazilian Telegraph Company.—The traffic receipts for the week ending 13th inst., after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, were £1,985.

Appointments Vacant.—The Corporation of Londonderry invite applications for the post of electrical engineer to their lighting station, and the St. Pancras Vestry require an inspector of works. Full particulars appear in our advertising columns.

Huddersfield.—The tramways manager and the borough engineer are preparing a report as to the application of the electric traction on one or more of the sections, having regard to the utilisation of the present rolling-stock and capital expenditure.

Peterborough.—After considerable discussion an amendment was carried at the meeting of the Town Council on the 15th inst. to the effect that Mr. J. C. Gill, C.E., be reappointed on the same terms as before, with power to obtain the advice of Dr. Fleming.

Swanscombe.—At the statutory annual meeting for that part of the parish of Swanscombe which is not included in the Greenhithe lighting area, held on the 11th inst., it was determined that £350 be raised for the purpose of the Lighting Act during the ensuing year.

Paddington.—At the last meeting of the Guardians it was agreed that it be referred to the Visiting Committee to consider and report as to the advisability of providing the necessary plant and machinery for generating the electricity required for the electric lighting of the workhouse and infirmary.

Newcastle.—A new Corporation committee have again the tramways under consideration, and have appointed Dr. John Hopkinson, of London, to report upon an electric system for the city, including several new lines of route. Mr. Colam, C.E., of Edinburgh, will be asked to report on cable tramways for the town.

St George's (Hanover Square)—The Vestry have received a notice from the Westminster Electric Supply Corporation, Limited, of their intention to lay distributing mains on the south-east side of Grosvenor-road, between St. George's-square and Claverton-street, and at crossings as shown on plan submitted, and have offered noobjection to the work.

New Premises.—We are informed that Mr. Chas. T. Crowden has acquired the motor works, Leamington, which he is fitting up with the necessary plant and machinery for the manufacture of motor vehicles and as an experimental engineering works. Mr. Crowden also intends to practice as consulting engineer and expert, especially in mechanical road traction.

Airdrie.—The Town Clerk reported at the last meeting of the Town Council that the Bill confirming the town's electric lighting provisional order had passed the House of Commons. The Coatbridge House-to-House Electricity Company had proposed to undertake the lighting of the town. It was agreed to ask the company to submit their proposal in writing.

Barnsley.—The following report was adopted by the Town Council on the 13th inst.: "The committee further considered Mr. Miller's report on the system of electrical supply to be adopted in this borough, and recommend that the report be adopted and carried into execution, except that the portion relating to public lighting be deferred for further consideration.

Lynn.—The Local Government Board have sanctioned the borrowing of £30,000 for electric lighting. At the last meeting of the Town Council the Town Clerk read a letter from Prof. Robinson stating that he was willing to prepare the necessary plans and supervise the work for the electric lighting. The committee of the whole Council will meet this week to discuss the matter.

Newington.—At the meeting of the Vestry the Clerk read a letter from the Local Government Board stating that they had considered and enquired into the application of the Vestry for sanction to purchase land in Penrose street for the extension of the depôt and the erection of an electric light generating station. They had decided to comply with the application, and forwarded their formal consent.

Paisley.—At the last meeting of the Town Council the Electric Lighting Committee reported that they had agreed to lay low-tension mains at an estimated cost of £532. The Council intend to make application for further borrowing powers—possibly for £25,000. Notice of a motion was given that no further extensions of the works be permitted until further borrowing powers have been sanctioned.

Birmingham.—At a meeting held on Tuesday evening, the West Birmingham branch of the Independent Labour party passed a resolution expressing satisfaction at the prospect of the City Council taking over the electric lighting of the city, but regretting that the matter had been delayed until the shares of the present company had been raised to a fictitious value in anticipation of sale to the Corporation.

Telephone Committee.—The House of Commons Committee on telephones have elected Mr. Hanbury, secretary to the Treasury, and representative of the Post Office in the Commons, chairman, and arranged to meet for the reception of evidence on Tuesdays and Fridays. The first meeting for the purpose was held on Tuesday, and the witnesses being examined in the first instance are departmental officials.

Reuter's Telegram Company, Limited.—The report for the past year states that the net profits amounted to £10,687, including £163 brought forward. The directors have carried £5,278 to the reserve fund, thus making it £26,000, and propose a dividend of 4s. per share, equal to 2½ per cent., making a total distribution, free of income tax, of 5 per cent. for the year, leaving a balance of £412 to be carried forward.

Bangor.—A special meeting of the Council was held on Saturday last. The minutes of a special meeting of the Lighting Committee, which recommended the extension of the electric lighting scheme to Upper Bangor, and to amend the application already made to the Local Government Board for sanction to borrow with the addition of £3,500 for this purpose, were approved. The additional amount is required in order to extend the scheme so as to include Upper Bangor.

Nottingham.—At a meeting of the City Council in committee a report with reference to the extension of the tramway system was adopted. Several alterations were decided upon. A paragraph relating to the site for the power station was altered so as to include other sites for power stations. At the same meeting the Electrical Energy Committee were authorised to reduce the price of electricity, and to extend the system to the whole of the borough as soon as possible.

Islington.—At a meeting to-day the Vestry will receive a report from the Electric Lighting Committee stating that, on account of the rapid progress of the electric lighting business, it is necessary that further extensions of the works should be made as soon as possible, and recommending that it be empowered to engage an architect forthwith to draw up the requisite plans and estimates for completing the new boiler-house and extending the works to meet the requirements of the department.

Ulverston.—At the last meeting of the Rural District Council a communication was read from the Board of Trade asking for views of the Council in regard to the contemplated revocation of the Windermere and District Electric Lighting Order, 1895, the promoters having failed to carry out their obligations under the said order. It was resolved that unless the provisions as to compulsory mains, etc., contained in the provisional order be fully carried out at once the Council was of opinion that the order should be allowed to lapse forthwith.

Greenock.—At the meeting of the Police Board on the 17th inst., Provost Erskine stated that it would be absolutely necessary, if the Police Board were to retain their provisional order, that they make some attempt at an installation within the year. The Board of Trade had made the statement that corporations which simultaneously developed gas and electricity had invariably found it to pay. It was agreed to remit the resolution of the Board to the sub-committee on electricity, and to report their views on the best method of carrying out the details of the proposed installation.

Tonbridge.—The *Kent and Sussex Courier* advocates the widening of the S.E.R. bridge in connection with the proposal to establish an electric tramway from Tunbridge Wells to Southborough. The paper points out that locally there would be two municipal advantages, apart from the general public convenience by increased facilities—viz., that the tramway would add a large revenue to the electric light works—thus adding to the profit to the rates, and it would also materially contribute to a great public improvement which otherwise does not appear so likely to be carried out as it would be were the cost divided between three parties.

Church-Lighting.—We are informed that the contract for the electric lighting of the Trinity Church House, Great Portland-street, W., which is to be opened next week by the Bishop of London, was placed in the hands of Mr. Leo Sunderland, of the Brush Electrical Engineering Company, 39, Victoria-street, S.W. This building contains a large public hall, extensive gymnasium, classrooms, reading-rooms, and residences for the clergy, and is wired for about 280 lamps. Mr. Sunderland has lately completed the lighting of St. Paul's Church, Clerkenwell; St. Paul's Church, Camden-square; the Church of the Smithfield Martyrs; St. Stephen's Church-room, East Putney.

Brighton.—At the last meeting of the Council, Councillor Blaker moved the exception to the Lighting Committee's decision not to reopen the proposal to reduce the charge for electricity after the first hour from 1½d. to 1d. Mr. Blaker urged that the vote which defeated the proposal in the Council was a small one, only 35 members out of the 56 being present. He was sure if there had been a full attendance the result would have been different. It was said that the electricity undertaking had only a very small reserve of £6,000; but he considered that the £19,348 redemption money could be counted as reserve, which would make the total £25,000. With cheaper light they would have more customers. Councillor Stafford seconded, but the amendment was defeated by 28 to 14.

Ipswich.—The report of the committee upon the lighting of the new workhouse contains the following: "The clerk has received three tenders for the electric lighting of the new workhouse. They are as follows: Messrs. Laing, Wharton, and Down, Limited, £3,583, less £20 allowed for the present boiler; Edmundsons' Electricity Corporation, Limited, £3,208, less £20 allowed for present boiler; Messrs. Crompton and Co., Limited, £3,035, less £20 for present boiler, if boilers made by Messrs. E. R. and F. Turner, £220 less if boilers made by Messrs. R. Taylor and Sons, Mardens. The committee recommended that Messrs. Crompton and Co.'s tender be accepted, the boiler being made by Messrs. Taylor and Sons." At a meeting of the Guardians on the 13th inst. the report was discussed and referred back to the committee.

Hanley.—At the quarterly meeting of the Town Council the Electric Lighting Committee recommended that the charge for electricity for motive power be reduced to 2½d. per unit for four hours per day and 1d. per hour afterwards, commencing on the 1st inst.; also that the borough engineer be authorised to approach the authorities of Stoke and Burslem with a view of ascertaining if they are willing to take electric current from Hanley in lieu of erecting separate stations for themselves and of discussing terms. These recommendations were confirmed. The General Purposes Committee have passed the following resolution: "That the matter of the advisability of purchasing the local tramways be considered at the next meeting of this committee, and that in the meantime the chairman, with Councillors Coates and Whittingham, be requested to prepare a scheme to lay before the representatives of the neighbouring local authorities at a joint meeting."

Ashton.—The Town Council have resolved that the conditions for the supply of electricity to consumers and form of application recommended by Mr. Clirehugh for adoption be approved. The Corporation will supply electrical energy at a pressure of 200 volts. The Corporation will supply and erect on the consumer's premises electricity meters at rentals ranging from 2s. 6d. for a five-ampere meter to 6s. for a 100 ampere meter. The Corporation will lay and connect service lines to consumer's premises free of charge, provided the distance does not exceed 60 ft. No combination gas and electric light fittings are to be used. Where old gas fittings are to be adapted for electric lamps, the fittings must be efficiently insulated from the gas-main or other earth connection. Payment

for current will be at the rate of 7d. per Board of Trade unit for the first hour's use per day, and 2d. per Board of Trade unit for subsequent hours' use, with a minimum charge of 13s. 4d. per quarter, exclusive of meter hire.

Shoreditch.—At the last meeting of the Shoreditch Vestry the Electric Lighting Committee presented accounts showing the work for the nine months ended March last. The power for the dynamos is obtained from the dust destructor. Less than one ton of coal is used per day. The accounts showed a profit and balance of £1,701. 17s. 9d. Altogether 491,017 units had been generated, of which 80,791 had been used for lighting the streets, 203,504 by private consumers, 156,725 used on the works, and 50,087 unaccounted for. After allowing for certain items which belonged to the dust destructor proper, there was a profit of £4,264 upon their capital outlay of £65,000, or equivalent to a dividend of 6½ per cent. After allowing for the proper repayment of principal and interest there was a net balance of £2,072, and if the committee repaid the amount advanced to them out of the rates there would still remain a balance of £700 upon nine months' working. The Vestry resolved to borrow a further sum of £15,700 for the purposes of the committee.

Hammersmith.—At the last meeting of the Vestry Mr. Searle directed particular attention to the very satisfactory results that had attended the electric lighting scheme, which had been in force nine months for private lighting, and six months for street-lighting. The report submitted by the chief engineer stated that "up to the present time an average price of only 4½d. per unit has been received from private consumers, being the lowest obtained by any London municipal authority whose accounts have been published. The charge to the lighting rate is only £22. 10s. per lamp per annum, as against about £40 per lamp per annum obtained by other authorities. On June 21, 1897, there were nine consumers of electric lighting in the parish, and this number had increased during the year to 132. The public lighting was being carried out by means of 87 arc lamps of 2,400 c.p. each. Mr. Searle, referring to the electric lighting staff, said the officials were to be credited with the present success of the undertaking.

Poplar.—At the last meeting of the Board of Works, the Electric Lighting Committee reported that they had directed the issue of an advertisement inviting applications for the position of resident electrical engineer, such applications to state terms required in return for services rendered, and also qualifications possessed by the candidates. The services to be rendered to include the devising of a scheme of electric supply for lighting and other purposes for the Poplar district, under the Board's provisional order, the preliminary outlay being estimated at £45,000, inclusive of land and buildings; and also to include the carrying of the scheme into effect up to the point of starting the station. The person appointed to act continuously thereafter during the pleasure of the Board, to give his whole time to the duties of the office, and to reside in the Poplar district. The committee would receive applications in answer to the advertisement on May 16, and would thereafter report to the Board. After some discussion, the committee's report was approved.

Aberdeen.—A sub-committee of the Town Council made an inspection of the street-lighting arrangements of Woodside and part of the east end of the city last week. They were accompanied by Mr. R. G. Botting, electric light and power engineer, Schoolhill, Aberdeen, who has erected the electric lamps for the Town Council. The sub committee found Castle-street brilliantly lighted, the arc lamps, incandescent electric lights, and the gas lamps having all been lit. The various incandescent lights, large and small, were inspected, and in order that the committee might better judge of the effect, the light was half cut off in some cases and wholly in others. The effect of a new reflector in one of the smaller incandescent electric lights was also observed. As an experiment, a circular clear glass globe was substituted for one of the old square lamps in front of the Municipal Buildings, and as the result was very satisfactory, it is proposed to erect lights of the same kind in front of the County and Municipal Buildings. The committee have not decided anything about the lighting of Union-street.—The borrowing of the further sum of £15,000 in connection with the electric lighting undertaking has been resolved by the Town Council.

British Electric Traction Company, Limited.—We are informed that the following staff appointments have been confirmed by the board of directors of the above company: Mr. George Stevens (late town clerk of Hyde) has been appointed secretary; Mr. C. H. Dade, assistant-secretary; Mr. C. Walmsley (late secretary of the company), accountant; Mr. Stephen Sellon, M.I.C.E., parliamentary engineer; Mr. C. H. Gadsby, Whit.Sch., M.I.E.E., contract engineer; Mr. W. Howard Smith (late engineer on the construction of Lynton and Barnstaple Railway, and formerly city engineer, Carlisle), permanent-way engineer; Mr. H. M. Sayers (late engineer to Madrid, Oporto, and Bournemouth electric light stations), power engineer; Mr. T. B. Goodyer (late traffic manager of Birmingham Tramways), general traffic superintendent; Mr. J. A. Lycett (late clerk to the Kingswinford Rural District Council), superintendent for Birmingham district (address, Wollaston, Stourbridge); Mr. J. Vincent Kitchener (formerly secretary of the company), superintendent for Manchester district, including the Potteries (address, 19, York-place, Oxford-road, Manchester); Mr. D. F. Sugrue (late manager of the Swansea Tramways Company), superintendent for South Wales district (address, Tramways Depôt, St. Helens, Swansea); Mr. Frank B. Lea, superintendent for Glasgow district and (*pro tem.*) for Newcastle district; Mr. W. Gambley, A.M.I.C.E., superintendent for Midlands and Eastern Counties district. Except where otherwise stated, the headquarters of the staff are Donington House, Norfolk-street, Strand, London, W.C.

Dewsbury.—At a special meeting of the Town Council last week, says *The Reporter*, the Council's past policy was severely condemned. In explanation of how the electricity deficit was caused, Councillor Oldroyd pointed out that the deficit of £625 on the electricity works account was not a loss which had been brought about during the last 12 months. At the end of last year they had a loss of £146, which was brought over as a balance to the new account. It had also been decided in Council during the year to supply electricity to the public library free, which cost in 1897 £67. 10s., and in 1898 £94. 2s 7d., making a total of £161. 12s. 7d. Another item which was expended for the public good—£79. 15s. 9d.—was charged to the electricity account. That was for the illumination of the town hall on the occasion of the Diamond Jubilee celebration. Deducting these figures, the deficit on the past year's working was £237. 8s. 1½d. The figures as presented did not show a fair year's working as far as the electricity department was concerned, seeing they had had to meet expenses incurred by other departments. Considering that the electricity works had only been established about two or three years, and the heavy expenditure they had had to meet, he thought they had a good prospect before them providing consumers would only meet them in a generous manner. With a view to inducing a larger number of people to use electricity they adopted the Brighton system, and supplied the light at a cheaper rate. The income in 1897 was £2,860. They expected an increase in the consumption by adopting the Brighton system, but during the past year the receipts only amounted to £2,698. When they began to supply the residential portions of the town with electricity he hoped they would reach the turning point, and that in the future the works would be successful.

Birkenhead.—The report of the special committee appointed to consider the question of the introduction of electric tramways into Birkenhead has been submitted to the Town Council. The report stated that the cost estimated by the borough engineer would be £182,000. The receipts for the tramways for last year were £9 515, and on the 90 per cent. basis the expenditure was £8,563. The cost of provender in connection with the tramways was £5,300; they paid at the present time for rent to the Corporation £750, £300 as directors' fees, and as far as a reasonable estimate could be made the profits were £1,200, which brought out the figure at £7,550. In addition to that, they had to add men's wages for grooming horses, etc., and that would bring the figures strangely near the 90 per cent. basis. The cost of haulage per mile was 1s. as against 6d. per mile per electric car. They might assume that the £7,550 would be available in the hands of the Corporation towards the sinking funds. They would have greater punctuality, more cleanliness, better speed, and would possess many items which went to make the difference between success and failure. They were willing to meet the company on fair grounds, but they were not able to carry out any arrangement, and no terms had been come to. They need not trouble about that part of the case, because if they adopted the report they could put down two-thirds of the track without any interference whatever with the present company. The track proposed was 21 miles; 10 miles of that track was double and 11¼ single; 8¼ miles was old track and 13 miles new track. Of that 11¼ miles of road track 7¼ would require new track and 4¼ old. The total length common to all tracks covered about 17¼ miles. The committee recommended that electrical traction should take the place of horse haulage, and that electrical traction should be by the overhead system. A resolution was carried approving and adopting the committee's report without, however, binding the members of the Council to the adoption in their entirety of the several routes recommended in the report.

St. Pancras.—At the last meeting of the Vestry, Mr. Menzies, clerk of the Electricity Committee, stated in view of the extensions of public street-lighting by arc lamps, the committee had decided to recommend after the June quarter the reduction under this head from 5d. to 4d. per unit. With regard to general lighting, the Vestry in December last approved that private consumers should have the option of being charged for current on the basis of their maximum demand, and on this 6d. per unit for the first three hours' consumption each day, and all after 3d. per unit, was decided on. The committee, in their report of Nov. 18 last to the Vestry, pointed out that the foregoing rates would chiefly have the effect of lightening the cost to consumers using current for long hours each day, but were not able at that time to recommend a direct reduction. In view of the very satisfactory results of the past year's trading, the committee recommended that the foregoing rates should be modified, the effect of which will be that all consumers adopting this method of charge would obtain a substantial reduction in their lighting bill. The committee recommended that after June quarter next the charge for current supplied to private consumers under the maximum demand indicator system be: for the first 1½ hours' consumption each day 6d. per unit, all after at 3d. per unit, 1s. per quarter for rental of indicator. Mr. Menzies added that the committee desire to correct a statement that had got abroad to the effect that the profit they made last year was made out of public lighting. So far from that being the case, if they had no revenue from public lighting at all, they should still have had a profit from private consumers, and, further, whereas formerly the revenue from public lighting was a third, it had now fallen to one-ninth of their total income. They had made a profit last year of £5,700, and of that sum just £270 was the profit from public lighting. He hoped that would once for all give the quietus to the statement that the department was making its revenue at the cost of the ratepayers. The reductions under both heads now

proposed would mean an important relief to public lighting and private consumers. He moved the recommendations of the committee. The recommendations of the committee were agreed to.

Hull.—At the meeting of the Electric Lighting Committee of the City Corporation on the 13th inst. the statement of the working of the installation in the city during the past year was submitted. The committee at the commencement of the year started large extensions of the electric system, estimated to cost £40,690. These works were now nearing completion, and the report says that during the year 65 old customers had increased their lighting and 134 new customers were added. The total expenditure on capital account was now £61,738, of which £14,153 had been spent during the year. The total revenue was £10,453; expenditure, £5 450; balance, £5,003. The interest on loans amounted to £1,496; contributions to sinking fund, £1,467; leaving a net profit on the year's working, £2,040. The Electrical Engineer submitted a report, in which he recommended a further extension of the generating plant for the purposes of extending the electric light to East Hull. The engineer reported that on March 31 last the lamps actually connected to the mains were equivalent to 43,534 8 c p; applications to be connected to present mains, 17,666; and on the east side of the River Hull, applications for 2,520—in all 53,720 lamps, against which the present capacity of supply is 36,666 lamps. Application to the Local Government Board had been made for sanction to borrow £10,000 for the extension to East Hull, but the sanction had been temporarily withheld till full details of the scheme had been submitted. The engineer urged that the time had now arrived to pursue the matter, and to consider the question of laying down additional mains, and he recommended a scheme modified from that of 1896. The Holderness-road he recommended should be placed as near as possible to the North Bridge on the west side of the river, so that the cables crossing the river should carry low-tension current only, the cables to be laid side by side with the tramway feeder cables. The engineer's report concluded by stating that the sum of £10,000 applied for would not be sufficient to cover the cost of the extensions now recommended, and that £26,000 would be needed. The report was received and adopted, and a resolution carried to apply to the Local Government Board for borrowing powers to the extent suggested.

Manchester.—A conference was held last week of representatives of the Manchester Corporation and the various local authorities in whose districts the tramway lines of the Manchester Carriage and Tramways Company run, with the object of deciding on what principle the outside districts shall be compensated by the Manchester Corporation in the event of that authority working the tramways over the whole of the Manchester Carriage Company's present system. The authorities represented included the Corporations of Salford, Oldham, Stockport, Eccles, Ashton-under-Lyne, and Stalybridge, and the Urban District Councils of Moss Side, Withington, Stretford, Denton, Swinton, Gorton, Heaton Norris, Failsworth, and Levenshulme. The proposals which were the subject of discussion stipulated that the several authorities outside the city should acquire and place the lines in their respective districts in a condition suitable for electric traction, and should provide electric energy and equipment on the same conditions as those proposed to be adopted by the city. Each authority should fix the fare in its own district, for which it would be credited and debited on the car mileage principle, with charges for traffic and management expenses, repairs, maintenance, interest, sinking fund, depreciation, electric energy, in cases where the Electricity Committee of Manchester supply the same, and 5 per cent. on the total working expenses other than electric energy. The net receipts in each district were to be handed over to the local authority, the repair and maintenance of permanent way in each district to be undertaken by the local authority at their own cost, and the arrangement to be subject to revision at the end of three years' working. A resolution was moved in favour of the general acceptance of a system of the payment of a car mileage rental by the Corporation of Manchester. An amendment, however, was carried to the effect that each authority should be allowed to make the best individual terms for its own district with the City Corporation. The *Manchester Weekly Times* says: "The question of the municipalisation of the tramways may be discussed altogether apart from the proposals to employ electric traction. It may be taken for granted that, whether the local authorities come to an agreement and arrange to work the lines themselves, or whether they decide that this duty shall be undertaken by the tramways company, electricity will be introduced."

Yarmouth.—Mr. W. H. Preece's report upon the explosion at the generating station states that in his opinion the cause of the accident was an undue level of water in one of the old single-drum boilers, and the main question was the remedy for preventing a similar accident in future. He says, whatever precautions are taken in arranging safety devices, such precautions are rendered useless if carelessness is shown by the workmen. The addition of four high-level indicators would be of advantage as a safeguard against future mistakes in gauging the water-level. He did not recommend the addition of separators on the ground of the extremely heavy expenditure that would be involved, and any omission on the part of the engine-driver to observe the level of water in the indicators would at once lead to a probable accident, and therefore introduce further danger. Mr. Preece, however, suggested an improved system of drainage, which he could conveniently include in the new extensions.—The Yarmouth and Gorleston Tramways Company, in their reply to points raised by the Town Council on their application in regard to the supply of electric light and power in Gorleston and Southtown, ask for an extension of 29 years beyond the time mentioned in the order, giving the scheme a total life of 35 years. The company could not pay more than the permit if they took electric power from the Corporation for the tramways. The company would erect a generating station, and undertake the supply of public and street lighting at an average charge of 6½d. per unit. If the Corporation provided the cables and handled the supply to private consumers, the average charge would be 4½d. per unit. The company offered to supply the current, to maintain and clean street arc lamps on the tops of the trolley posts, at a charge of £22 to £28 per annum, or at £2 per annum less if the Corporation supplied the standards. Incandescent lamps would be fitted into the existing gas lanterns where arc lamps were not needed at £4 per annum, where the mains were already laid. The Corporation would be asked to take over the electrical plant when exercising power to purchase the tramway equipment, under the Tramways Act, at a premium of 10 per cent. upon the cost of the plant. The company are not prepared to make any concession, monetary or otherwise, to the Corporation for surrendering its rights. The Electric Light Committee has recommended the Council to adhere to its former agreement—*i.e.*, to supply the tramway company with electric energy according to a graduated scale, commencing at 3½d. per unit, provided the amount of energy does not exceed 250,000 units per annum.

St. James's.—At a meeting of the Vestry held yesterday, the committee reported that they had considered the letter from the St. James's and Pall Mall Electric Light Company, stating, in reply to the Vestry's representations to the company urging a further reduction in the charges for the supply of electricity in the parish, that the average charge for the eight years since the company started is 5 82d. per unit, and both this average and the present rate, which works out at 5d. per unit, compare most favourably with those of any other metropolitan undertaking; that the company has carried out its work in a manner which has placed it at the head of metropolitan undertakings; that they have made a service to the district which has given general satisfaction, both as to the quality and price, and have not received any intimation from their consumers which would show dissatisfaction with their charges, or justify the proposed action on the part of the Vestry to apply to the Board of Trade under Section 53 of the company's order for an alteration in the price or method of charge; that the policy of the directors has always been a liberal one, as they recognise that the continued success and extension of their business depends upon the steady cheapening of the supply, and that the Vestry may rest assured that this, with the element of competition with another company, will have the full effect desired by them; that the small consumer in this parish has, looking at the question broadly, received better treatment than those of any other parish of the Metropolis, and, should circumstances justify their action, they will endeavour to meet the wishes of the Vestry in this direction; that the accounts are audited and passed by the Board of Trade, and they have every confidence in submitting their case to the arbitration of that body; that at the same time they recognise and are in sympathy with the desire on the part of the Vestry to secure the benefit of a cheap supply of electricity in the district, and submit that they have in the past followed, and are still following, the best methods to meet the same. It was recommended that the company be informed that the Vestry were dissatisfied with their reply, and that they be urged to further consider the subject, and give the Vestry a definite reply to their communication of April 18. The committee also reported that they had considered a proposal from the St. James's and Pall Mall Electric Light Company, to the effect that Carnaby-court, running from Carnaby-street to Marlborough-row, and the south end of Marlborough-row, should be lighted by electricity at the cost of the company, subject to the Vestry providing and supplying the necessary lamps and fittings for the incandescent lamps and keeping such lamps and fittings in repair; and recommended that the said proposal be agreed to, subject to the company entering into an agreement, the draft of which had been approved by the committee.

Birmingham.—Referring to the long-pending negotiations between the General Purposes Committee of the City Council and the Birmingham Electric Supply Company, the *Birmingham Daily Post*, from which we extract the following, says that a provisional arrangement has been entered into—subject, of course, to the approval of the Council and the company's shareholders—for the transfer of the company's plant and business to the Corporation. The committee recommend the purchase by the Corporation, on terms arranged, of the plant, machinery, and business of the Birmingham Electric Supply Company. The terms of purchase are on the basis of £10. 10s. per £5 share, which is about their actual Stock Exchange quotation. On these terms, if they are accepted, there can be no question that the Corporation would secure a bargain for the ratepayers, seeing that the company's dividend is an advancing one, and that the needful money can be raised for considerably less than 3 per cent. For 1891, the first year of the company's existence, the net profit earned was only £361. For 1892 a dividend of 3½ per cent. was paid. For each of the three following years the distribution was at the rate of 4 per cent. For 1896 it was raised to 4½ per cent., and last year's dividend was at the rate of 5 per cent., with a balance of £1,042 carried forward. It is not, however, solely, or even principally, as a financial investment that the acquisition of the company's business by the Birmingham Corporation ought to be considered. It is to be regarded primarily as a necessary public service, which should be conducted in the interests, not of a private body of shareholders but of the community, in like manner with our municipal gas and water undertakings, and under this aspect we think it will be generally admitted that the premium represented by the

10811. Improvements in or applicable to alternating-current meters or like apparatus. Stuart Richardson, 46, Lincoln's-inn-fields, London.

10816. An electrical two-way pear or pressel switch. Julius William Hintzl, 21, Liverpool-street, London.

10818. Improvements in electricity meters. George Hookham, 18, Southampton-buildings, Chancery-lane, London.

May 12.

10821. Improvements in the manufacture of electro-plate. Sherard Cowper-Coles, 39, Victoria-street, Westminster, London.

10848. Improvements in dynamo-electric machines and motors. Sidney George Brown, 9, Queen's-road, Bournemouth.

10869. Improvements in electrical clocks. Alfred Griffiths, Chichester-rents, Chancery-lane, London.

10883. Apparatus for transmitting motion to a distance by means of electrical energy. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

10900. Improvements in electric arc lamps. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (John Henry Hubbell, United States.) (Complete specification).

10901. Improved system of vacuum-tube lighting and apparatus for use therein. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The Moore Electrical Company, United States.) (Complete specification.)

May 13.

10922. An improved switch for electric motors. Albert Edgar Tanner and Frederick Augustus Cortez Leigh, 78, King-street, Manchester.

10941. Improvements in conduits for electric railway and tr mway traction. Egmont Charles Hoegerstaedt, 89, Chancery-lane, London.

10942. Improvements in electromagnetically-operated switches for strong electric currents. Egmont Charles Hoegerstaedt, 89, Chancery-lane, London.

10960. Improvements in electrical storage batteries or accumulators. Joseph Barton Scammell, 56, Leadenhall-street, London.

10965. Improvements in electrical switches. Arthur Vernon Gifkins and Frederick Robert Hill, 68, Victoria-street, Westminster, London.

May 14.

11044. Process of and apparatus for covering metallic wires with asbestos for insulating and other purposes. Ettore Albasini, 77, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Dec. 3, 1897, being date of application in Italy.) (Complete specification.)

11051. Improvements in apparatus for use in the electro-deposition of zinc or other metals. The Cowper-Coles Galvanising Syndicate, Limited, and Sherard Osborn Cowper-Coles, 47, Lincoln's-inn-fields, London.

11068. Improvements in the production of zinc and sulphate of copper by electrolysis. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Alfredo Lotti, Italy.)

11075. Improvements in apparatus for vacuum-tube lighting. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The Moore Electrical Company, United States.) (Complete specification.)

11076. Improvements in and relating to telephone installations. Edouard Baivy, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1897.

9675. Electric clocks. Hennequin.

9748. Method of protecting, supporting, and carrying electric conductors and other wires. Taylor and Eck.

10484. Electric batteries. Dobell.

10582. Brushes for dynamos and electric motors. Guy.

11334. Electric ignition devices for gas-engines and other gaseous explosive mixture engines. Vaughan-Sherrin.

12531. Electric switches. Partridge.

13059. Electric ship log apparatus. Brookes. (McCurdy.)

14439. Manufacture or production of an insulating material, and the application thereof to the insulation of electrical conductors. Edmunds.

14456. Electrical pushes and contacts therefor. Byng and Holt.

15239. Carbon clamp for electrical purposes. Bachmann, Vogt, Kirchner, König, Weiner, and Jörg.

16725. Reflector mounting or holder for electric incandescent lamps. Jergle and Wolffhardt.

1898.

3319. Electromotors. Iserloth.

4995. Electromagnets or magnetic closers for use on electric railway vehicles. Thomas.

TRAFFIC RECEIPTS.

Liverpool Overhead Railway.—The traffic receipts for the week ended May 15 were £1,446, as compared with £1,352 in same week of 1897, being an increase of £94.

Birmingham Tramways.—The traffic receipts for the week ending May 14 were £3,748. 9s. 0d., as compared with £3,476. 1s. 8d. for same week in 1897, being an increase of £272. 7s. 4d.

Dover Tramways.—The traffic receipts for the week ending May 7 were £130. 11s. 8d. The total receipts for the year 1898 are £2,082. 2s. 8d. The mileage open at present is 3 miles.

Bristol Tramways.—The traffic returns for the week ending May 13 were £2,648. 6s. 7d., compared with £2,288. 1s. 0d. for same period of last year, being an increase of £360. 5s. 7d.

South Staffordshire Tramways.—The traffic returns for the week ending May 13 were £606. 9s. 6d., as compared with £594. 14s. 5d. in same week of 1897. The aggregate receipts for the year are £11,267. 11s. 2d., as against £11,314. 12s. 6d. in the same period of the previous year.

City and South London Railway.—The returns for the week ended May 15 were £958, compared with £1,000 for same week of 1897, being a decrease of £42. The total receipts for the half-year amount to £20,679, compared with £20,503 for the same period last year, being an increase of £176.

Dublin S.D. Tramways.—The traffic receipts for the week ending May 13 were £528. 0s. 6d., as compared with £531. 6s. 11d. in the corresponding week in the previous year, being a decrease of £3. 6s. 5d. The number of passengers carried was 84,256 in 1898 and 95,616 in 1897. The aggregate returns up to date are £8,357. 17s. 9d., as compared with £8,697. 17s. 11d. last year, being a decrease of £340. 0s. 2d. The mileage open is the same as last year—viz., 8 miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	[illegible]	10-10½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	[illegible]
—— 6 p.c. Cm. Pf., 30,001-40,000 (iss at £2. 10s. pm., all pd.)	4	7-8
Brush Company, Ordinary	2	[illegible]
—— Non. Cum., 6 per cent. Pref.	2	[illegible]
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	101-104
Callender's Cable Company, Debentures	100	110-112
—— Ordinary	5	9-10
Central London Railway, Ordinary	10	10-10½
——	6	6-6½
—— Pref. Half-Shares	1	[illegible]
—— " "	5	[illegible]
Charing Cross and Strand	5	[illegible]
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	[illegible]
—— 4½ per cent. Debentures	100	[illegible]
City of London, Ordinary	10	[illegible]
—— Prov. Cert. 90,001-100,000	5	16-17
—— 6 per cent. Cumulative Pref.	10	[illegible]
—— 5 per cent. Debenture Stock	100	[illegible]
City and South London Railway, Consolidated Ordinary	100	67-70
—— 4 per cent. Debenture Stock	100	[illegible]
—— 5 per cent. Pref. Shares	10	[illegible]
—— " " '96	10	[illegible]
County of London and Brush Provincial Co., Ordinary	10	[illegible]
—— " " "	4	6-7
—— 6 per cent. Cum. Pref.	10	15-16
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	[illegible]
—— 5 per cent. Debentures	—	[illegible]
Crystal Palace District, Ordinary 5 per cent. Stock	100	[illegible]
—— Preference 5 per cent. Stock	100	[illegible]
Edison and Swan United Ordinary	3	[illegible]
—— 5 per cent. Debentures	5	[illegible]
—— 4 per cent. Deb. Stock, Red.	100	[illegible]
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	3	[illegible]
Electric Construction, Limited	2	[illegible]
—— 7 per cent. Cumulative Pref.	2	[illegible]
—— 4 per cent. Perp. 1st Mort. Deb.	100	[illegible]
Elmore's Copper Depositing	1	[illegible]
Elmore's Wire Company	2	[illegible]
W. T. Henley's Telegraph Works, Ordinary	10	[illegible]
—— 7 per cent. Preference	10	[illegible]
—— 4½ per cent. Debentures	100	[illegible]
House-to-House Company, Ordinary	5	[illegible]
—— 7 per cent. Preference	5	11-12
India Rubber and Gutta Percha Works	10	[illegible]
—— 4½ per cent. Debentures	100	[illegible]
Kensington and Knightsbridge Ordinary	5	[illegible]
—— 6 per cent. Pref.	5	[illegible]
London Electric Supply, Ordinary	5	[illegible]
Metropolitan Electric Supply, Limited, Ordinary	10	[illegible]
—— 4½ per cent. First Mortgage Debenture Stock	100	[illegible]
National Telephone, Ordinary	5	[illegible]
—— 6 per cent. Cum. First Pref.	10	[illegible]
—— 6 per cent. Cum. Second Pref.	10	16-17
—— 5 per cent. Non. Cum. Third Pref.	5	[illegible]
—— 3½ per cent. Deb. Stock, Red.	100	[illegible]
Notting Hill Company	10	[illegible]
Oriental, Limited, £1 shares	1	[illegible]
—— £5 Shares	5	[illegible]
—— £4½ shares	4	[illegible]
Oriental Telephone and Electric Company	[illegible]	[illegible]
Royal Electrical Company of Montreal	—	[illegible]
—— 4½ per cent. First Shares Mortgage Debentures	100	[illegible]
South London Electric Supply, Ordinary	2	[illegible]
St. James's and Pall Mall, Limited, Ordinary	5	[illegible]
—— 7 per cent. Pref.	5	[illegible]
—— 4 per cent. Deb. Stock, Red.	100	[illegible]
Telegraph Construction and Maintenance	12	[illegible]
—— 5 per cent. Bonds	100	[illegible]
Waterloo and City Railway, Ordinary	100	[illegible]
Westminster Electric Supply, Ordinary	5	[illegible]
Yorkshire House-to-House	5	[illegible]

NOTES.

Vacant Appointment.—The chair of electrical engineering in McGill University is vacant by the retirement of Prof. Carus-Wilson. Applications for the position will be received by the secretary up to June 20.

The Piccadilly Electric Railway.—It is said that the work on this line is to be commenced shortly. Sir James Szlumper is the civil engineer for the construction of the line, and the electrical arrangements will be designed and carried out under the supervision of Prof. A. B. W. Kennedy, F.R.S.

Waterloo and City Railway.—The first trial run of a train on this line, connecting Waterloo with the Mansion House, is likely to take place next week. The train is already on the siding at Waterloo, and the work on it is now almost complete. The carriages are most comfortably furnished, and should be appreciated by the public.

"Scientific American."—We have received the special navy supplement of the above paper, and find in it most interesting and fully illustrated descriptions of the different types of vessels in the United States Navy. The only fault we find with the paper is a note to the effect that it was entered as second-class matter at the New York Post Office. It is a first-rate issue in spite of the above.

New Cable.—The cable steamer "H. C. Oersted," which left Henley's Telegraph Works at North Woolwich on the 21st inst. with the Gotland cable on board, arrived at Copenhagen on the 24th inst., and proceeded at once to Ahr, from which point she will start laying the cable. This is the second Gotland cable made and laid by Messrs. Henley; the first, laid many years ago, being still in good condition.

Happy Chicago.—The *Electrical Review* of New York announces that "two masked and armed men boarded a General Electric Railway car which was standing at Thirty-ninth and Morgan streets, Chicago, the end of the line, the other night, and, compelling the conductor and motorman to hold up their hands, robbed the conductor of 33dol. and his watch. This is the second robbery of the kind recently in that neighbourhood."

The Institution Conversazione.—As announced in our last issue, the conversazione of the Institution of Electrical Engineers is again this year to be held in the Natural History Museum, South Kensington. The change to the spacious halls of this museum was welcomed last year, and we trust that even more space will be available this year. The lighting question is the only trouble, and doubtless the electrical engineers of the Kensington and Knightsbridge Company can double their efforts of last year.

Municipal Melbourne.—The electric lighting of the city of Melbourne, it would appear, will at no distant date be under the entire control of the City Council. This body is at present considering the advisability of buying out the private companies which carry on that business. The matter is of the utmost importance to the citizens of Melbourne, and it is to be hoped, should the City Fathers decide to monopolise the business, the hideousness and danger caused by the labyrinthic interlacing of wires will not be overlooked.

The London Chamber of Commerce.—A meeting of the honorary officers and council of this Chamber has been fixed to take place on Thursday, June 9, 1898, at 2.30 p.m., to receive and consider nominations. Members of the Chamber are entitled to make nominations, which must be in writing, enclosed in sealed envelopes, and addressed to the chairman of the council, prior to the said meeting. The nominations have to include one president, 12 members of council, and two honorary auditors. The following retiring members are eligible for re-election: Colonel G. R. Birt, Mr. Thomas F. Blackwell, Sir E. H. Carbutt, Bart., Mr. E. J. Gillespie, and Mr. Arthur Serena.

Royal Institution.—On Tuesday next, May 31, Prof. S. H. Butcher begins a course of two lectures at the Royal Institution on "Literary Criticism in Greece"; on Thursday, June 2, Dr. Edward E. Klein delivers the first of two lectures on "Modern Methods and their Achievements in Bacteriology"; and on Saturday, June 4, Dr. Richard Caton begins a course of two lectures on "The Temples and Ritual of Asklepios at Epidaurus and Athens" (with lantern illustrations). The Friday evening discourse on June 3 is by Prof. W. M. Flinders Petrie, on "The Development of the Tomb in Egypt"; that on June 10 is by Lord Rayleigh, whose subject is, "Some Experiments with the Telephone."

Society of Arts.—This society's conversazione will take place at the Natural History Museum, Cromwell-road, S.W. (by permission of the Trustees of the British Museum), on Wednesday, June 22. The reception will commence at 9 p.m. The following portions of the museum will be open on this occasion: on the ground floor—the central hall, British saloon, and bird gallery; on the first floor—the east and west corridors, and the lecture-room. In addition to the members' invitation, a limited number of tickets will be sold to members of the society, or to persons introduced by a member, at the price of 5s. each if purchased before the date of the conversazione. Visitors arriving or leaving by either of the Metropolitan Railways will be allowed the use of the District Company's subway, which leads from the South Kensington railway station direct into the grounds of the museum.

Magnetic Observatory.—It has been decided that Agincourt is to be the site of the new home of the instruments from the magnetic observatory now in the Queen's Park, Toronto, which have been rendered useless by the electric railways. The building to be erected will consist of a circular stone underground chamber of some 30ft. in diameter, topped by a brick structure for the making of absolute determinations. In the underground room the needles of vertical force, horizontal force, and the declinator will make photographic records of the earth's magnetic currents. The new building, it is estimated, will cost in the neighbourhood of £800, and that the utmost care will be exercised in its erection can be seen from the fact that every stone put in the walls must be tested to ascertain that it contains no iron to disturb the delicate working of the magnetic instruments within.

Electric Carriages.—The Western of France Company has decided to provide passengers at their Paris terminus with electric carriages. As at the Saint-Lazare station there is electric plant, the entire output of which is available during the greater part of the day, the company propose to utilise this to charge the accumulators of the cabs in question. The company has applied to motorcar builders to provide a type of electric car to carry four passengers and 331lb. of luggage, capable of running with safety 31 miles per day. The company will take these cars for a trial of six months at a rate of pay per day to be fixed. At the end of this time the company reserve the right to make a choice and purchase at a previously fixed price the vehicles which have taken part in the competition. This is an example which the *Railway News* thinks should be followed by some of the leading railway companies in this country.

Electric Thermometers.—We learn from the *Canadian Engineer* that Prof. Callendar, who has just resigned from the staff of McGill University, has designed a platinum electrical resistance thermometer capable of measuring temperature to the ten-thousandth part of a degree. The extreme delicacy of the instrument makes it a valuable aid in securing accurate observations of the temperature of lake and river water during the various seasons of the year, as no thermometer is available for such minute measurements. A long series of observations of the temperature of the St. Lawrence has been made this winter by the McGill professors, in all of which the new instrument has been used. By its aid it has been found that the greatest deviation that takes place in the winter during the ice-forming period is only about one-thousandth part of a degree. Prof. Callendar's invention is undoubtedly of great interest to the scientific world.

Federated Mining Engineers.—The annual meeting of the Federation of Mining Engineers, the headquarters of which are at Newcastle-upon-Tyne, was held in the rooms of the Geological Society, at Burlington House, on Thursday and Friday last week. The president (Mr. Chambers), in his opening remarks, commented on the progress of coal-mining since 1854—the year in which the great official record was established. The pits then were seldom beyond 200 yards in depth, and mostly in Durham. There were some able mining engineers even in those days, but the pits were generally sunk for the owners by managers, who were practical, but not scientific, and beyond the winding engine and the pumping engine there was little machinery. Since that time the progress in the coal industry has been constantly onward. Now, with the deep sinkings, often of 1,000 yards or more, the mining engineer has to be also a civil, mechanical, hydraulic, and electrical engineer, and with the development of by-product coke ovens has to possess a knowledge of chemistry as well.

Municipal Electric Lighting in America.—Mr. Horatio A. Foster contributes a short article to our New York namesake in reply to one by Prof. Common. The following extract illustrates some of the troubles which he has noticed as occurring from municipal ownership. The author says that he has had occasion to discuss such matters with two ex-superintendents of municipal plants. One said that no lighting committee did he ever work under but demanded that for that particular year he would have to run the plant cheaper than for any previous year, and to ensure that being the case they would allow no repairs of any nature, the result being that before five years were ended the plant was entirely rebuilt. The other man was superintendent of one of the Massachusetts municipal plants, and was forced out of his position because he would not employ all the help that was tendered him, and which has been employed since the change of management. The real charge is that of incompetent committees after all, or perhaps in some cases of public men, who are more keen for their own good than the public weal.

Hydraulic Jointing of Tubes.—This is not strictly an electrical subject, but all mechanical inventions tending to new processes of manufacture are of interest to electrical engineers. The idea of using water pressure to expand a tube into intimate contact with a socket originated with Mr. C. J. Crowder some two or three years ago. The first idea was to do away with the brazed joints in cycle frames, but, of course, the invention is equally applicable to other tubular work. Mr. Walter Claude Johnson, of the well-known firm of Johnson and Phillips, took the matter up, and has perfected the details in many ways. In the application of water power for such purposes the detail determines the success or failure of the process, and, as a rule, requires much more thought and car[e] the original invention. The method of procedure o[f] ing up a cycle frame is briefly as follows: The socket[s] which the tubes are fitted have their inner surfaces g[r] with interlacing recesses. Then after the tubes hav[e] put together the frame is clamped in supporting dis[c] water at a pressure of about $3\frac{1}{2}$ tons per square admitted to the inside of the tubes. This causes the to expand into the recesses, so as to form a sound which it is claimed is equal or better than a brazed It is claimed that a complete frame can be jointed in minutes. The process may be used for other work similar nature.

Alleged Injurious Effects of X-Rays.—I[t] decided, says the *Lancet*, at a meeting of the council [o] Röntgen Society on April 5 to nominate a commit[tee] collect information on the subject of the alleged inj[urious] effects on the human body caused by exposure to X[-rays]. The following members were selected, with power t[o] to their number: Prof. Silvanus P. Thompson, Dr Walsh, Mr. Thomas Moore, Dr. Barry Blacker, an[d] Ernest Payne (of Hatchlands, Cuckfield, Sussex), w[ho] acting as secretary to the committee. We are inf[ormed] that the committee will be glad to hear from all w[orkers] with X-rays of any case of injury that may have under their notice after exposure of a patient to the and in order to obtain accurate reports the committe[e] prepared a set of questions which have been framed view to elicit opinion and collect information to show w[hether] the injury was the result of any of the following c[auses]: (1) the X-rays themselves directly; (2) some elect[rical] or electro-thermal action of a leakage discharge c[oming] from the leads or from the terminals of the tube; (3) action due to the varying electrostatic charges o[n the] surface of the tube; (4) some combination of thes[e]; some other hitherto unrecognised kind of radiation e[mitted] simultaneously with the X-rays; or (6) some other hitherto unobserved. The secretary of the committ[ee will] be glad to send copies of the questions to any m[edical] man or other worker in X-rays who may know a case the circumstances of which he is willing to give parti[culars]. No names will be published in connection with the in[forma]tion supplied except by the distinct consent or requ[est of] those concerned.

Canadian Electrical Association.—At the meeting of the executive committee of the Canadian [Elec]trical Association, it was decided to hold the conventi[on] Tuesday, Wednesday, and Thursday, June 28, 29, an[d 30] in Montreal. The headquarters of the association d[uring] the convention will be at the Windsor Hotel, whe[re] business sessions and the annual banquet will be held. draft programme, recommended by the local commit[tee of] arrangements, with some slight amendments, was ad[opted] and is as follows: First day—Executive meeting, 9 10 a.m.; session, 10 a.m. to 1 p.m.; session, 2 to 5 7.30 p.m., trip round Mount Royal by special Par[k and] Island cars, afterwards ascending incline railway to lo[okout] on mountain to view the city under illumination. S[econd] day—Session, 9 to 12, noon; cabs and 'buses from W[indsor] Hotel at 1 p.m. to visit (1) Bell Telephone Company building, (2) Street Railway Company's power-hou[se] power-house and works of the Lachine Rapids Hy[draulic] and Land Company, returning to city at 7.30 p.m.; annual banquet of association at Windsor Hotel. day—Session, 9 to 12 a.m, election of officers and McGill University; 1.30 p.m., visit to Royal Electric [Com]pany's lighting station and factory, then by specia[l] train to visit the works of the Chambly Manufa[cturing] Company at Chambly. A number of very interesti[ng]

instructive papers relating to various phases of electrical work have been promised and are in course of preparation. Negotiations are in progress with the object of securing special transportation rates to enable a large number of the western members to participate in the proceedings of what will undoubtedly be a very pleasurable and instructive occasion. We take the above from the *Canadian Engineer.*

Electrical Fires.—The last quarterly report of the electrical bureau of the National Board of Fire Underwriters of America contains several interesting accounts of fires due to electricity. Three characteristic "burn-outs" are illustrated in the report. The first is a reproduction of a photograph from F. R. Whitney, superintendent of fire-alarms at Lewiston, Maine, and in the official report is numbered 2,164, the explanation being as follows: "Cross between arc light and telephone circuits caused the telephone line to ground where it entered the office of a large grist mill. The wire laid on a cross-timber over the office and the arc formed by the ground ignited the thick dust on the timber and spread the fire rapidly. The mill was burned to the ground. Loss, £5,000." Another fire was caused by "a guy wire to a telephone pole fastened to a three-storey brick building, which touched an eave trough, and drain which extended nearly to the ground also being in contact with the suspension wire of a telephone cable on the pole. Workmen half a mile away, while putting up a derrick, allowed a wire rope to fall across the telephone cable and a trolley wire. The trolley current found no ground until it reached this building. At this point an arc formed between the guy wire and the eave trough which set fire to the surrounding woodwork. Fire was soon discovered and extinguished with small loss." In another case "a cross between the fire-alarm and trolley wires allowed the heavy trolley current to enter fire-alarm boxes located on switchboard. The shunt of the door of the boxes was small and of insufficient capacity. The loss to boxes amounted to £180, besides crippling the service until after a severe storm." It seems to us that in all the above instances guard wires as required by our Board of Trade would have prevented the fires.

Rontgen Rays in War.—Surgeon-Major W. C. Beevor's lecture on "The Working of the Röntgen Rays in Warfare" at the Royal United Service Institution last Friday was most interesting. The lecture was based on the result of experiences the officer gained during the recent operations on the North-West Frontier. Surgeon-Major Beevor at the outset said his object was to give the results of the employment of the Röntgen ray in military surgery on the recent frontier expedition in India, and then to lay before them some modifications in the construction of the appliances for generating the X-ray which had suggested themselves to him after working amongst the wounded on the field of battle and its adjacent hospitals. He proceeded, with the aid of magic-lantern slides thrown upon a screen, to give representations of cases of interest from the campaign. These consisted of bullet wounds sustained by officers and men who had injured bones, joints, and internal organs baffling the skill of surgeons to ascertain their exact position, and which, but for the application of the X-rays, must have resulted in amputation of limbs and probable loss of life. The pictures shown included wounds in the arm, leg, chest, back, finger, and other parts of the body. The most remarkable results obtained by the Röntgen rays was perhaps that in the cases of a bullet embedded in the backbone, another in the hip, and an Indian soldier, who, at Rawal Pindi, was shot in the foot, pieces of the bullet finally lodging in the back of the heel, and the case of General Woodhouse, who received bullet wounds in the leg and arm at Dargai. In every one of the instances enumerated, the bullets were, by the use of the rays, successfully removed, the men subsequently rejoining their comrades at the front. Surgeon-Major Beevor proceeded, says the *Standard*, to give details of the requirements of an X-ray outfit for easy transport to the front.

The Telegraph from Cape Town to Cairo.—Mr. Cecil Rhodes, presiding last week at a shareholders' meeting of the African Trans-Continental Telegraph Company, Limited, sketched the history of the construction of the telegraph in the past and his hopes for the future. The present company was formed in 1892, and although the scheme appeared hopeless at the time, what a position it was in now! The £140,000 subscribed was sufficient for the first section, but it was almost spent. They went on from Umtali to Tete, thence to Kotacota, and they were now close to Bandawei. They expected that in 15 months they would get as far as Abercorn, at the south end of Lake Tanganyika. Mr. Rhodes added that they must not expect to make a profit until through communication was established with Cairo. He expected Kitchener to get to Khartoum by next October, bringing the telegraph with him. From there to Uganda was about 1,300 miles, with a river all the way. At Uganda the northern and southern lines would meet. He expected the Egyptian Government would undertake the construction of this section, taking up about a hundred miles of poles in the desert which had been abandoned by Gordon. He anticipated that the whole line from South Africa to Cairo would be completed in about five years, and then, Mr. Rhodes continued, when they had completed that undertaking, which even their opponents must admit to be a first-class undertaking, he hoped one day to be able to erect an obelisk bearing the names of those who had subscribed to the undertaking. Even their strongest opponents were now shaking their heads and saying, 'I really believe they are going to get through.' He himself was perfectly sure of it. However annoyed their opponents might be at their success, he hoped to meet them all in five years to celebrate the success of that great undertaking. An extraordinary meeting of the shareholders was subsequently held to increase the capital to £300,000. We are indebted to the *Manchester Guardian* for the above report.

Volenite, Limited.—The oft-repeated query, "What is Klondyke?" is to be replaced for electrical engineers by "What is Volenite?" The answer is that it is a new insulating material, which, according to Mr. F. Lamplough, C.E., industrial chemist and Board of Trade engineer, is to work wonders in the electrical world. "It is made in some way from fish oils, and may be sold, we are told," at a large profit for imperishable railway sleepers, railway carriage wheels, pulley wheels, friction wheels for hoists, and clutch couplings, brake blocks, carriage panels, embossed panels for artistic internal and external decoration; electrical switchboards, fuse bases, electric bell bases, magnet ends for dynamos, electric motors, and insulating material capable of resisting up to and above 70,000 volts pressure of electricity according to thickness; accumulator cells, dry cells, Leclanché cells, plating cells and vats, and many other articles. "The material for electrical purposes is, in Mr. Lamplough's judgment," vastly superior to any vulcanised fibre; and as it is an admitted fact that ever since the growth of electricity engineers have been anxiously seeking for a substitute for vulcanite and vulcanised fibre, the former being too expensive and the latter non-effective and unsuitable for their purposes in many respects, this should cause a very large demand. The material when only $\frac{1}{16}$in. thick is capable of resisting up to 70,000 volts pressure of electricity, which makes it invaluable for insulating purposes. The best vulcanite this thickness breaks down at 10,000 volts."

The other facts we gather from the advertisements in the daily Press are: that a company with a capital of £80,000 has been formed to make volenite, no shares are offered to the public, and the inventor takes the bulk of them in any case. Still we are told that the shares now stand at 500 per cent. premium, which means anything or nothing at the wish of the reader. We are inclined to be cynical at present, as no electrical expert has reported on the new material, which may hence have defects, from an electrical point of view, not suspected by Mr. Lamplough. At any rate, the public will do well at present to resist the temptation to buy at such a high premium, which perhaps would induce the inventor and others to unload.

Shades for Electric Lamps.—An interesting paper by Mr. J. C. Thompson appears in the *Electrical Engineer* of New York on the above subject, in which actual tests are given. The author also considers the question of colour in lighting. He says: "The effect of the reflection powers of various colours and characters of surfaces is not sufficiently appreciated. Where the lighting is of necessity economical, it makes a great difference whether the ceiling, walls, and furniture reflect 50 per cent. or whether they reflect 10 per cent. of the light they receive. Offices, workshops, schoolrooms, lecture halls, etc., therefore, should be finished in the lighter and warmer colours in order that a minimum of light may be necessary for their proper illumination. The following list of colours, with the respective reflective properties in percentage of incident to reflected light, will make this point clear: black velvet, 0·4 per cent.; black cloth, 1·2; deep chocolate, 4·0; black paper, 4·5; dark blue, 6·5; dark green, 10·1; dark brown, 13·0; bright red, 16·2; dirty yellow, 20·0; dark brown, 23·2; white sandstone, 24·0; blue paper, 25·0; yellow cardboard, 30·0; straw yellow, 34·4; yellow paper or paint, 40·0; green paper, 46·5; yellow paper, 50·0; grey paper, 50·0; light-coloured wood, 50·0; bright yellow paper, 50·3; light orange paper, 54·8; white paper, 70·0; freshly fallen snow, 78·0; white-washed ceiling, 80·0; dead white, 80·0; white blotting-paper, 82·0; mirror, 83·0; white cardboard, 92·3." The figures are collected from the work of Dr. Sumpner, Messrs. Rood and Tufts, Mr. O'Conner, etc. The above figures show how important it is to select the proper tint or paper for a wall or ceiling. Not less important, says the author, is the selection of shades. The diffusion of light, having for its object simply ease upon eyesight, considers but the area of the light source and its colour. Thus with shades of the same size and colour, that one should be selected which absorbs the least light during transmission. Data upon this subject is quite meagre. There does not seem to be any reason why the makers of these shades should not give the percentage absorption along with the description contained in their catalogues. This practice would no doubt lead to considerable improvement in diffusion globes and shades.

Rough Surveys for Tramways.—Mr. John Riddell, of Schenectady, has devised a small instrument for giving quickly the topographical peculiarities of a roadway, together with a record of distance. The instrument can be mounted on a cart, or even on a bicyle. It consists of a metal cylinder carrying the paper for the record, which is provided at the lower end with a worm-wheel engaging with a worm on a shaft running toward the rear of the bicycle and driven by a laced belt from a pulley on the crankshaft. Movement of the bicycle produces, therefore, revolution of the record cylinder, which, as it revolves, unwinds the paper for the record from a small drum. The marker is mounted on a nut on a threaded vertical rod, movement of which raises or depresses the nut and the marking point. The lower end of the rod is fastened to a horizontal disc free to move clockwise, or the reverse. Beneath the disc, and just clearing it on each side, are two smaller discs at each end of a toothed sleeve, and revolving vertically. Through the sleeve passes a disc shaft, provided with a gear-wheel meshing into a small gear on the main shaft driven from the crank axle. Suspended beneath the bar of the bicycle, and consequently beneath the entire machine, is a pendulum, having at its upper end a toothed quadrant, gearing into the teeth of the sleeve on the shaft carrying the vertical discs. As the small discs revolve in the same direction, one in contact with the large horizontal disc revolves it clockwise and causes the marker to ascend, the other counter clockwise, depressing the marker. The nearer the centre of the large disc the small disc comes the faster the former moves, and the sharper the angle described by the marker. The pendulum hangs vertically, whatever be the angle of inclination of the bicycle. If the machine is ascending, the horizontal bar assumes an obtuse angular position to the pendulum, the rear vertical disc is brought beneath the horizontal disc, and the marker moves upward; if a declivity is descended, the angle of the bar and the pendulum becomes acute, the forward disc comes into play, and the marker moves downward. On the level, both vertical discs are out of contact with the horizontal disc, and the marker records a plain, horizontal, straight line. It seems, from the description of this instrument in the *Street Railway Journal*, that lengths and elevations only are recorded, and not the curves of the roadway.

Compound-Wound Motors.—In the early days of power distribution by direct-current electric motors, says the *Electrical World*, a compound winding was used by which the field excitation was reduced as the speed increased, thereby maintaining a closer speed regulation on constant potential than is attainable with a simple shunt motor. This practice has gone quite out of use, the speed regulation of the shunt machine being sufficiently close for all practical purposes. On the other hand, the compound winding has come into favour, so connected that the field excitation increases with the increase of load, thereby giving greater torque with the same armature current, lower speed, and increased field excitation at the time when it is most needed to reduce the field distortion. These features are of value in many applications of a motor—such, particularly, as crane and elevator work, where close speed regulation is of no advantage, and, in fact, the reduction of speed with the increase of load is preferable. This compounding has of late been carried further and further, at least one machine now being made for elevator work, with all the resistance of the starting rheostat mounted upon the field coils to give a greatly overcharged field at low speeds. There is a danger in this that does not seem to have been generally appreciated. With machines that are reversed, working both ways and with loads that may be negative, or, in other words, loads that may under certain conditions tend to drive the machine in the same direction that the motor is driving it, thus turning the motor into a generator, the series winding may involve serious trouble. While, on a motor load, the series coils add to the excitation of the shunt coil, if the load reverses, and tends to drive the motor as a generator, the current in the series fields neutralises in part the excitation of the shunt fields, weakening the magnetisation, and tending to speed the motor up and make it run away. In extreme cases the series windings may completely demagnetise the fields, leaving the armature to act as a short-circuit across the lines. In machines that invariably absorb power when

running in one direction and give it out when running in the other—such as crane hoists or under-counterweighted elevators—this danger may be provided against by reversing the connections of the series field simultaneously with the reversal of the armature connections for changing the direction of motion. In that case, when the load comes down, the current generated in the armature tends to increase the field excitation—just as when the load is lifted, the current delivered to the armature increases the excitation; but with under-counterweighted elevators, or any load where the torque may reverse when running in either direction, the series field is a decided element of danger.

Cable-Cutting.—Mr. T. E. Holland, writing to the *Times*, says he ventures to think that the question which has been raised as to the legitimacy of cable-cutting is not so insoluble as most of the allusions to it might lead one to suppose. The question is a new one, but, though covered by no precedent, the writer considers that it is covered by certain well-established principles of international law, which, it is hardly necessary to remark, is no cut-and-dried system, but a body of rules founded upon, and moving with, the public opinion of nations. That branch of international law which deals with the relations of neutrals and belligerents is, of course, a compromise between what Grotius calls the *belli rigor* and the *commerciorum libertas*. The terms of the compromise, originally suggested partly by equity, partly by national interest, have been varied and redefined from time to time with reference to the same considerations. It is, perhaps, reasonable that in settling these terms preponderant weight should have been given to the requirements of belligerents engaged possibly in a life-and-death struggle. There is no doubt that in land warfare a belligerent may not only interrupt communications by road, railway, post, or telegraph without giving any ground of complaint to neutrals who may be thereby inconvenienced, but may also lay hands on such neutral property—shipping, railway carriages, or telegraphic plant—as may be essential to the conduct of his operations, making use of and even destroying it, subject only to a duty to compensate the owners. This he does in pursuance of the well-known *droit d'angarie*, an extreme application of which occurred in 1871, when certain British colliers were sunk in the Seine by the Prussians in order to prevent the passage of French gunboats up the river. Count Bismarck undertook that the owners of the ships should be indemnified, and Lord Granville did not press for anything further. Such action, if it took place outside of belligerent territory, would not be tolerated for a moment. The application of these principles to the case of submarine cables would appear to be, to a certain point at any rate, perfectly clear. Telegraphic communication with the outside world may well be as important to the State engaged in warfare as similar means of communication between one point and another within its own territory. Just as an invader would without scruple interrupt messages, and even destroy telegraphic plant, on land, so may he thus act within the enemy's territorial waters, or, perhaps, even so far from shore as he could reasonably place a blockading squadron. It may be objected that a belligerent has no right to prevent the access of neutral ships to unblockaded portions of the enemy's coast, on the ground that by carrying diplomatic agents or dispatches they are keeping up the communications of his enemy with neutral Governments. But this indulgence rests on the presumption that such official communications are "innocent," a presumption obviously inapplicable to telegraphic messages indiscriminately received in the course of business. It would seem, therefore, to be as reasonable as it is in accordance with analogy that a belligerent should be allowed, within the territorial waters of his enemy, to cut a cable, even though it may be neutral property, of which the *terminus ad quem* is enemy territory, subject only to a liability to indemnify the neutral owners. The cutting, elsewhere than in the enemy's waters, of a cable connecting enemy with neutral territory receives no countenance from international law. Still less permissible would be the cutting of a cable connecting two neutral ports, although messages may pass through it which, by previous and subsequent stages of transmission, may be useful to the enemy.

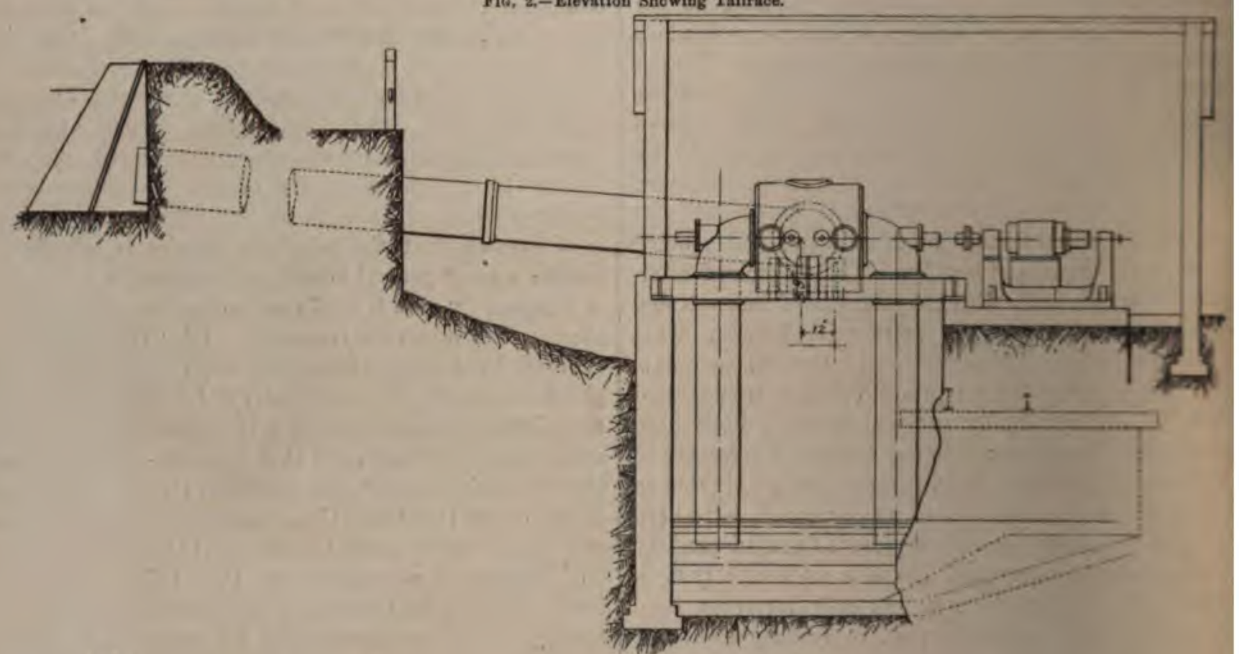
The Telephone Question.—On Monday last a conference of representatives of various municipal authorities was held at the County Hall, Spring-gardens, over which Mr. T. McKinnon Wood presided. The object of the conference was to discuss the telephone question. The resolutions which were passed overlap to a certain extent, and denote that the meeting was not well organised beforehand. The following are the texts of the resolutions actually passed according to the *Times*: (*a*) "That this conference is of opinion that the telephone service is calculated to become a great general benefit, and is so much in the nature of a monopoly that it ought not to be left permanently in the hands of a private company." (*b*) "That the evidence afforded by foreign towns and cities shows that similar places in this country—especially in London—do not utilise the telephone for business and private purposes to nearly the same extent as abroad, and that such non-use arises mainly from excessive charges and inefficient service, and from the failure of the Post Office Department to provide an adequate number of trunk lines to connect the local exchanges." (*c*) "That in the event of the Post Office being unable forthwith to take over the whole telephone service of the country it is practicable and advisable that municipal authorities should be empowered to provide such service in their respective localities, on the understanding that every facility will be afforded for close co-operation between the local authorities and the Post Office." (*d*) "That as the National Telephone Company obtained its powers and raised its money upon the basis of being subject to actual effective competition, it is just and expedient that steps should be taken to protect the public against the practical monopoly that this company has obtained for itself and against the inordinate charges that are only leviable by the company by reason of such monopoly." (*e*) "That as one of the causes of the excessive charges is the fact that the company's capital, upon which dividend is paid, has been swelled by the expenditure of large sums of money not represented by any works, it is inequitable that the public should be forced into the position of having either to submit to such charges permanently or to buy out the company on the basis of such charges." (*f*) "That, seeing that the license of the National Telephone Company will expire in 1911, it is expedient (1) that Parliament should decide that no extension of the license should be granted to the company; (2) that, in the event of the various municipalities being granted licenses to establish and work local telephone services prior to 1911, such licenses should carry all trunk and other facilities and liberty to speak over other lines, and that such licenses shall only be terminable on the payment by the State of the outlay upon the undertakings." (*g*) "That the power of the breaking up of the streets which is claimed on behalf of the National Telephone Company—acting through the Postmaster-General—is a grave interference with the rights of municipal authorities." It was agreed that these resolutions should be laid before the Select Committee on the Telephone Service.

AN ENGLISH WATER-POWER PLANT.

Before the days of steam-engines the water power in the southern counties of England was most carefully developed and utilised for flour-milling purposes. In fact, the small streams in these counties are almost all checked by dams and millponds formed for storage. The power available in such case is not as a rule very great, but the miller, by husbanding the water coming down, could as a rule obtain all he wanted during working hours. Now, the improvement in steam milling plants, and the consequent establishment of mills of very large outputs, has played havoc with the small millers, who in years gone by had a profitable business. The water power is thus in some cases falling into disuse, or is available for other purposes. We know of no better example of how these small powers can be used than the installation at Worth Park, at Three Bridges, recently completed by Messrs. J. S. Cunnington and Co., of 93, St. Martin's-lane, W.C. Worth Park is the country seat of Mrs. Montefiore, and the house has been electrically lighted for some years. The steam-driven dynamo was situated in the farm buildings some three-quarters of a mile away. The accumulators are placed at the house, where there are some 400 lamps fixed. The power to drive the agricultural machinery is produced by electric motors, as are also two pumps lifting the water out of a well and forcing it up to a reservoir on some high land behind the house.

It need hardly be said that for all these purposes a considerable amount of coal was used, and hence the advisability of using water power arose. An old corn mill abou yards from the farm, on the side farthest from the h was little used, and the steward for the property took the water rights from the tenant at a most moderate The contract for the supply of the necessary turbine dynamos was then placed with Messrs. J. S. Cunni and Co., whose engineer, Mr. Cunnington, had tak active part in recommending the use of this power. The construction work was none too ea the old waterwheel was not to be removed, a roadway restricts the space available on the free si this wheel. The arrangements finally adopted are in plan in Fig. 1 and in elevation in Fig. 2, whil photograph reproduced (Fig. 3) shows the machine

FIG. 2.—Elevation Showing Tailrace.



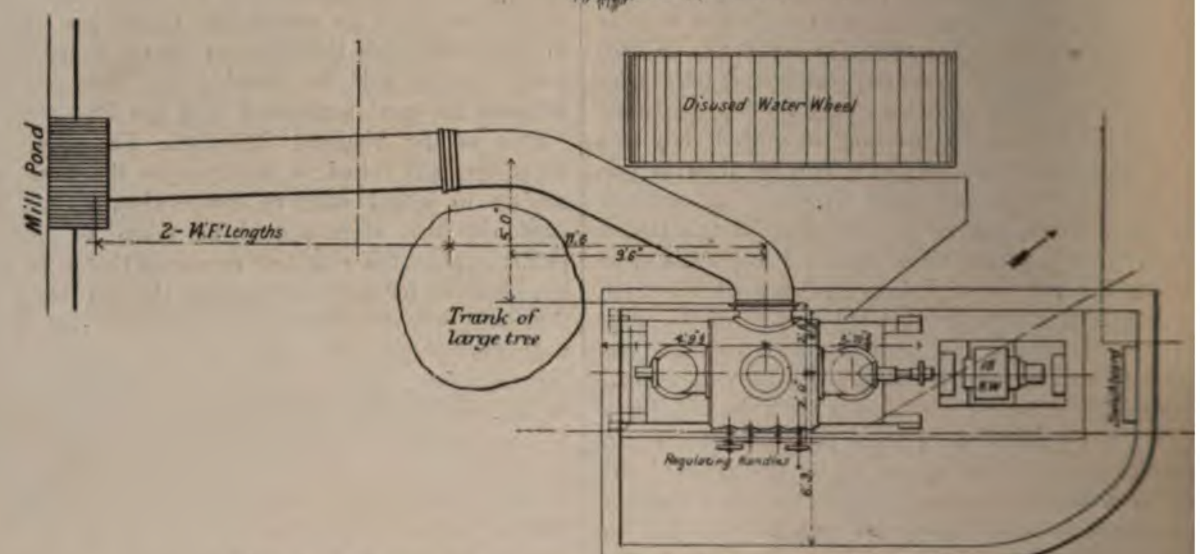


FIG. 1.—Plan of the General Arrangement of the Turbines and Dynamos at Worth Park.

fixed before the building was completed round it. large tree, the trunk of which appears also in the pla considered too valuable from an artistic point of view cut down. The pond above the dam is of large are of no great depth, as it has not been kept clear of The head available for power purposes varies from 1 15ft., but some contemplated alterations to the tail-rac increase this by at least 1ft. The main flume, adm water from the pond to the twin turbines, is of r steel 2ft. in diameter, while each turbine is provide a waste-water or suction out-take about 1ft. 6in. dia These, as shown, project well down below the level tail-race water, so that a water seal is always tained. The flow of water is regulated at the turbi a sluice, not shown in the drawing, also allows of th of the intake flume being shut.

I am especially induced to do this as I venture to think that all mystery on this very important subject will vanish as soon as it is acknowledged that the ether is the residue of the primary unformed stuff, and was left after the formation of matter by condensation, as it will then be ascertained that the ether holds a place in nature only second to that of formed matter, and it will be seen that great simplicity attends the evolution of natural phenomena.

It will be well to recapitulate and accurately define the points upon which my theory is based. They are as follows:

1. That space was primarily occupied by a medium which was perfectly homogeneous, continuous, and of one uniform density throughout. To this medium I have ventured to give the name of "eogen."

2. That motion was originated in this medium by power acting upon it from without. The external manifestation of power being essential, because its characteristics would not admit of motion being self-originated.

3. That motion gave origin to variations in density and to quantitative segregation.

4. That absolute contact and the force of cohesion were defined and limited in extent by segregation upon the

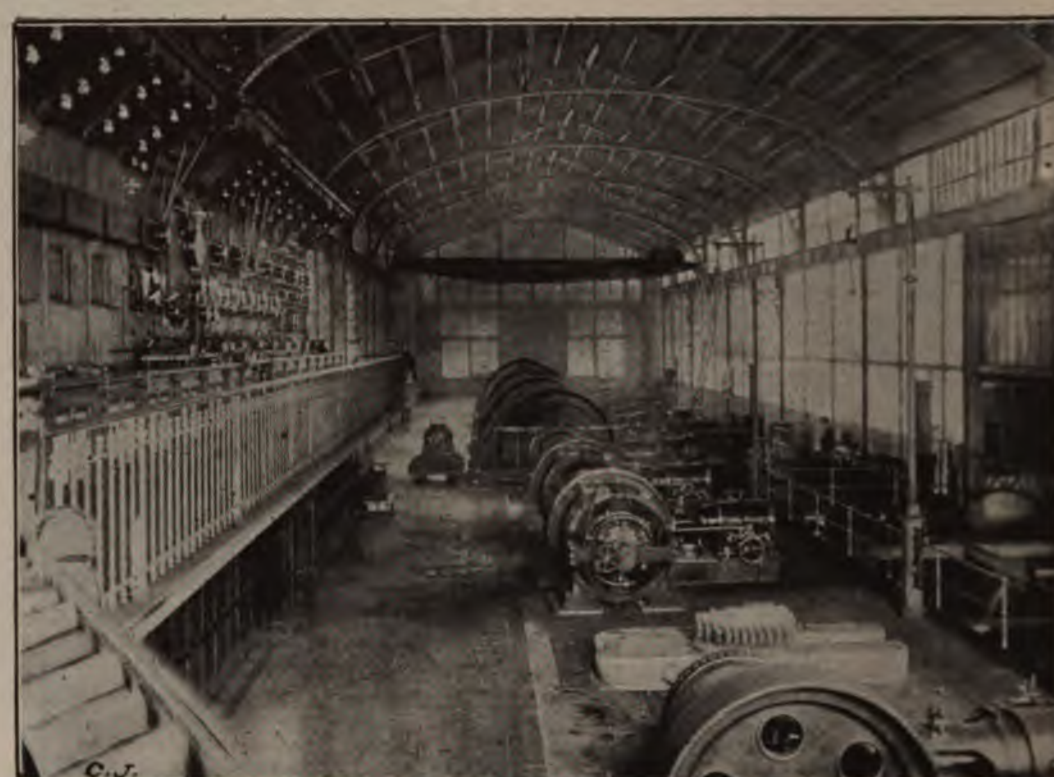


FIG. 10.—Electricity Works of the Secteur de la Rive Gauche.

same principle as exists between a condensed gas and its uncondensed residuum. But whilst a gas liquefied by external pressure tends, if the pressure is not maintained, to resume its gaseous state, matter formed by cohesion in the manner which I have described, tends by cohesion to maintain its normal solid, liquid, or gaseous states.

5. That the force of cohesion then acted centrally upon each segregated portion, and caused it to assume the spherical form.

6. That the physical properties of formed matter, more especially density and axial rotation, were determined by the quantity of "eogen" existent in each.

7. That centres condensed under cohesion became force centres—*i.e.*, centres of gravity—in proportion to mass, and exercised stress or strain upon each other, under which they took on rotation, and the spherical was exchanged for the spheroidal form.

Note.—Cohesion thus appears to be a non-molecular, and gravity a molecular, manifestation of stress, a view which, I believe, accords in measure, at least, with Boscovich's theory, the more especially as absolute contact throughout is ensured in the former and cannot occur in the latter or *molecular* condition of matter, except in a very modified degree. It is true, indeed, that under certain artificial conditions, such as occur when two flat and highly-pol
surfaces of glass are placed in contact, they may coher
cannot again be separated; or, again, in the process k
as electric welding, when the parts cohere very firmly
in each of these cases the cohesion, according to my th
is effected by the ether which is condensed upon
molecular surfaces, ether which, according to Fre
theory, is agglomerated or bound round each atom, be
to the matter and travels about with it.

8. That the extent of attenuation of the residuum
in proportion (*a*) to the quantity of "eogen" which
undergone condensation and conversion into formed m
and (*b*) to the stress or strain which these bodies exer
upon the intermediate stuff.

It is not difficult to define the characteristics
should pertain to ether formed in the manner I
described above, because these must partake large
those which pertain to the "eogen." Thus such an
must be continuous, homogeneous, frictionless, posse
inertia, having great tenuity and variable density, de
which, from the suction force which is exercised up
by the stress of each unit of formed matter, must,
gravity, vary with its proximity to matter. Consequen
should be condensed upon the surfaces of the mole
in conformity with Fresnel's views, and should for
ethereal atmosphere to each. The same principle d
it to be compressible, but shows also that its gr
attenuation and its greatest rigidity must be found i
line of the greatest gravity—*i.e.*, in the line which p
through the centre of any two bodies, such as the su
the earth—because the strain is greater along such
than it can be elsewhere. Further, as each unit of fo
matter is undergoing axial rotation whilst it is exer
great suction stress upon the ether in which it is imm
and with which in proportion to the density of this me
it is continuous, it is creating vortex motion in the
the intensity of the suction forces of which vortices
vary with their areas on the same principle as gr
The areas of such vortices it seems impossible to
further than to assume that they are more or less
mately associated with the systems in and by which
were originated.

The above is a general sketch of the nature o
compressible ether evolved by the formation of matt
condensation of the original primary stuff or "eoge
accordance with my theory.

	Price of the kilowatt-hour. For lighting. d.	For motive power. d.
Municipal works at the Halles	10·0	5·76
Continental Edison Company	10·3	3·84
Société d'Eclairage et de Force	10·0	3·84
Compagnie Parisienne de l'Air Comprimé	10·9	4·8
Sector of the Place Clichy	10·7	4·8
Compagnie du Secteur des Champs Elysées	12·2	5·76
Sector of the Rive Gauche	9·3	3·84

The present concessions will expire in 1906 and in 1907. The Municipal Council of Paris has latterly given much consideration to the conditions under which they may be prolonged. M. Charles Bos has made a special report on this subject. Without entering into all its details, we will indicate some particular conditions. Electrical energy should be delivered at the price of 9·6d. per kilowatt-hour for private lighting, and at the price of 4·8d. for public lighting. Electrical energy for motive power, heating, and various uses should be paid for at the rate of 3·84d. per kilowatt-hour. The charging of accumulators for automobile vehicles should be effected also at prices varying from 2·86d. to 1·53d. and upwards per kilowatt-hour according to consumption. These various conditions have not yet been accepted, and the concessions are not extended. But it is probable that a solution will shortly be arrived at, so as to allow of all the necessary arrangements being made to ensure an abundant distribution of electrical energy in the interior of Paris during the Exposition of 1900.

INSTITUTION OF ELECTRICAL ENGINEERS, May 19.

The Design of Electric Railway Motors for Rapid Acceleration.

BY PROF. CHARLES A. CARUS-WILSON, MEMBER.

The torque on the shaft of a motor may be expressed by the equation:

$$t = 1{\cdot}41\, p\, A\, C\, N\, 10^{-8} \text{ inch-pounds} \quad . \quad . \quad . \quad (1)$$

where N is the number of C.G.S. lines per pole, A is the number of surface conductors, C is the total current passing into the motor, in amperes, and p is a numerical constant depending upon the way in which the armature is wound. This equation may be written,

$$t = 1{\cdot}41\, C\, M \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where M is given by

$$M = p\, A\, N\, 10^{-8} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

We shall call M the induction factor of the motor. Since the tension e induced at n revolutions per second is given by

$$e = A\, N\, n\, 10^{-8} \text{ volts} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

the induction factor may be found by dividing the induced tension in volts by the speed in revolutions per second, and the induced tension is given by the product of the induction factor and the speed. The constant p may be defined as the ratio of the number of surface conductors in series between the main terminals to the number of surface conductors lying between two adjacent neutral points, and is unity for a bipolar machine, whether drum-wound or ring-wound.

When a motor is running at n revolutions per second, and taking a current of C amperes, we have the following expression for the speed:

$$n = \frac{E - C\,R}{M} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where E is the terminal tension in volts, and R is the resistance of the motor in ohms measured between the same points as the tension. Hence, in the case of a railway motor, the speed in feet per second is given by

$$s = 0{\cdot}262\, \frac{d}{M\, v}\, (E - CR) \quad . \quad . \quad . \quad . \quad . \quad (6)$$

where v is the ratio of the speed of the motor to that of the main axle—afterwards called the velocity ratio—and d is the diameter of the driving wheel in inches.

If an experiment be made in which the speed, the tension of the line, and the current are observed, we can find from equation (5) the value of the induction factor for different currents, and thus obtain what we shall call the induction curve. Such a curve is given in Fig. 1 for the "G.E. 800" railway motor made by the General Electric Company.

From the induction curve we can deduce the curve of total torque for different currents. This curve will lie above that obtained by measuring the torque at the rim of the brake-wheel, the difference for any current representing the torque expended in overcoming friction of gearing, hysteresis, etc. Th[e] ratio of the two ordinates for any current gives the mechanic[al] efficiency for that current.

If the current passing through the motor at any instant i[s] greater than that required to overcome the frictional and othe[r] resistance to motion, the motor will accelerate, and the accelera[-] tion in feet per second per second will be given by

$$a = 405 \times 10^{-4}\, \frac{M\, v}{d}\, \frac{C_a}{W} \quad . \quad . \quad . \quad . \quad . \quad (7)$$

where C_a is the current in amperes available for acceleration and W is the whole weight that has to be accelerated, in tons o[f] 2,240lb.

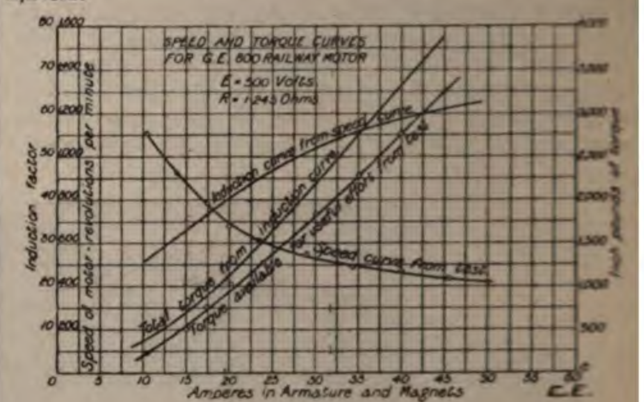


FIG. 1.

As an illustration, we may take the motors used on th[e] Baltimore and Ohio Railroad. The conditions are as follows: a train weighing 780 tons has to start from rest on a grade o[f] 0·8 per cent.; the train is drawn by a locomotive equipped wit[h] four motors permanently connected in series. The drivin[g] wheels, which are gearless, have a diameter of 62in. Th[e] maximum current from the line is limited to 1,800 amperes and the mean value of M while the motors are starting may b[e] taken as 155.

The tractive effort per motor required for the grade i[s] 3,490lb., and for friction, allowing 9lb. per ton, 1,755lb., making altogether 5,245lb. If we allow 95 per cent. mechanica[l] efficiency, we find from equation (2) that the current required t[o] overcome friction must be equal to 780 amperes, leaving 1,02[0] amperes available for acceleration. Under these circumstance[s]

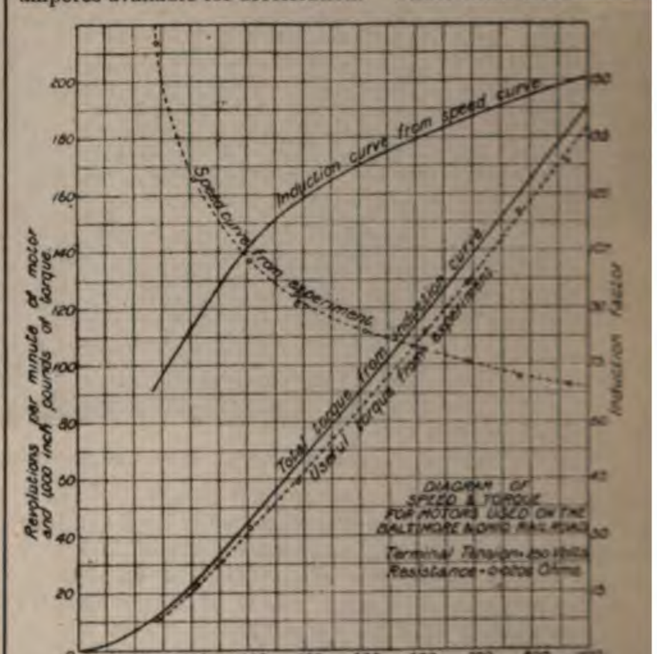


FIG. 2.

the train will start up from rest with an acceleration o[f] 0·53 f.p.s. per second. The induction curve of these motors i[s] given in Fig. 2, and the current curve observed in starting i[s] given in Fig. 3.

If a pulley of d centimetres diameter is placed on the shaft o[f] a motor of induction factor, M, carrying a current of C amperes the tangential force at the rim of the pulley is given by

$$T = \frac{1}{\pi d}\, M\, C\, 10^{7} \text{ dynes} \quad . \quad . \quad . \quad . \quad (8)$$

If $d = \frac{1}{\pi}\, 10^{7}$cm., this may be written,

$$T = M\, C \text{ dynes} \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

force of a motor may thus be defined as a force of M C at the rim of a pulley 10^7cm. in circumference. We shall C the force factor of the motor. Thus, in the preceding e, each of the four motors must have a force factor of lodynes in order to start up with an acceleration of p.s. per second.

rating of a motor in horse-power gives us no indication of ity to accelerate, though this may be the most important n it is called upon to perform. Thus, in the last example, rse-power of the motors at the moment of starting is g. In the problem that we now propose to discuss we ind it convenient to be able to define the action of a in terms of a force unit instead of a power unit, and for

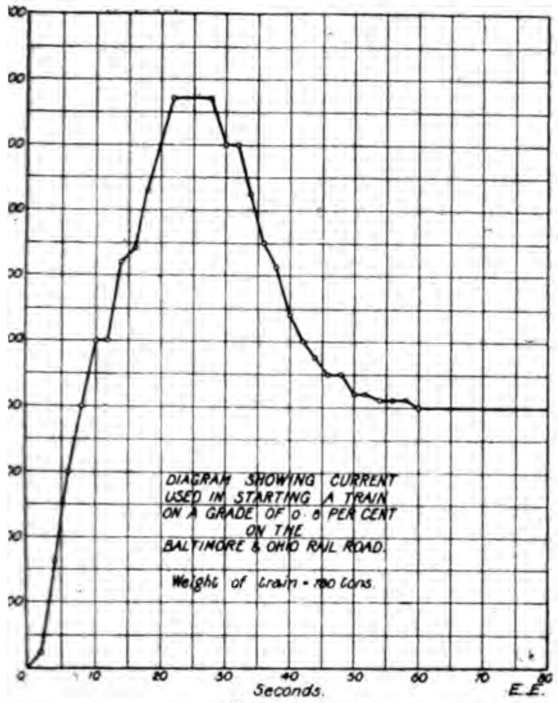


FIG. 3.

irpose we shall make use of the force factor. We may n passing that the power in kilowatts at any moment is by multiplying the force factor in kilodynes by the number olutions per second. When a given distance has to be d, we may divide the whole period of motion into two —that of acceleration, and that of uniform speed. For resent we shall assume that, if there are two or more s in the locomotive, they are connected in parallel, and hey speed up with uniform acceleration until full speed is ed. From equations (6) and (7) it appears that, if everything

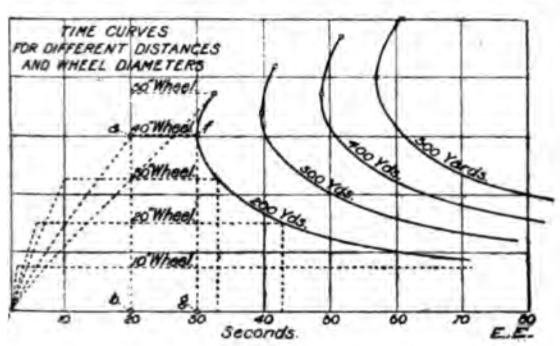


FIG. 4.

remains unchanged, the acceleration increases directly, the final speed inversely, as $\frac{M\,v}{d}$. For example, if we M and v the same, we can increase the acceleration utting on a smaller wheel, but we shall thereby reduce final speed. The accelerating period will then be small, most of the distance will be covered at full speed. e other hand, if we increase the diameter of the driving l we shall get a small acceleration but a high final speed. of the distance will then be covered during the process of rating, and full speed may not be reached before the given ce has been traversed. Similarly, if we vary the velocity keeping M and d the same, we shall get the reverse of results; or if we keep v and d fixed and vary M we shall e same results as if we varied the velocity ratio.

Fig. 4 the horizontal axis represents seconds, and the al axis speed in feet per second. Let us suppose that the conditions are such that with a driving wheel 40in. in diameter an acceleration of 1·5 f.p.s. per second is obtained, and that the final speed is 30ft. per second. A distance of 200 yards will then be covered in 30 seconds, 20 seconds being occupied in accelerating, during which time 100 yards is covered, the remaining 100 yards being covered in 10 seconds at full speed. If now we replace the 40in. wheel by one whose diameter is 30in., we increase the acceleration to 2 f.p.s. per second, but reduce the final speed to 22·5 f.p.s., so that it takes 33 seconds to travel 200 yards. If we put on a 50in. wheel the acceleration is decreased to 1·2 f.p.s. per second, and full speed is only just reached when the 200 yards has been covered, the time being nearly 33 seconds. If a line, such as $a\,f$ in the figure, is drawn to a point at which the given distance is covered, the points thus found by using wheels of different diameters will lie on a curve. We shall call this the time curve. In the figure, dotted lines such as $h\,a$ represent the accelerating period, and dotted lines such as $a\,f$ the period during which the motors are running at full speed. The area $h\,a\,f\,g$ then represents the whole distance covered in the time $h\,g$. Time curves have been drawn for distances of 200, 300, 400, and 500 yards. An increase in the value of M or of v gives the same result as a decrease in the value of d.

It is evident that there is a certain value of $\frac{M\,v}{d}$ for which the time occupied in covering any given distance is a minimum. This value we shall now proceed to find. We know from equation (7) that the acceleration varies inversely as $\frac{d}{M\,v}$. We may express this fact as follows:

$$\frac{a\,b}{h\,b} = k_1 \frac{1}{\beta} \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

where k_1 is a constant, and $\beta = \frac{d}{M\,v}$.

From equation (6) we have

$$a\,b = k_2\,\beta \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

where k_2 is a constant.

If D is the whole distance in feet that has to be covered, we have

$$D = \tfrac{1}{2}\frac{k_2^2}{k_1}\beta^3 + k_2\,\beta \times b\,g \quad . \quad . \quad . \quad . \quad (12)$$

hence, by substitution, we get

$$t = \frac{D}{k_2\,\beta} + \tfrac{1}{2}\frac{k_2}{k_1}\beta^2. \quad . \quad . \quad . \quad . \quad . \quad (13)$$

where t is the time occupied. To find what value of β makes the time a minimum, differentiate and equate to nothing, and we have $\beta^3 = \frac{k_1}{k_2^2}\,D$, or $b\,g = \frac{1}{2}\,b\,h$. The given distance then is covered in the shortest time, when the equipment is such that the distance travelled during the process of acceleration is equal to that travelled at full speed, the time of acceleration being two-thirds of the whole time.

Substituting for k_1 and k_2 their values as given by equations (7) and (6), we get

$$\left\{\frac{d}{M\,v}\right\}^3 = 0{\cdot}59\,\frac{D}{W}\,\frac{C_a}{(E - c_f\,R)^2} \quad . \quad . \quad . \quad (14)$$

It appears, then, that when a train of weight W tons has to be started from rest and moved through a distance of D feet, the tension of the line being E volts, the accelerating current, c_a amperes, and the internal drop when running at full speed, c_f R volts, the time occupied is least when the ratio $\frac{d}{M\,v}$ is that given by equation (14); and that if this value of $\frac{d}{M\,v}$ is adopted, half the distance will be covered in the process of accelerating.

Since the equation (14) gives the value of $\frac{d}{M\,v}$ for covering any distance in the least time for a given accelerating current, it follows that, when the time as well as the distance is given, the accelerating current will be least when half the distance is covered during acceleration. For, if any other ratio of $\frac{d}{M\,v}$ is adopted than that which covers half the distance during acceleration, the time will be prolonged, and consequently a greater accelerating current required.

We have then, two conditions to fulfil. First, half the distance must be covered at full speed in one-third the time. If we are at liberty, as we generally are, to adjust the value of the resistance so that the drop at full speed is independent of M, v, and d, we then have

$$\frac{M\,v}{d} = 0{\cdot}1747\,\frac{t\,e}{D} \quad . \quad . \quad . \quad . \quad . \quad (15)$$

where e is the induced tension at full speed, or the tension of the line minus the heat drop. It thus appears that the ratio $\frac{M\,v}{d}$, which governs the design of the whole equipment, is given

by the consideration that half the distance must be covered at full speed in one-third of the time.

The accelerating current can now be found from equation (7). We know that half the distance has to be covered in two-thirds of the time; this gives us the acceleration. We know also the value of $\frac{M\,v}{d}$, and of W. Hence we deduce:

$$C_a = 55{\cdot}5\,\frac{D\,W}{t^2}\,\frac{d}{M\,v} \quad . \quad . \quad . \quad . \quad . \quad (16)$$

or we may write at once,

$$C_a = 318\,\frac{D^2\,W}{e\,t^3} \quad . \quad . \quad . \quad . \quad . \quad . \quad (17)$$

If we know the retarding forces at full speed we can find the current, since $\frac{M\,v}{d}$ is fixed, and hence we can obtain the resistance of the motor.

For example, suppose that we have to design an equipment by which a tramcar weighing 10 tons can be started from rest and moved through 500ft. in 30 seconds. We may suppose, further, that two motors are to be used, connected in parallel throughout; that the tension of the line is 500 volts, and the drop at full speed nine volts. From equation (15) we obtain the value of $\frac{M\,v}{d}$, and find it to be 5·15. We may assume for the present that v is limited to 4·78, and that d is 33in.; hence M=35·5. The maximum speed is 25ft. per second, or 17 miles per hour. If the frictional and other forces retarding the motion are equal to a torque of 3,580 inch-pounds on each axle, the current at full speed will be 15 amperes, and the resistance of each motor 0·6 ohm.

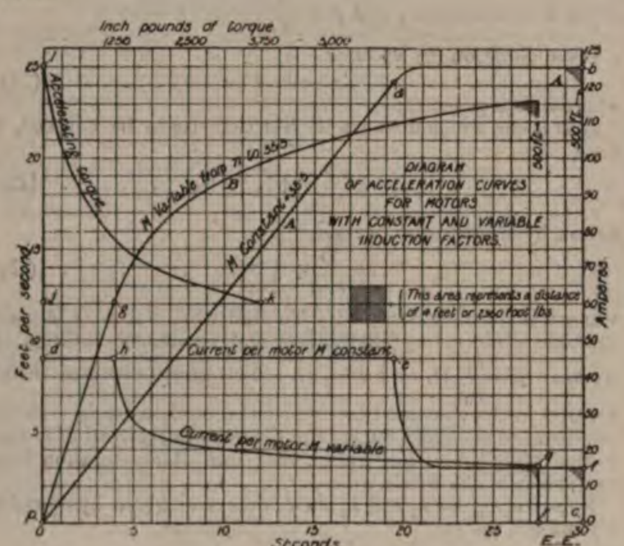


FIG. 5.

From equation (16) we find the accelerating current to be 30 amperes; so that the total current at starting is 45 amperes, assuming that the induction factor remains constant throughout. These results are shown in Fig. 5. Horizontal ordinates represent time in seconds, and vertical ordinates speed in feet per second, and also amperes. The acceleration is 1·25 f.p.s. per second, and can be kept constant until the starting rheostat is all out. The speed at which this takes place can be found from equation (6), by inserting the known value of $\frac{M\,v}{d}$ and putting E=500, R=0·6, C=45. We find that the speed is 24·2 f.p.s., or 97 per cent. of the final speed. The error involved in assuming that the acceleration is constant up to full speed does not amount to 1ft. of distance. From the figure we see that half the distance is covered in 20 seconds during the process of accelerating, and the remaining 250ft. is covered at full speed in 10 seconds. The whole area of the curve, $p\,a\,b\,c$, represents 500ft. The maximum current, 45 amperes, is constant up to the point a, when the starting rheostat is all out. This is shown by the current curve. At the point e on this curve, corresponding to the point a on the acceleration curve, the current will rapidly diminish; the form of the curve has been calculated and plotted in the figure.

We must now consider the influence of series winding on the curves of current and acceleration. In Fig. 6 let values of the current be measured horizontally, and values of the induction factor be measured vertically. Take $a\,h$ equal to 15 amperes, and set up $h\,b$ equal to 35·5 on the vertical scale. Then b is a point on the induction curve of the motor. For whatever are the values of M for large currents, the value of M for 15 amperes must be 35·5 in order that the motors may run at the required rate at full speed. Take $a\,g$ equal to the maximum current,

45 amperes. Produce $a\,b$ to cut a vertical line thr
The greatest possible induction factor the motors
45 amperes is given by $g\,c$, equal to 106 on the M
the induction curve of a series-wound motor cannot
to the axis of current, though it may be a straight l
throughout the origin if no part of the iron in th
circuit is magnetised over the bend of the magnetisa
We have shown in this case that the induction curve
through the point b; hence the greatest possible
for these motors is found by making the inductio
straight line passing through b, giving us a maximum
factor of 106.

Our calculations hitherto have shown us that
must have an induction factor of 35·5 at 15 amperes
the maximum current at starting must be 45 amperes.
not, however, determined the value of the inductio
45 amperes. All we know is that if M is constant an
35·5 for all currents, we shall cover the given dist
given time. It is clear that there are an infinite
possible induction curves, all passing through the poin
different values of M for 45 amperes, all less than
one of these curves would comply with the specifica
time and distance, but we shall see that none of them
so good from the point of view of economy as the lin

When the maximum current to be carried by a mot
the weight increases nearly in proportion to the induc
for that current. We shall assume that for any c

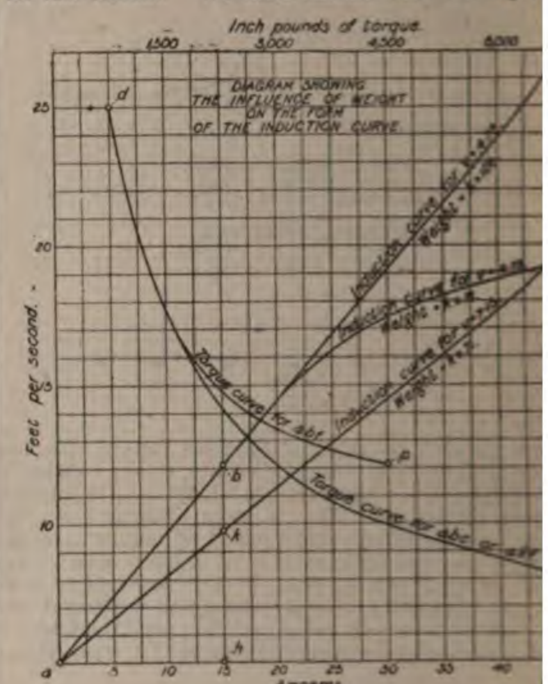


FIG. 6.

weight is given by k times the induction factor for th
where k is some constant. Hence, of all induction
might be chosen, that given by $a\,b\,c$ will involve th
weight. Let us suppose that the practical consid
space and cost limit the weight of the motors in t
that maximum value of M for 45 amperes is 71—twi
15 amperes. The induction curve must then pass t
points $a\;b\;f$; let the curve $a\;b\;f$ in the figure be
chosen. From the induction curve we can constru
giving the total torque available for all purposes. In
this is drawn at $d\,p$, horizontal ordinates giving torq
pounds on each motor axle, and vertical ordinates sp
per second. By deducting from the horizontal o
this curve the torque required to overcome the retard
we obtain a curve of torque available for accelerat
curve is reproduced at $l\,k$ in Fig. 5; it cuts the sp
25ft. per second.

We can now construct the acceleration curve for
wound motors. The maximum total torque is 4
pounds. Deducting 750 inch-pounds for the retardi
assumed to remain constant at all speeds, we get
acceleration of 3·12 f.p.s. per second—more than
obtained when M was constant. The speed of the
the rheostat is all out is 12·1 f.p.s. This speed is
about four seconds, and is shown by the point g. F
the acceleration is constant. The form of the a
curve beyond this point has been found by graphic co
and continued up to the point at which the area, a
with a planimeter, is equal to a distance of 500ft.
27·5 seconds from the moment of starting. The cur
has also been drawn. The maximum current is passi
seconds, after which time the current decreases, th

any time being obtained from the acceleration curve by using equation (6). An examination of the curves in Fig. 5 shows that the effect of increasing the induction factor by series winding has been to decrease slightly the time required to cover the given distance, the saving of time in this case being 2·5 seconds. If we compare the acceleration curves for the constant and variable induction factors, we shall see that the series-wound motor gains in distance up to the point at which the curves cross one another, and after this point loses in distance. If the distance gained is equal to that lost, there will be no difference in the time required to cover a given distance. This may often happen. The form of the acceleration curve depends upon that of the curve of accelerating torque. If this is nearly straight between k and l the acceleration curve will rise up steeply, and the gain in time may be considerable. If, on the other hand, the torque curve is very much bent the acceleration curve will bend over rapidly, and the series-wound motor will take a longer time to cover the given distance than one with constant induction factor.

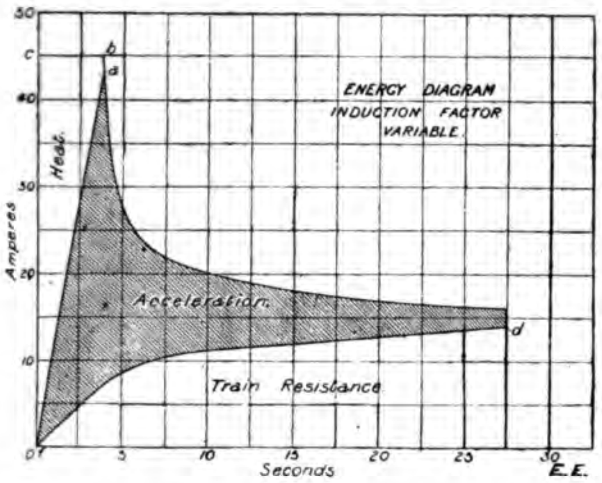


FIG. 7.

The form of the torque curve depends on that of the induction curve. Hence, the straighter we can make the induction curve the shorter will be the time required to cover the given distance. A ratio of maximum to minimum induction factor of 2 to 1 is very commonly obtained, and in such a case the series-wound motor may show a gain of 5 to 10 per cent. in the time occupied. We have here, then, a reason why the induction curve should be as straight as possible. The energy expended in covering the given distance is shown in each case by the area of the current curve. A glance at the diagram is sufficient to show how great a saving is effected by the use of the series winding.

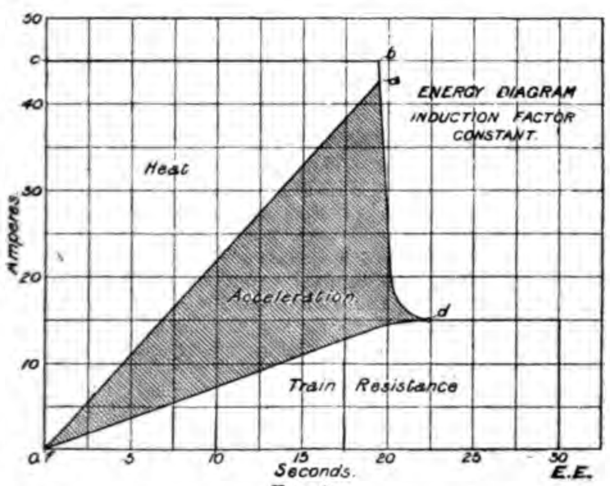


FIG. 8.

The two current curves have been reproduced in Figs. 7 and 8. If we multiply the vertical current ordinates by the tension of the line, we may take these to represent watts instead of amperes. At the point f the whole of the energy is being expended in heat. The heat loss at any point may be calculated by finding the speed and the resistance in the circuit, and then multiplying this by the square of the corresponding current. If the heat watts is divided by the tension of the line, we obtain the part of the total current that represents the loss due to heat. When the current representing the heat loss has been deducted from the total current at any instant, the remainder represents the expenditure of energy in producing acceleration and overcoming train resistance. The proportion of these two can be obtained from the curve of total torque, since that tells us how much is being used for accelerating, and how much for overcoming train resistance at any speed. The curves, $o\,a$ and $o\,d$ in Figs. 7 and 8, have been constructed in this way, thus dividing the whole area into three portions, representing respectively the energy used in heating, in accelerating, and in overcoming train resistance.

In comparing the two diagrams we see that the areas giving the energy used in overcoming friction must be the same, for the distance is equal, and so is the frictional resistance to motion. In this case the energy thus expended is, by calculation, 109 thousand foot-pounds. Since the final speeds in the two cases are respectively 25ft. and 23·2ft. per second, the kinetic energy for the motors with constant and variable induction factor will bear to one another the ratio of the squares of these numbers. The values are, by calculation, 109 and 88·7 thousand foot-pounds. There is thus a small gain in favour of the series-wound motors, owing to the fact that the final speed is less than with the motors with constant induction factor.

It is, however, when we come to consider the areas representing the heat loss that we see wherein lies the great advantage of the series winding. The energy expended in heating with the motors having constant M is more than five times that expended with the series-wound motors, the actual values being 32·2 and 169 thousand foot-pounds respectively. Examination of the diagram shows that the area giving the heat loss is very nearly one-half of the area of the current curve up to the point at which the starting rheostat is all out. Now the effect of the series winding is to reduce the time during which the starting rheostat is in the circuit. And this reduction is brought about in two ways: (1) the speed at the point when the rheostat is all out is reduced in direct proportion as M is increased; (2) the increase in the initial acceleration sets back this point still further. Thus, in Fig. 5, the point a gives the moment when the rheostat is all out with constant M. The speed is 24·2 f.p.s. If M at the start is doubled, owing to the use of series winding, the speed is reduced to 12·1 f.p.s., and the point g then still further set back, so that the time is reduced from 20 seconds to 4 seconds. Since the speed when the starting rheostat is all out varies nearly inversely as M, and the initial acceleration varies nearly directly as M, the area giving the heat loss varies nearly inversely as the square of the induction factor at the moment of starting. By increasing the induction factor indefinitely we could reduce the heat loss to that due to the resistance of the motor only; in other words, we could do without the starting rheostat altogether. The reason why we are unable to do this is because the maximum possible value of M is determined by the form of the induction curve. Thus, we have seen in Fig. 6 that in this case the greatest possible value of M is 106. If the weight involved in using this value of M were not an objection, we could reduce the heat loss to 13,000 foot-pounds. Such a value for M would, however, be inadmissible, on account of the cost of construction and the space taken up, and we have to be content with a loss two or three times this amount.

A reference to Fig. 5 shows that the points, such as a and g, where the rheostat is all out lie on a curve passing through the origin. This curve is nearly a parabola, whose horizontal ordinate varies inversely as M^2. It is thus evident that the more the heat loss is reduced, the greater will be the increase in M required to effect any further reduction, so that there is a point at which it is not worth while increasing the weight of the motor, the saving effected not being large enough to compensate for the disadvantages of the heavier motor. The following table shows the expenditure of energy in foot-pounds in the two cases:

	Constant induction factor.	Variable induction factor.
For acceleration	109×10^3	$88·7 \times 10^3$
For train resistance	109×10^3	$109·0 \times 10^3$
For C^2 R loss	169×10^3	$32·2 \times 10^3$
	387×10^3	$229·9 \times 10^3$

The expression "train resistance" means here all forces opposing the motion, including those due to the friction of the gearing and the torque lost in the motor itself.

Referring once more to Fig. 6, we have seen that the induction curve of the motors must pass through the point b, and that if the maximum value of M is limited to 71 the induction curve must be bent so as to pass through the point f. If now the velocity ratio employed can be increased, in the ratio of 71 to 106, or—what would come to the same thing—if the diameter of the driving wheel can be decreased in the same ratio, the induction factor at 15 amperes must be reduced to 23·8, so that the final speed may remain unaltered. Let $h\,k$ equal 23·8 on the M scale. It follows that a straight line through a and k will cut the vertical line through g at f, where $g\,f$ is equal to 71 on the M scale. We have thus made our induction curve pass through the point of maximum M for 45 amperes, and $a\,k\,h$ is the best induction curve from the point of view of economy. We have done this by simply increasing the velocity ratio and altering the inclination of the induction curve to the axis of the current. This inclination will depend upon the permeance of

the air-gap if the iron circuit is unaltered. Hence by rightly proportioning the gap and the velocity ratio we can obtain results approaching very nearly to the greatest possible economy. Since $h\,k$ in Fig. 6 is equal to $0{\cdot}1747\,\frac{e\,t\,d}{\mathrm{D}\,v}$, and $a\,h$ is equal to $2{\cdot}03\,\frac{\mathrm{T\,D}}{e\,t}$ (T being the retarding force in pounds at the car axle), the tangent of the angle $k\,a\,h$ is given by

$$\tan k\,a\,h = 0{\cdot}086\,\frac{e^2\,t^2}{\mathrm{T\,D}^2}\,\frac{d}{v} \quad . \quad . \quad . \quad . \quad (18)$$

Hence we can write,

$$p\,\mathrm{A\,S}\,g = 685 \times 10^4 \times \frac{e\;t^2\,d}{\mathrm{T\,D}^2 v} \quad . \quad . \quad . \quad (19)$$

where p is the numerical constant defined in line 6, A is the number of surface conductors, S is the number of turns per pole in the series winding, each carrying the whole current, and g is the permeance of each polar gap in centimetres. It will generally happen in practice that the weight limit requires a velocity ratio that is unattainable even with the largest values of d. We have here a difficulty that influences greatly the design of railway motors when spur gearing is employed—namely, the limited clearance between the gear wheel and the ground. We have to get the largest value of v with the smallest value of d. It is obvious that the greatest possible ratio of v to d is determined simply by the clearance. If single-reduction gearing is used, the largest ratio of v to d is limited by the number of teeth in the pinion for a driving wheel of given diameter. For example, let us take a driving wheel 33in. in diameter. If the clearance between the casing of the gear wheel and the level of the rail is limited to 4⅝in., we cannot get more than 67 teeth in the gear wheel. If the least number of teeth in the pinion is 14, the velocity ratio is limited to 4·78, and the ratio of v to d is limited to 0·145. These dimensions and numbers are taken from the standard street railway equipment made by the General Electric Company.

In our example, if the driving wheels were 33in. in diameter, the velocity ratio required to get the better results would be 7·15. This would be impossible with single-reduction spur gearing. We should therefore have to use a smaller value of v than the best. If the series-parallel controller is used, the maximum current from the line at the moment of starting is reduced by one-half. Since the current per motor is the same as with the parallel controller, the acceleration will be unaltered. The motors can be held in series until the speed is 5·7 f.p.s.; the result then is to reduce very nearly by one-half the expenditure of energy due to heat. In estimating the energy required to cover any distance, we may generally assume that the effect of series-parallel control is to halve the heat lost.

As an illustration of the application of these principles to the heavier class of railway work we may take the Metropolitan Elevated Railroad of Chicago. Particulars of this railway have been given by Mr. M. H. Gerry, and may be found in a paper published in the *Proceedings* of the American Institute of Electrical Engineers for 1897. The rolling-stock consists of motorcar and passenger cars. The former measure 47ft. in length, and weigh 62,000lb. when fully loaded. They are mounted on locomotive trucks, with driving wheels 33in. in diameter, the velocity ratio being 3·18. One truck of each motorcar is equipped with two motors. The passenger cars are 47ft. in length, having trucks fitted with 30in. wheels, and weigh 46,000lb. when fully loaded. Trains of two, three, and four cars are made up according to the demands of the traffic at different hours. We shall consider a train of one motorcar and three passenger cars, weighing in all 90 tons. We shall take the case of two stations separated by a distance of 2,500ft. of level track, and consider first the effect of the period during which the brakes are being put on. If the distance covered during the period of retardation bears to the time occupied the same ratio as the whole distance to the whole time—*i.e.*, if the mean speed during retardation is equal to the schedule speed—the value of $\frac{\mathrm{M}\,v}{d}$ will be independent of the time during which the brakes are on. For this quantity depends only on the ratio of t to D, and by our supposition this is unaltered by the length of the retardation period. The final speed will therefore be unaltered, and hence the energy expended in accelerating will be independent of the rapidity of stopping. Again, the accelerating current varies as $\frac{\mathrm{D}^2}{t^2}$, hence it will decrease as t increases—*i.e.*, the accelerating current will decrease with the time occupied in braking. But the work done in heating will be nearly the same, since C_a constitutes by far the greater proportion of the whole starting current. The energy spent in overcoming friction, however, will increase with the distance during which the motors are working, but the amount of increase will generally be a small proportion of the whole energy thus spent. If, then, the mean speed of retardation is equal to the schedule speed, we may determine the time occupied and the distance covered during the retardation period simply with reference to the ability of the brakes to stop the train. In the case before us we shall allow 20 seconds and 500ft. for retardation, leaving 2,000ft. to be covered in 80 seconds. The tension of the line is 500 volts. If the drop at full speed is limited to five volts, we find from equation (15) that $\frac{\mathrm{M}\,v}{d}$ must be 3·46. If we adopt the existing values of v and d we get M = 35·9. From the results of tests made on this line, the retarding forces at 15 miles an hour, including gear friction, amount to 13·6lb. per ton of load, or 614lb. horizontally per motor. Hence the current at full speed will be 63 amperes, and each motor must have a resistance of 0·0795 ohm. The train resistance, excluding gear losses, amounted to 450lb. per motor. We have thus found one point on the induction curve—namely, M = 35·9 for 63 amperes. In Fig. 9 horizontal ordinates represent current, and vertical ordinates values of M. Take a point, a, giving M = 35·9 for 63 amperes.

The accelerating current is found from equation (6) to be 226 amperes. If the induction factor at the start is twice that at full speed, the current then required for friction is only 31·5 amperes, so that the total current at starting must be 257 amperes, and the corresponding induction factor 72. This gives us a second point on the induction curve, and is plotted at b in the figure. We shall suppose that A is the best curve that can be obtained passing through the given points. The diagrams of current and acceleration with motors having A as their induction curve are given in Figs. 10 and 11, and are drawn in full lines. The time taken to cover 2,000ft. is 78 seconds, the saving of two seconds being due to the series winding. Full speed is 37·3 f.p.s., but is not reached, the highest speed being

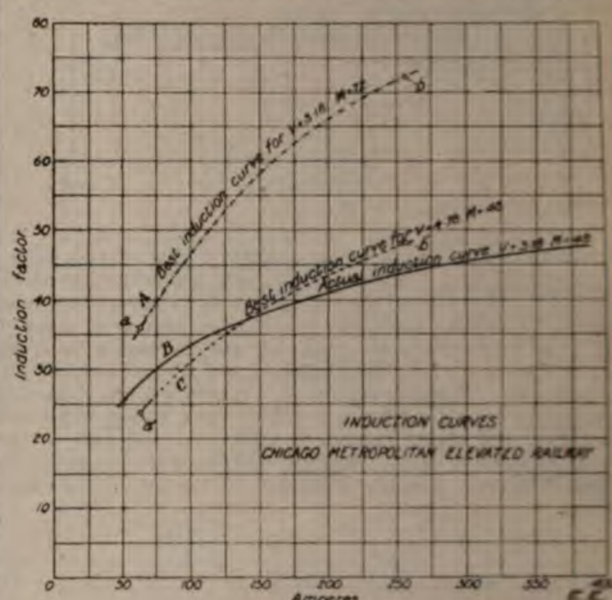


FIG. 9.

33·5 f.p.s., or 23·6 miles an hour. The initial acceleration is 1·27 f.p.s. per second. The induction curve for the motors actually used is given at B in Fig. 9, and the curves of acceleration and current for these motors are shown in Figs. 10 and 11 by dotted lines. The brakes were applied at the end of 77 seconds, when 1,930ft. had been covered, and the remaining distance of 570ft., making up the total of 2,500ft. was covered in 27 seconds, making the whole time 104 seconds. The irregularities in the current curve are the result of the uneven handling of the controller. The motors take 380 amperes each at the moment of starting, and are allowed to speed up in series for 10 seconds after the starting rheostat is all out. When thrown into parallel, the current per motor is 330 amperes, or 660 from the line. More careful manipulation of the controller would have effected a better start.

We have already seen that the force of a motor may be conveniently expressed as the product of the current and the corresponding induction factor. Since the ordinates in a diagram giving the induction curve represent current and induction factor, a curve of equal force is a hyperbola. In Fig. 9 the point b represents an induction factor of 72 for a current of 257 amperes; in other words, the force factor required to start up with an acceleration of 1·27 f.p.s. per second is 18·5 kilodynes. If we draw a hyperbola through the point b it will cut the induction curve, B, at a point giving the current that the motors in actual use must take in order to get an acceleration of 1·27 f.p.s. per second. The current thus found is 390 amperes. An inspection of the acceleration curves in Fig. 10 shows that the acceleration obtained in the test is rather greater than that obtained by calculation, while the current is 380 amperes. The experimental curve, however, is somewhat irregular, and the agreement is as close as might

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TO CORRESPONDENTS.

MOTOR VEHICLES FOR HEAVY TRAFF

The trials at Liverpool of heavy motor v which have been organised by the Self-Pr Traffic Association commenced on Tuesda are not yet completed. Enough has, howeve already shown by the first two days' work to good indication of the results of the whole. lorries are under trial. One, by the Thorn Steam Carriage and Wagon Company, to car tons, and one, by the same firm, to carry tw a half tons; one, to carry two tons, by the l Fuel Engineering Company; and one, to carr tons, by the Lancashire Steam Motor Con All these vehicles are of very creditable desig a great advance upon anything hitherto sho this country, and in several respects in adva those which entered and went so creditably th the French trials last year from Versailles, org by the Automobile Club de France. The boi all are of the water-tube class, those of the Th croft lorries being of quite a different type to the firm have hitherto used. They are vertica upright tubes arranged in a circle round the fu and communicating with a circular water-tru the bottom and a water and steam chamber Coal is used as fuel and a pressure of seven pounds carried. Enclosed horizontal high engines are used, and the power is conveyed the crankshaft by double helical gear to a co shaft, and thence to the driving wheels by Re silent chains. The five-ton lorry is a six-w vehicle, the engine and boiler being on a di bogie frame, which carries the fore end of the which runs on two rear wheels. The road v are of wrought iron. The steam from the e passes into a tubular air condenser on th over the front part. The lorry of the l Fuel Engineering Company has a vertical t boiler in front of the vehicle and driver, an horizontal engines below the lorry, which is wheeled, are compound, and work with ste two hundred pounds per square inch. The e steam is sent into capacious water-tanks, ordinary lamp petroleum is used as fuel. No gear is used, the power being conveyed fr countershaft to the driving wheels by p working in internal toothed rings whic fastened by strap belts to every spoke and the rings for band brakes. The lorry o Lancashire Company is fitted with a vertical of the fire-tube type, oil fuel being employed pressure of two hundred pounds carried. Po conveyed from the crankshaft by silent chain outer ring of the compensating gear on the co shaft, and from this to the road wheels, are of wood, by similar but larger c The route traversed included the steep ris of Liverpool, but no very steep inclines where. The average speed required is six per hour for the two-ton lorries and four mil those above that load, these averages requir speed on levels of a good deal above the speed made by the Liquid Fuel Com vehicle was much above that required. O performance of the several lorries on Tu

Wednesday, it may be said that the trials shown that the small light high-class boilers loyed are fully capable of providing an ample ly of steam to the little high-speed engines loyed for this heavy class of vehicle. It may be said that the higher class of lighter gearing, ompared with traction-engine practice, may be essfully used when every care is taken to keep well covered and running in oil. Of all this, ever, much remains to be said, which we leave to another impression. Meanwhile, ever, it may be noted that the wheels of the lorries showed that the makers have a good deal to learn relating to the construction of wheels suitable for the carrying of y loads and performing the work of propulsion. he wheels gave way more or less, and even the of those used as drivers proved insufficiently ig, those not used as drivers being much less sed or damaged. Some of the traction-engine ers' experience will have to be applied in this ect, and much may be learned from the practice e makers of the wheels of the heavy Liverpool e-hauled lorries. The latter, however, are all at less than half the speed required by the lations from these self-propelled vehicles, or these would have to be much heavier than are and much more frequently in the repair . The heavy load and the heavy hammering the badly-paved roadways of some parts of rpool and the county roads of the route n in the trials, will smash anything that man make at the speeds attempted. Many s of these roads are a disgrace to any munity, and the great carrying concerns of rpool must be wonderfully blind to their own to the public interest if they allow the present of the roads to continue. Until these roads better, it is futile to talk of haulage by motor cles at any speed greater than that observed by heavy lorries and drays hauled by horses. This ns that the advantages mechanical vehicles offer mpossible of realisation in and round Liverpool. mechanical road transport question is a road tion, and so long as the roads are such as ld disgrace even an uncivilised population, the oved and cheapened road transport must remain beyance.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

INVENTORS' CREDITS.

R,—In your leading article in this week's issue you are enough to recall my labours in clearing up disputed s in the history of electrical and telegraphic discovery. add : "Many people, however, are still doubtful as to alidity of Mr. Fahie's contention."

y I ask what are the points as to which people are doubtful ? In my "History of Electric Telegraphy to " I have given chapter and verse for every important nent, and in the preface I asked my readers to point ny errors, either of omission or of commission, that I correct them. No one has done so; indeed, from my sher's account of sales, very few people have done me onour of reading my book at all.

n afraid they find it easier to repeat one after another the old, old fictions, as that "Bishop" Watson first discovered the earth circuit; that "Bishop" Watson, Franklin, and Volta all suggested electric telegraphs; that Romagnosi discovered electromagnetism 18 years before Oersted, and that Oersted knew it and yet annexed all the honour; that Steinheil first discovered the earth circuit for current electricity; that Morse dashed off his telegraph as a going concern on board the ship "Sully" in 1832; that Wheatstone first proposed submarine cables in 1840; that Wheatstone, again, and Morse invented the relay, and that Edward Davy and Prof. Henry didn't; that, in short, Wheatstone and Morse did everything by their own unaided genius, and that Davy, Cooke, Bain, Henry, Vail, Gale, and others were of no account—mere assistants, or mechanics, or professors; and many others of the same kind. Verily, superstitions die hard.

I need hardly say that I cordially subscribe your remarks as to old-timers being urged to write their memoirs, or, as the French so well call them, *Aides Mèmoirs pour servir à l'histoire*. I have written to two "old-timers" myself in the sense you suggest, but one simply won't, and the other can't, as he has kept no diary or notes !—Yours, etc.,

Jersey, May 21, 1898. J. J. FAHIE.

ELECTRICAL ENGINEERS (ROYAL ENGINEERS) VOLUNTEERS.

The following is the full text of the new circular issued by the above corps which was referred to in the "Notes" of our last issue :

The headquarters of the corps are at 13, Victoria-street, Westminster. The uniform will be same as that worn by other Royal Engineer Volunteers, with such modifications as the War Office approve. Uniform will be supplied free to members. The corps will be armed with the Lee-Metford rifle. The training is divided into two kinds—military and technical. The military work consists of infantry drills, musketry, etc. The technical work includes every application of electricity to war, with the exception of telegraphy, and such other work as will be useful to an electrician or engine-driver in carrying out his duties, such as signalling; fitting, loading, priming, and connecting up submarine mines; a certain amount of boat work, and knotting, splicing, etc. This work will be carried out partly in London, but mainly at defended ports.

In order to become efficient each member must attend a continuous training at a defended port for at least eight days each year. In addition, 12 hours' technical work must be done each year. For this purpose, each working day—after the first eight—of the continuous training counts as six hours; each half-day, four hours. Or, these drills may be done in periods of 1, 1½, 2, 2½, 3, and 3½ hours. The capitation allowance is £4. For each of the eight days of the continuous training, an allowance of 5s. per member in camp is paid to the corps. This allowance will be primarily devoted to the maintenance in camp. Drills—both military and technical—are being carried out in London and Woolwich at present. Members from other districts will only be permitted to join on undertaking to make private arrangements to learn their infantry drill. Intending members are requested to study the conditions of efficiency.

Below will be found an extract from the rules of the corps: "5. Every enrolled member who is non-efficient in any year shall pay to the funds of the corps, on or before Nov. 10 in that year, a sum equal to the Government capitation allowance which he failed to earn. . . . The commanding officer shall have power to remit payment, wholly or in part, in special cases. 8. No person shall be admitted as member or honorary member unless proposed by one or more members of the corps, and approved by the commanding officer. 24. Any member wishing to leave the corps may do so on Nov. 2, providing he shall have given notice of his intention not later than the 30th of the preceding September. Failure to comply with this rule shall render him liable for half the amount of the succeeding year's capitation grant. Note.—Age limit, 17 to 47 years."

Intending members should write to the adjutant, Captain Brady, R.E., 13, Victoria-street, S.W., who will supply all information. They should give their full name, address, occupation, and electrical qualifications. If they wish to join as engine-drivers they should state their qualifications for that work. Every application must be accompanied by a reference to a member of the corps, or to some other person well known to the commanding officer. Before enrolment each candidate must be passed as fit by a medical officer. Every member shall be enrolled for three years at least. A member leaving before completing three trainings shall be liable to a penalty of £2. 10s. (Note.—The head-quarters are open on week-days from 10 to 4, Saturdays from 10 to 12. On Mondays and Thursdays at 8 p.m., in addition.)

The circular is signed by Major J. Hopkinson, F.R.S.

SELECT COMMITTEE ON ELECTRICAL ENERGY.

Generating Stations and Supply.

This Select Committee has now concluded its mission by drawing up a report, which was agreed to by all the members last week. It will remembered by our readers that this Select Committee was appointed to consider the following items:

1. Whether, notwithstanding the provisions of Section 12 (1) of the Electric Lighting Act, 1882, powers should be given in any cases for acquiring land compulsorily for generating stations; and, if so, under what conditions as respects liability for nuisance, notices to surrounding owners, and otherwise.

2. Whether compulsory powers of acquiring land for generating stations, if proper to be given in any case, should be given where the proposed site is not within the area of supply.

3. Whether, in case of a generating station however acquired not being situate within the area of supply, power should be given for the breaking-up of streets between the generating station and the boundary of the area of supply.

4. Whether powers should be given in any case for the supply of electrical energy over an area including districts of numerous local authorities, involving plant of exceptional dimensions and high voltage; and, if such powers may properly be given, whether any, and what, conditions should be imposed (*a*) with respect to system and plant, and to the construction and location of generating stations, in view of the powers of purchase conferred upon local authorities by Sections 2 and 3 of the Electric Lighting Act, 1888; (*b*) with respect to the relations of the promoters to other undertakers and to local authorities within parts of the area.

5. Under what conditions (if any) ought powers to be conferred upon promoters seeking to supply electrical energy to other undertakers and not directly to consumers?

A *résumé* of the evidence heard has been regularly published in our columns. The decisions of the committee may be summarised as follows:

That the proved public advantages of electrical energy in the generation of light and power warrant the granting to undertakers of compulsory powers for acquiring sites for generating stations and lands or rights-of-way for pipes and mains therefrom, and other works. Provision should, the committee thinks, be made for the granting of these powers in the provisional orders of the Board of Trade, subject to confirmation by Parliament. Such provision would facilitate a continuance of the existing practice, according to which more or less uniform conditions under which undertakers are to work are provisionally settled by the Board of Trade. Procedure by private Bill should be reserved, as at present, for exceptional cases. The committee hold that such powers might be given either to local authorities or to incorporated companies, whether the incorporation be by special Act or provisional order or under the Companies' Acts. With respect to liability for nuisance, they are of opinion that where the site for a generating station is acquired under compulsory powers, and is specified in the provisional order or special Act, the undertakers should not be subjected to any further liability than that which, according to the decision of Lord Blackburn in the case of Geddis *v.* Bann Reservoir, is imposed by the common law in the case of persons exercising statutory powers and duties. On the other hand, where the site for a generating station is acquired by agreement, they think the undertakers ought to be subject to the liability imposed by the common law. With respect to notices, they think that the existing practice as to notices to the local authorities and also to owners, lessees, and occupiers of lands proposed to taken should be followed.

On the question of compulsory purchase of land the committee consider that compulsory powers for the acquisition of land for a generating station, and lands or easements for pipes and mains and other works to the area of supply, may also properly be given where the proposed site is not within the area of supply. The local authorities for the district or districts in which the site is, and the owners, lessees, and occupiers, should in that case have the same notices and the same *locus standi* as if that district were the area of supply, and provision also should be made for serving notices to local authorities and owners, etc., of districts or land through whose districts or land mains are to be run from the generating station to the area or areas of supply.

In the case of powers being given for the erection of a generating station outside the area of supply, the committee think that powers may properly be given for laying the mains in streets leading from the generating station to the boundaries of the area of supply, under similar conditions to those now in force for streets within the area of supply.

The committee is also of opinion that while it may be advisable to maintain the veto of local authorities as to the erection of overhead wires, given by Section 14 of the Act of 1882, in respect of other electric wires it is not advisable that in the case of overhead wires for traction purposes the local authority, other than the London County Council and county boroughs, should have an absolute veto. While due weight should be given by the Board of Trade to the representatives of such local authorities, the committee think that in the case of wires for purposes of traction it would be sufficient to give a *locus standi* to such local authorities.

It is considered that where sufficient public advantage is shown powers should be given for the supply of electrical energy over an area including districts of numerous local authorities, and involving plant of exceptional dimensions and high voltage. The committee further think that undertakings of this character may properly be authorised on conditions differing in some respects from those imposed by and under the existing Acts.

With respect to undertakers which will supply light or power in bulk, and the question of giving compulsory powers of purchase of such undertakings to local authorities, the committee, without questioning the policy of Parliament in having given such powers, observe: (1) that when the power of purchase was granted in 1882 and 1888, no such schemes of supplying energy in bulk were contemplated as are now before Parliament; (2) that when the power of purchase was thus granted the question then before Parliament was chiefly one of light, whereas the evidence given before the committee shows that although electric light is at present the predominant feature of the enterprises now before the public and Parliament, the application of electrical energy in the form of power to an infinite variety of other purposes is likely to be in the near future the predominant feature and function of these undertakings; (3) it does not appear to them that an undertaking supplying energy in bulk at high voltage and in comparatively few mains is as a rule so desirable for the local authority to acquire as a low-voltage undertaking with many distributing mains.

The committee think that the provisions of the Electric Lighting Act, 1888, enabling the local authority to purchase an undertaking after a term of years, are inapplicable, as a general rule, to the case of an undertaker supplying energy in bulk at high voltage, but there may be special cases where it is desirable that the local authorities should have the right to purchase reserved to them. To meet such cases they suggest that the Board of Trade should have power to insert the purchase clause in the provisional

if the local authorities concerned can, in the opinion Board, show good cause for such a course. It will served that the exemption from liability to comy purchase would not prevent local authorities, either or in combination with other local authorities, from ng for powers to purchase, but each case would have judged on its merits, and such conditions imposed as be thought fit. In cases of the exemption from y to purchase, it would in the committee's opinion cially expedient in the interest of the consumers that kind of sliding scale, as in the case of gas unders, should be imposed. The committee consider that ovisions of the Electric Lighting Act, 1888, which the consent of the local authority as a condition ent to the granting of a provisional order, should nded. In their opinion, the local authority should itled to be heard before the Board of Trade, but not have, so to speak, a provisional veto, only to be sed with in special cases by the Board of Trade. espect to conditions, the committee think it reasonat where a local authority, or company having power ply light within a certain area of supply, seeks to compulsorily land for a generating station outside ea it should not be allowed, except where Parliament Board of Trade decide otherwise, to supply from nerating station any area outside the area of supply authority or company.

regards to provisional orders generally, the comrecommend that the ordinary clause which forbids nnection with the earth, except with the approval Board of Trade and the concurrence of the Post-General, should be inserted in every case. As to ion of telegraphs and telephones, the clauses now d in provisional orders are deemed to be sufficient ordinary cases, and further regulations to protect iblic can be made by Board of Trade under 6 of the Act of 1882. The clauses which gas and water pipes have worked satisfacand should be continued, but the committee attention to the observations of Mr. Preece ards the difficulty arising from the working iways by trolley wires. His suggestion as to a "control clause" should be carefully considered. mmittee are disposed to concur generally with Morley and Sir C. Boyle in thinking that as com- powers are given solely for the benefit of the it would be desirable to make some provision these companies being subject to foreclosure on ge, and against their rolling-stock and plant being o distress.

TOR LECTURES ON ELECTRIC TRACTION.

ough Prof. C. A. Carus-Wilson's Cantor lectures on ric Traction" have been somewhat poorly attended, no doubt that they have been thoroughly appreby those privileged to hear them. Their educational as the greater on account of being delivered at the sychological moment when everyone is on the *qui* lectric traction problems. A further point of interest fact that the lecturer comes from one of the universi-Greater Britain, and it is devoutly to be hoped that ll have other Cantor lectures from amongst our c kinsmen in the Colonies and in the States. The will appear in due course in our columns, but lowing notes may be interesting at the immediate t.

lecturer referred at length to what he called the tion factor" of the tramway motor, which he d from the equation

$$M = p \,.\, A \,.\, N \,.\, 10^{-8},$$

M is induction factor.
p is number of pairs of poles of motors.
A is total number of surface conductors.
N is useful lines of force per pole.

induction factor has an important bearing on series-l control, because it is by varying M that electrical rs are enabled to obtain all the speeding up and torque that they require without the use of variable speed gear.

In his second lecture Prof. Carus-Wilson gave some interesting experiments, showing the time taken in acceleration, etc., under various conditions of running; transparent dial measuring instruments being used instead of the more familiar spot of light on a scale. Local colour, if such it may be called, was given by frequent references to the Liverpool Overhead Railway, the City and South London Railway, etc. For example, in the third lecture a comparison was made between the working of the motors of a car when they are (1) always in parallel, as on the Liverpool Overhead Railway; (2) always in series, as on the City and South London Railway; (3) in series-parallel, the now recognised method of working. Taking a particular case of a car weighing 40 tons, and fitted with two gearless motors, the line voltage being 500, car wheels 33in., full speed 30 miles an hour, limit current 200 amperes, internal resistance of motor 4 ohms, and resistance to motion 200 inch-pounds of torque on car axle, it was shown that the following results would be obtained:

—	Motors in parallel, as on Liverpool Overhead Railway.	Motors in series, as on City and South London Railway.	Motors with series-parallel control, as Chicago Elevated Railway.
Induction factor ...	96	44	96
Current, amperes ...	100	200	100 and 200
Acceleration, in feet per second per second	·4	·37	1·0
Hauling power required	100×96	200×44	—
Energy to start, in foot-pounds	793×10^4	972×10^4	562×10^4
Time to start, in seconds	107	160	80

It will be seen that the "all series" method takes longest for the car to get up to full speed. It was further pointed out that the area of the starting current curve with series-parallel control is smaller than with the other methods. At the same time, for runs of greater distance than 2,000 to 3,000 yards the method of connecting up the motors does not much matter. Acceleration was given as being equal to

$$\frac{C_a \, M \, v}{W \, d} \times \cdot 04,$$

where C_a represents that portion of the starting current obtained by subtracting.
C_f, the current necessary to overcome frictional resistance from C—the total current.
M, the induction factor, as before.
v, the velocity ratio of the gearing (generally 4·78 to 1).
W, the weight of the car.
d, the diameter of the road wheels (usually 33in.).

For a certain fixed speed $\frac{M\,v}{d}$ is a fixed quantity, and as W and C are also fixed we are left with only one variable—namely, C_f. This can be reduced, as, for example, on the Liverpool Overhead Railway, with roller bearings. These bearings enabled them to start three cars in the same time and with the same current as two cars were started formerly. It may also be pointed out that the larger the diameter of the road wheel, the smaller will C_f become.

In the last lecture it was shown that whereas the final speed is proportional to $\frac{d}{v\,M}$, the gathering of speed or acceleration is proportional to $\frac{v\,M}{d}$, the one being the converse of the other. To make M small—that is, to get a light-weight motor—we must make v large, and with gearless motors v will, of course, be unity.

The lectures were profusely illustrated with curves, those giving an analysis of the energy lost in the controller resistance, energy used in acceleration, and energy used up in overcoming frictional resistance being especially interesting.

ON THE USE OF BLAST-FURNACE GAS FOR MOTIVE POWER.*

BY ADOLPHE GREINER, DIRECTOR-GENERAL OF THE SOCIETE ANONYME JOHN COCKERILL, SERAING (BELGIUM), MEMBER OF COUNCIL.

The problem of the direct employment of blast-furnace gas for motive power has been dealt with in several papers. In England, Messrs. Galbraith and Rowden read a paper on Dec. 18, 1897, before the Glasgow Association of Engineers. In Belgium, Mr. Hubert, on Oct. 17, 1897, read a paper before the Association des Ingénieurs de l'Ecole de Liège, and this was published in the *Annales des Mines de Belgique* for February, 1898. A note on the subject by M. Lencauchex was read Nov. 8, 1897, at the meeting of the Société de l'Industrie Minérale at St.-Etienne, France; whilst in Germany M. Lurmann presented an account at the meeting of metallurgists at Dusseldorf on Feb. 27, 1898. The theoretical aspect of the question has been amply investigated, and the author's present intention is not to join in this discussion, for which he does not feel qualified. In such a novel matter as this is, experiment should be the predominating factor, and theory should be considered afterwards. This is the first time that the subject has been brought before the Iron and Steel Institute, so the different published accounts will be summarised; and it is claimed that Messrs. Bailly and Kraft, the engineers of the Société Cockerill, were the first to run a small gas-engine regularly with blast-furnace gas, starting Dec. 20, 1897, with an 8-h.p. engine, and their published results of experiments have formed a basis for discussion at several meetings of metallurgists. The gas-engine at Wishaw, as described by Mr. Galbraith, is not really driven by ordinary blast-furnace gas, as the gas used is drawn from furnaces using anthracite as fuel, and its calorific power, according to Prof. Rowden, is superior to that of producer-gas.

The first engine at Seraing has been described by Mr. Hubert, and for a description of its details of construction reference may be made to the *Annales des Mines de Belgique*. Some explanation of the results obtained are, however, necessary to obviate useless discussion. The gas consumption of this engine was measured by a borrowed anemometer (*compteur*), and not by a gasometer, as the plant did not include the latter. Mr. Hubert, therefore, properly called attention to the fact that the results must be regarded as only approximate. Although these figures have been much used for the purposes of calculation and discussion, they should only have been regarded as an encouragement for the production of further details. Up to the present, however, none have appeared, and the correction of those totals must await the publication of the trials of a 200-h.p. engine which has been running for some weeks at the Cockerill Works.

During the discussion on Mr. Lurmann's paper, German metallurgists and engineers were unanimous in considering the consumption as too high, and several drew most pessimistic conclusions. We were well aware that the consumption was too great, but the reason is easily discovered when consideration is given to the circumstances of the trial. These are fully dealt with in Mr. Hubert's paper, though perhaps not so clearly as might be wished. As a matter of fact, the gas-engine used was designed for ordinary illuminating gas, being a Simplex engine by Delamarre-Debouteville, of Rouen. It was put to work near the blast furnaces just as it was received from the manufacturers, without any modification except as regards the amount of gas compression. The gas inlet and valve were very small, and in order to obtain the desired mixture of equal volumes of gas and air, the incoming air had to be throttled to such an extent that the vacuum behind the piston was at least two-tenths of an atmosphere. This is clearly shown by the diagrams published by Mr. Hubert, and under these conditions the engine only developed 4 h.p., and the governor only gave 87 out of 109 possible explosions. This was only half of the normal power. For some months later 8 h.p. were obtained after enlarging the gas passages and admission ports. It is somewhat astonishing that these unfavourable features received no comments from those

* Paper read before the Iron and Steel Institute, May 6, 1898.

who discussed Mr. Lurmann's paper, although ma
spoke were well acquainted with gas-engines. Un
above-mentioned conditions, therefore, the 8-h.p.
only developed 4 h.p., and consumed 5·3 cubic
(187·18 cubic feet) per horse-power. The expe
were not repeated at full loads, as the anemometer (c
was not available, and as the new 200-h.p. engine i
supplied with a gas-holder, more exact tests can re
made in the future. Nevertheless, if the statem
Kennedy and others, that the consumption of gas-
at half loads is 25 per cent more than at full l
accepted, it may be taken for granted that three-
of the 5·3 cubic metres (187·18 cubic feet) will b
when running fully loaded—that is, four cubic
(141·27 cubic feet) per brake horse-power, or thr
metres (105·95 cubic feet) per indicated horse-pow
this basis it is confidently expected that blast-furn
may be economically used.

The calorific power of the Seraing blast-furn
varies from 800 to 1,000 calories per cubic metr
to 28·5 calories per cubic foot). Certain authors, e
Mr. Lurmann, give much lower figures, without sta
methods employed for their determination, but tho
above may be taken as exact. They were arrive
follows: Every day for 15 days a sample of 1
(0·35 cubic feet) of gas was taken, starting at six
each morning, and finishing at the same hour
following day. All the 15 samples were sent to M
the well-known specialist at Lille, to have their
value estimated. These blast furnaces average one
coke to a ton of pig, and it is not suggested th
gases are richer than those from other works. M
determined the value by explosion in his calo
bomb, and the average result showed 987 calories p
metre at 0deg. C. and 760mm. pressure. No m
superior to that of the calorimetric bomb for the
in gas-engines. All comparisons of calorific p
determined by the bomb with those calculat
chemical composition, in which certain compou
neglected, or by other less exact means, are of no v

At Seraing, the average out-turn amounts to 60
pig iron daily. It is generally agreed by Messrs.
Lurmann, and others, who quote the calculation
Hiertz, that the average gas production amounts
cubic metres (158,924 cubic feet) of gas per ton
At least 2,000 cubic metres (70,633 cubic feet)
under the boilers, and the remainder is accounte
the stoves and leakage. Six hundred tons daily co
to 25 tons hourly or 50,000 cubic metres (1,765,8
feet) of gas used hourly for raising steam. Th
actually at work have a heating surface of 2,30
metres (24,757 square feet) out of a total of 2,75
metres (29,601 square feet), a goodly number of th
being always laid up for cleaning. The blowing
lifts, pumps, etc., together average 2,300 i.h.p.

Careful experiments show that 12 kg. to 1
water are evaporated per square metre of heatin
(2·45lb. to 3·07lb. per square foot) per hour, an
about the same as is obtained in other works using
etc., boilers. The total 2,300 square metres (24,7
feet) give 28,000 kg. (61,729lb.) of steam per h
pressure of four to five atmospheres, or about
(26·49lb.) of steam per indicated horse-power p
when all the machinery and losses by condens
taken into account. This figure has been con
Seraing by direct tests of the consumption of
machines. The following results are thus a
current practice:

$$\frac{50,000}{28,000} = 1{\cdot}8 \text{ cubic metre of gas per kg. of ste}$$

$$= 28{\cdot}9 \text{ cubic feet per lb. of steam.}$$

$$\frac{50,000}{2,300} = 22 \text{ cubic metres of gas per h.p.*}$$

$$= 776{\cdot}96 \text{ cubic feet of gas per h.p.}$$

* Theory indicates a cubic metre of gas for 1 kg. of steam
as is shown by the following calculations. The calorific
cubic metre of blast-furnace gas at 15deg. C. and 760m
with 1 per cent. of moisture is 1,000 calories, as stated al
boilers should utilise 65 to 67 per cent. of this amount

There are some modern plants where better results are attained, but even then they might be dubbed laboratory experiments. Pumps, lifts, and other appliances, which make excessive demands on the steam supply, are left out of consideration; and besides, the boilers are carefully cleaned and tended in readiness for the test, so that exaggerated returns are made. The totals given above are, on the contrary, the results of everyday work, and on them all calculations ought to be based.

The consumption of a small trial gas-engine at full load has been given as four cubic metres (141·27 cubic feet) per effective horse-power. If it be admitted that 3·5 cubic metres (123·6 cubic feet, an amount that will probably be confirmed shortly) will serve for larger motors, then, in addition to the 2,300 h.p. necessary for running the blast furnaces, there will be available

$$2{,}300 \times \frac{22}{3{\cdot}5} - 2{,}300 = 12{,}000 \text{ h.p.}$$

To avoid any misconception, it may be stated that one brake gas horse-power is taken for one indicated steam horse-power. Mr. Hubert, in his pamphlet, bases his calculation on the average output of gas and steam engines, and by this means obtains a surplus power of 12,000 h.p., or 2,000 h.p. per 100 tons of pig iron.

There is no exaggeration in these estimations, and even if they are reduced by one-half, there is still an advantage of 1,000 h.p. per 100 tons of iron. Such an advantage may well attract the attention of manufacturers to this new departure in the production of iron and steel. It is not more than a quarter of a century since it was the custom to burn the gas at the mouth of the furnace. The direct utilisation of gas in prime movers without the intervention of steam generators, and the consideration of the blast furnace as the greatest and surest source of power, are novel developments which will not await the next century for their full realisation. Certainly the progress at the beginning has been slow. Gas-engines are not working everywhere like steam-engines. Different types are being tried at Wishaw, at Hoerde, at Differdange, and at Seraing, but without doubt the future rail-mill, including the Bessemer converters, driven simply by blast-furnace gas, is a fascinating subject for investigation. When a 200-h.p. gas-engine has run successfully for six months, manufacturers will be emboldened to put up one of 500 h.p. or 800 h.p. to drive the blowing engines for a blast furnace or converter plant, and thence to a rolling-mill engine is an easy advance. Those who intend to travel on these lines ought to draw much encouragement from these successful trials, lasting over two years, at Seraing, with the little 4-h.p. to 8-h.p. gas-engines. With gas as dusty and as variable as blast-furnace gas is, any hesitation in an attempt to use it was very pardonable; but now experience has spoken, and experience is paramount.

A short description of the great 200-h.p. engine at Seraing may be of interest. Gas from the blast-furnace gas mains is led through three pairs of coke scrubbers, 1·5 metres in diameter and six metres high (5ft. by 19⅔ft.). The coke is washed with water delivered by Koerting spray producers. The gas passes successively through the two scrubbers of each of the three pairs and then straight to the engine. It may be sent at will through a gasholder which is used for testing or as a reservoir in case of eventualities. The gasholder is 12m. (39½ft.) in diameter, and has a lift of 3m. (10ft.). It holds 300 cubic metres (10,600 cubic feet). Gas is drawn through it by a fan driven by an electromotor. The gas-engine is of the four-cycle type, with a single horizontal cylinder 800mm. (31½in.) in diameter and a stroke of 1m. (39·37in.). It runs at 100 revolutions per minute. The connecting rod works on to a counterbalanced crankshaft. The fly-wheel is 4m. (13ft.) in diameter, and weighs 15 tons. Compression in the cylinder is carried up to 8 kg. per square centimetre (about 114lb. per square inch). Ignition is produced electrically, and is adjustable; the governor is outside, and the whole build of the engine is simple and strong.

It was proposed to utilise this engine for running a belt-driven dynamo for power and lighting purposes, but this will be done with the second engine, and the first will be used for driving an air-compressor directly off the main shaft. The air compressed to five atmospheres will be led by pipes to different machines and pumps, which are now driven by steam at the same pressure. A simple cock will enable steam or compressed air to be used at pleasure.

(To be continued.)

CONNECTING ALTERNATORS IN PARALLEL.

Mr. Carl Hering in his digest boils down a long abstract of a paper by Mr. Schueler in the *Elektrotechnische Zeitschrift*, describing a method for automatically connecting alternators in parallel. The engine of the one to be connected is brought to nearly the proper speed, and if a current is then sent into it from the other machine or 'bus bars, it will be brought to synchronism, provided the current is strong enough; a variable resistance may be put into the circuit, it being short-circuited after they are in phase. In place of this resistance a sort of transformer may be used, consisting of two like coils on two opposite sides of a square frame of iron, and an adjustable iron core, which may be inserted between the two coils and joining the two yoke pieces; the transformer ratio is 1 to 1; one coil is connected to one alternator and the other to the 'bus bars; when the movable core is between the coils they will be independent, but as it is gradually withdrawn the coils will affect each other more and more, bringing the two machines into synchronism. Instead of this movable core a fixed core with a separate coil may be used, this coil being gradually short-circuited through a resistance. Another device to replace the phasing lamps consists of an ordinary three-phase motor with sliding contact rings in which the number of windings in the short-circuited armature is equal to that on the exciter; these two circuits are connected respectively to the two alternators; the action of the two circuits will bring the two machines into synchronism and the speed of the motor will diminish until finally it has come to rest, which indicates the state of synchronism; to show, furthermore, whether the currents are then in phase or not, a pointer is secured to the shaft which shows the angle between the two phases; the machines should be electrically connected when this pointer points to zero. A modification of this consists in applying a brake to this motor; when the shaft is brought to rest they are in synchronism, after which the shaft is turned by means of the brake until the currents are also in phase. The tests he made were with a 10-h.p. motor for a 100-h.p. machine; the size of the motor depends on the engine, but can generally be taken at about 5 per cent. of the output. Still another device is shown in which an automatic interlocking is brought about by regulating the steam supply; a motor is connected to one alternator and a certain pulley travelling on a screw thread on the motor shaft is revolved from the other by means of a belt; when the speeds are not alike this pulley will travel on its threads, and by means of a lever will regulate a valve in the steam supply, but when the speeds are equal the pulley will not travel axially. In the discussion the devices were thought to be too complicated.

blast-furnace plants the dusty flues prohibit such good returns as a rule. The combustion of a cubic metre of gas will not give more than 670 calories. For the sake of comparison with gas-engines, assume a steam-engine working at 15 kg. pressure. The total heat contained in 1 kg. of steam at this pressure (corresponding to 200deg. C.) is $606{\cdot}5 + 0{\cdot}305 \times 200 = 667{\cdot}5$ calories. A cubic metre of gas burnt under the boilers can then be vaporised as a maximum $\frac{670}{667{\cdot}5} = 1{\cdot}003$ kg. of water. Thus in round figures a cubic metre of gas will generate a kilogramme of steam. The efficiency of boilers may be increased by saving some of the heat escaping in the chimney by using feed-water heaters or economisers; but this is detrimental to the chimney draught, and at most the yield would not be increased beyond 80 per cent., thus giving 1·2 kg. of steam per cubic metre of gas. Under any circumstances, a kilogramme of steam at the boilers does not mean a kilogramme of dry steam at the engines, owing to loss by condensation in the more or less extended ranges of steam-pipes. Therefore it is safe to repeat, without discounting future advance too heavily, that no more than 1 kg. of steam is to be expected from a cubic metre of blast-furnace gas, or about 0·062lb. of steam per cubic foot.

CITY AND GUILDS OF LONDON INSTITUTE.

ELECTRIC LIGHTING AND POWER TRANSMISSION.

HONOURS GRADE.

The following are the questions set by the Examinations Department of the City and Guilds of London Institute, 1898:

Candidates in honours must have previously passed in the ordinary grade. They may select their questions from one only of the following sections.

Section I.—Electrical Instruments, etc.

Answer questions 11, 16, and 19 of the ordinary grade; together with not more than *six* of the following:

21. What is creeping, or time lag, in springs, and how can it be avoided? (10 marks.)

22. Describe a potentiometer suitable for measuring from 10 to 1,000 amperes, and give a sketch indicating the principal dimensions. (25.)

23. How does the construction of an amper-hour, or quantity meter differ from that of a volt-ampere-hour, or energy meter? Give a sketch of a good specimen of each type. When can one be used in place of the other? Have you any suggestion to make with reference to the name "recording wattmeter" as applied to the Elihu Thomson supply meter? (25.)

24. Write an account of the method of making magnets so that they may be permanent. Explain what sort of variation you would expect to find in a good magnet belonging to some measuring instrument. (25.)

25. Compare the advantages and disadvantages of slide wire, dial, and P.O. pattern Wheatstone bridges. (15.)

26. If a motor-supply meter has the armature and brake on the same magnetic field, how will the rate be altered by the weakening of the field? (10.)

27. A gradual change is found to occur with ebonite. What is the cause, what effect does it produce, and how can it be prevented? (12.)

28. A resistance to take 0·015 ampere at 2,000 volts is required for a wattmeter to be used on an alternating-current circuit. Give full particulars of the size and material of the wire and the number of turns; also the size and material of the core, and the outside dimensions. (25.)

29. When testing a small resistance with a Wheatsone bridge, trouble is found to be produced by thermo-electric action. Explain the various methods of allowing for this, and prove that they lead to accurate results. (15.)

30. What standard of light, and what kind of photometer, would you use for accurate work? Explain the details of measuring the light and efficiency of a small incandescent lamp, and describe all the precautions that should be taken to ensure accuracy. (20.)

Section II.—Dynamos, Motors, Lamps, etc.

Answer questions 3, 15, and 17 of the ordinary grade; together with not more than *six* of the following:

31. Discuss the various special armature windings which have been devised during the last two or three years to avoid sparking. (30.)

32. What are the relative advantages and disadvantages of carbon and metallic brushes, and what are the special points to be attended to when using them respectively? (15.)

33. Give sketches of two of the principal types of alternators, and discuss briefly their special advantages and disadvantages. (20.)

34. You are required to test at full load a dynamo which can maintain a terminal potential difference of 500 volts when producing 250 amperes and running at 400 revolutions per minute. The only engine available cannot generate more than 50 h.p., but you have two compound-wound dynamos, each of which can maintain 200 volts when producing 250 amperes and running at 450 revolutions. Describe in detail the best arrangement to be used for carrying out the test. (25.)

35. Determine the winding of a Gramme armature, the core of which has a length of 12in. (not including the thickness of the insulation), a diameter of 7in., and a radial depth of iron of 2in. The bore of the pole-pieces is not to exceed 13in. The dynamo is to produce 100 volts at 1,000 revolutions per minute, and the largest current permissible so as not to raise the temperature of the armature more than 75deg. F. above that of the air. Assume such an induction as you think desirable. Calculate the resistance of the armature cold and hot. (30.)

36. What are the advantages of smooth, toothed, and tunnel armatures? (10.)

37. Give your own ideas as to where the stress comes with a toothed and with a tunnel armature, and explain why with such armatures the air space must exceed that required for clearance only. (20.)

38. Discuss the advantages of high and of low frequency with dynamos, motors, leads, transformers, and with arc lamps. (12.)

39. What is the inductive drop in a transformer? and consider whether it is greater or less on an inductive load than on a non-inductive one. (20.)

40. Draw polar curves showing the distribution of light with an open direct and with an open alternating current arc; also with an enclosed direct-current arc. From these estimate the total amounts of light that are sent out downwards within a cone, the generating lines of which make an angle of 45deg. with a vertical line through the arc. (20.)

Section III.—Lighting and Power Supply.

Answer questions 3, 5, and 20 of the ordinary grade, together with not more than *six* of the following:

41. Give details of the complete plant required for electrically lighting a country house with 100 16-c.p. incandescent lamps, and make a sketch of the switchboard showing the connections. (30.)

42. It is desired to transmit 200 h.p. two miles, to be distributed at the receiving end to a number of electric motors, ranging from 1 h.p. to 30 h.p. Describe the plant which you would recommend. (30.)

43. What is a pilot wire? How should it be led? Where should it be connected with the mains or the feeders? Give full reasons for your answers. (15.)

44. What are the relative merits of direct and multiple current motors for driving, say, a machine shop, and for working coal-cutting machinery in a mine? (10.)

45. Describe, with sketches, the various systems of laying underground mains, and discuss their relative advantages. Would there be any disadvantage in using long separate lead-covered cables with the lead insulated from the ground for alternating work? (25.)

46. Is any difficulty experienced with running transformers of different sizes in parallel? Give full explanation. (25.)

47. Describe in detail, with sketches, the best method with which you are acquainted for making an incandescent lamp. (20.)

48. What types of water-motor and of dynamo would you propose to use in the two following cases: (1) 1,000 cubic feet of water per minute with a 10ft. fall, and (2) 10 cubic feet per minute with a 1,000ft. fall? The power to be used on the spot. (25.)

49. What are the most important errors to be looked for in consumers' meters? (15.)

50. Describe in detail, with sketches, the kind of electric tramway that you consider most suitable to be introduced into the busy streets of an important city. (20.)

INSTITUTION OF ELECTRICAL ENGINEERS, May 26.

At last night's meeting of the Institution of Electrical Engineers the following were the candidates balloted for.

Associates.—Walter James Leeming, Corporation Electricity Works, Blackburn; E. S. Lowes, Mons Veltro, Villa Vova de Lima, Estados de Minas, Brazil; George William Maddison, South Hetton Collieries, South Hetton, Sunderland; Edward Goodson Phillips, Electrical Department, Metropolitan Railway, Bishop's-road Station, W.; Edgar Poole, 33, Hartham-road, Holloway, N.

MUNICIPAL ELECTRICAL ASSOCIATION.

following is the official programme of the third . convention of the above association, which is to l in London on June 8, 9, 10, and 11 :

convention will commence on Wednesday, June 8, at m. at the Royal United Service Institution, Whitehall, At this meeting Mr. A. H. Gibbings, city electrical r, Bradford, will deliver his presidential address, and owing papers will be read and discussed: "The Manage- Electrical Undertakings," by Councillor Hesford, chairman Electricity Committee of the Southport Corporation; chboard Apparatus," by J. R. Blaikie, chief assistant al engineer, Bristol; and "Steam-Using Plant," by J. A. , borough electrical engineer, South Shields. Members or taking part in the discussion are requested upon rising to o mention their name and the town they represent. The will adjourn at 1 p.m.

the afternoon the following excursions are arranged: (a) d Waterloo Railway. By kind permission of the directors gineers, Messrs. Galbraith and Kennedy, the association it the above works. Members of the association visiting terloo and City Railway should meet at 2.30 p.m. in what l the "Booking Hall" of the railway. It is under one of es of the Waterloo (main line) Station. The entrance is e Post Office yard of the London and South-Western , adjoining the general offices of the company in York- (b) Islington electricity works: A reception by the Elec- Committee of the Islington Vestry will be held at the electricity works, Eden-grove, Holloway, N., at 3.30 p.m. e evening of the same day (Wednesday) the association will be held at the Holborn Restaurant at 6.30 for 7 p.m. (exclusive of wine), 7s. 6d. each; after June 1 the price t will be 10s. each.

THURSDAY, JUNE 9.

general meeting for discussion of papers will again be held Royal United Service Institution, opening at 9.45 a.m. The g papers will be opened for discussion: "Uniformity of by C. H. Wordingham, city electrical engineer, Man- ; "Appropriation of Profits and Repayment of Loans," ie Wm. Maclay, convener of the Electricity Committee of sgow Corporation; "Single *versus* Multiple Generating s," by J. F. C. Snell, borough electrical engineer, Sunder- The meeting will adjourn at 1 p.m.

Afternoon Excursions.

directors of Messrs. Willans and Robinson, Limited, have the members of the association to visit their works at on Thursday afternoon, and have arranged for a special leave Euston for Rugby at 1.45 p.m., returning from at 7.15, and timed to arrive at Euston at 9 p.m. Luncheon served on the journey down and dinner on the return . Tickets for the special train, etc., may be obtained on ion to the hon. secretary before June 6.

eption by the Electric Lighting Committee of the Croydon tion will be held at the electricity works, Croydon. Trains ictoria Station at 2.3 and 2.35 p.m., returning from East n at 4.15, 4.38, and 5.48 p.m.

nd permission of the directors, the General Electric Com- lamp works at Brook Green, Hammersmith, may be d by members of the association.

FRIDAY, JUNE 10.

general meeting for discussion of papers at the Royal United Institution will again be opened at 9.45 a.m. Papers for on: "Electric Traction," by R. C. Quin, borough elec- ngineer, Blackpool, and J. E. Stewart, borough electrical r, Derby; "Accumulators in Connection with Lighting action," by J. H. Rider, borough electrical engineer, th; "Stand-by Supply," by R. C. Quin, borough electrical r, Blackpool. The meeting will adjourn at 1 p.m.

Afternoon Programme.

nd permission of Messrs. Siemens, arrangements have been r an inspection of their works by members of the associa- The train leaving Charing Cross 2.17 p.m. will be taken, at Charlton Junction (the nearest station to the works) at n.

tion by the Shoreditch Electrical Committee at the elec- works, Coronet-street, Shoreditch, E.C., at 3.30 p.m.

SATURDAY, JUNE 11.

usiness meeting at the Royal United Service Institution, cing at 9.45 a.m., will consider the following business: meeting for next convention; election of officers; report cil; wiring regulations; loan of motors, etc.; treasurer's nt; and the secretary's report.

Afternoon Excursions.

gements have been made for members of the association either Portsmouth or Dover electricity works during the n and evening. Trains leave Victoria Station for Ports- at 1 p.m. and 1.45 p.m.; and from Victoria Station to at 12.40 p.m. and 1.38 p.m. Week-end tickets may be l.

n the above programme it will be seen that the rs will not be idle during the convention, and we recommend all to take week-end tickets and recruit sea on Sunday.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared, and should be written on one side of the paper only. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time.

QUESTIONS.

66. The product of the volts and amperes in an alternate-current circuit does not always represent true watts. Give examples of cases where there is a wide difference between this product and the watts expended.—P. T.

67. What are the causes of the back-firing in some gas-engines, and how can it be prevented ?—R. G.

ANSWERS.

Question No. 61.—Give details of a test for efficiency and steam consumption of any one dynamo or alternator coupled to a steam-engine, selecting a test on which you were personally engaged ?

Best Answer to No. 61 (*awarded* 10s.).—The following details are of a test made with a continuous-current shunt-wound machine, direct-driven. During the six hours' test indicator diagrams were taken, and the water consumption measured. The mean output for the whole six hours was 1,010 amperes at 120 volts. At starting the speed was 332 revolutions per minute, and at the end of the trial had only increased to 337 revolutions. The shunt current was 14·5 amperes at start, then fell slightly, remaining steady at 14 amperes during the last half of test. The energy expended in magnetising the fields was thus less than 1·4 per cent. of the whole output. The engine was a compound condensing. During the time when the condensed steam was being measured, the mean output was 121·5 kw. The condensed steam amounted to 3,314lb. per hour, which corresponds to 27·3lb. per unit, or 20·3lb. per electrical horse-power hour. The indicated horse-power at the same time works out to 190·2, so that the combined efficiency of engine and dynamo reaches the high figure of 85·6 per cent. The steam used per indicated horse-power hour works out to 17·4lb. The steam used was all weighed in a tank placed on a standard weighing machine, after having been condensed in a surface condenser. This is the most accurate method of determining the amount of steam used which has as yet been practically carried out. The accompanying table gives the principal results of observations during the test:

Conditions.	I.H.P.	Amperes.	E.M.F.	Kilowatts.	E.H.P.	Revolutions per minute	Exciting current.	Water used per hour. Libs.
Full power	190·2	1010·5	120·2	121·5	162·8	339	14·0	3,314
Three-quarter power	147·5	746·0	120·5	90	120	334	12·8	2,631
Half power	108·8	523·5	120·1	62·9	83·9	336·5	11·1	2,048
Quarter power.........	65	263	120·2	31·6	42·1	338	10·5	1,384
Excited	—	—	120	—	—	346	9·5	722
Light with dynamo..	—	—	—	—	—	343	—	580
Light with armature uncoupled	—	—	—	—	—	340	—	524

F. BRUTON.

Question No. 62.—What are the relative merits of two and three phase installations for supplying power and light in such places as large factories ?

Best Answer to No. 62 (*awarded* 10s.).—As regards the actual design of two and three phase motors and alternators, there is, perhaps, not much to choose between them. Machines designed for similar outputs, whether synchronous or non-synchronous, are found to have about the same efficiencies, weight, and apparent watt consumption. The three-phase machines are, if anything, slightly

better, but this is balanced by the winding details of the two-phase type being a little simpler. The main difference between the two systems lies in the relative weights of copper required in the conductors for given conditions, and the ease with which the currents may be handled, regulated, and controlled. The first experiments with three-phase working brought to light difficulties in the regulation of pressure between the three mains at the points of supply, when the currents in the three circuits were not approximately the same, which, though since overcome to some extent, are greater than those obtained with two-phase currents. Two-phase currents, if worked with two separate circuits, are almost as easily dealt with as single-phase currents, and serve readily most purposes to which single or polyphase currents are usually applied. With two separate circuits, lamps may be run by either circuit alone, and thus one-half the armature may be cut out without causing inconvenience. Of course, both circuits must be used for the motors. Four transmission wires are usually employed, but three only may be used, the two inner legs of the circuits being made into one wire of nearly equal cross-section, so that the three wires require almost as much copper as the four. It may, therefore, be taken as a general rule in alternating-current work that for power distribution in workshops where lighting is a secondary consideration, and the amount of lighting is small in comparison to the amount of power, the three-phase system is preferable; but where power and light are to be delivered in approximately equal amounts, the two-phase system should be used in order to simplify the lighting circuits, whilst if the load is nearly all lighting single-phase is best. It has been seen that the question of the relative weights of copper which are required by the two and three phase systems is not so very important inside a factory. For a factory the cost of cables will probably not be more than 35 per cent. of the total cost; but as the interest and depreciation on these cables must go into the annual charges, it is advisable to give the matter consideration. Below is given a table showing relative weights of copper for equal power, voltage drop, and taking into account the stress on the insulation.

Number of wires.	System of transmission.	Remarks.	Weights of copper — On basis of equal effective E.M.F. at end of cable.	On basis of stress on insulation or maximum E.M.F.	Average of the two preceding values.
2	Single-phase.	—	100	200	150
3	Single-phase three-wire.	The third wire ·6 the section of outers.	32	64	48
3	Two-phase.	With common return.	72	290	181
4	Two-phase.	Two separate circuits.	100	200	150
3	Three-phase star or Y connections.	—	25	150	87
3	Three-phase mesh or Δ connections.	—	75	150	112

F. BRUTON.

[N.B.—Owing to the pressure of urgent matter we are unable to print more than the winning answers this week.—ED., *E. E.*]

ELECTRIC WIRING PRACTICE.*

BY FRED BATHURST, A.I.E.E.

There are to-day in England, either in operation or in course of erection, over 200 central electricity stations, which are capable of supplying upwards of 300,000 h.p. of electrical energy, and which can be utilised for the purpose of lighting, heating, and motive power. The above figures will show that every town of importance has now the means of providing for the public a supply of electricity, and we may take it that nearly 50 per cent. of these central stations are directly under municipal control. Although the members of the association we have to-day the pleasure of welcoming may not be immediately directing these "depôts of power," they must, nevertheless, by reason of the prominent directive positions they hold in our towns and boroughs, find it necessary to acquaint them-

* Paper read before the meeting of the Incorporated Association of Municipal and County Engineers at Wimbledon, April 30.

selves with the general trend of the practice connected
these latest adjuncts to town life. Granted that elec
supply is available to every householder living in an up-
town, the problem with which we are now about to
ourselves is how best to instal the conducting wires on th
sumers' premises with due regard to safety and conven
In other words, we are to enquire into the conditions af
or governing the "interior electrical wiring," by whi
electricity supplied from the street main is conveyed
points of utilisation within the house, be it for incand
an electric glow lamp for lighting, heating an electric ra
for warmth, or driving an electric motor for power.
the greater part of the above 300,000 h.p. is utilise
lighting purposes only, and when we consider that the
million incandescent lamps already supplied from
stations represent the accomplishment only of perhaps
cent. of the total lighting which is carried out in towns, w
an idea of the immense field still open to electricity i
particular sphere of utilisation. Knowing further the
and continued progress electric lighting is all the while m
we must recognise that the question as to whether
wiring in the nature of its installation is good or bad, wh
it is temporary or permanent, is a matter of great and in
ing importance. We may take it, in fact, the position
art of wiring dominates the progress of extended electrical
cation, and affects the immediate prosperity as well as the
of the whole electrical industry.

Conditions.—It is now generally understood that when
trical wires are imperfectly installed the electricity
from them can under suitable (and too liable condition
fire to its surroundings, and knowing that fires caused by
trical means are so insidious in their character that their
mention breathes danger and alarm, it will be instru
before directly considering the present practice of wirin
briefly review a few of the conditions which create or r
the possibility of danger, and gain some idea of the prin
which underlie effective construction. Conducting
although designed with the intention of carrying curren
portionate to their sectional area, will, if permitted, carr
current that is passed through them, becoming over-hea
so doing and damaging any insulating covering that
upon them. This possibility of their being able to set
their covering and the ultimate fusion of the conductor
can be readily shown by experiment. [Experiment sh
Having, therefore, an ordinary insulated electric wire
current we must face the possibility of injury occurring
from within itself, and note that in this respect the co
of electric service is very different to that we are accus
to in gas practice.

As supporting the method of wiring the author will adv
we will here make the experiment of arranging the ins
in the form of a tube which directly surrounds the con
but without being immediately attached to it. You wi
note that, although under the same conditions as befor
conductor can now be burnt out inside the tube witho
destruction. [Experiment shown.] Comparing our firs
of an electric wire and its tight-fitting insulating coverin
a gas-pipe, we see that the copper conductor is equival
the orifice of a gas-pipe, whilst the frail insulating
has to be compared with the coating material formin
gas-tube. As regards mechanical considerations, there
rubber-insulated electric wire installed in a house
other protection compares with a gas service furnished
rubber tubes, and it is unnecessary to add that a gas su
the latter nature, although perhaps permissible for a tem
connection, would not be countenanced in standard p
Some might here argue that so-called "safety fuses"
in circuit with electrical conductors in order to protect
from becoming overheated, but commercially these
generally consist of a short length of easily fusible tin,
lead alloy wire, and they are found to have great limit
In the first place, no satisfactory form of fuseholder ha
devised that prevents the enlargement of its capacity by
or unitiated persons, and it is common experience to fin
when a fuse is continually breaking the recurrence
trouble is prevented by replacing the tin wire by one
or copper, which will carry any excess of current. A
sized tin or alloy wire, which will act as a fuse for a
current of certain value, will momentarily allow a very
larger current to pass (the fuse acting with a steady cur
10 amperes may on "short-circuit" permit a momenta
of 50 or more amperes), and this time-integral further
with the same sized fuse wire in fuse terminals of di
makers. Further, a fuse of fixed capacity affords no pro
against "leakage" current so long as this current do
exceed that of the fuse capacity, and a later experime
show how an electrical fire can result from a current
not capable of breaking a small fuse, although it is
which the limit of physical strength is very nearly appr

Returning to our experiment, we see that it is the int
of the coating of insulating material which confines the
to the conductors, and that the "insulation" of a con

wire must be correctly designed and proportioned to the tendency to leakage. Electricity is supplied to the wire at a certain pressure, or voltage, and this factor also determines the ability of the current to break through the insulating environment, for just as "pressure" (the number of pounds per square inch) in the case of steam or water can be raised so as to burst a metallic pipe, so can the voltage of the current on a conductor be increased until the insulating covering is broken down. Here, still, in comparison with gas service, we find electricity again at a disadvantage, for, although the insulating material may be properly designed to withstand the voltage with the material in a perfectly dry state, the slightest unforeshadowed presence of moisture can act disastrously and cause the insulating material to lose its electrical value. This fact can be brought home to our bodily senses by first of all touching the charged conductor, which is protected by a coating of dry cotton, and then touching the same conductor when the cotton has been wetted. This fact can be determined by anyone desirous of testing it. [Experiment shown.]

There is a further condition in electrical work—that when the insulating covering of a wire becomes partially damaged the escaping current not only chars and destroys its covering, but creates an electrolytic effect on the conductor itself, which results in its gradual corrosion and a corresponding decreased carrying capacity, until ultimately a condition is arrived at when the conductor is not large enough to carry the current it was designed for. The very first requirement, therefore, in providing for "insulation" is to rigorously exclude the possibility of moisture reaching the conductors, and in looking for suitable materials for insulation (porcelain, mineral wax, oils, rubber, dry silk, and cotton are insulators, whilst all metallic bodies are usually good conductors) we have not only to find good non-conductors, but choose those materials which are resistant and repellent to the effects of moisture. We have now gained an idea of the importance of the considerations underlying the question of insulating conductors, and noted that the direct insulating covering of an electrical wire is exposed to possible injury both from within and without, and that in providing perfect protection we have to guard against certain electrical, chemical, and mechanical conditions. Indiarubber, now the generally used standard material for insulating light wires, whether applied in its pure and plastic state or in its vulcanised condition, has, it must be allowed, a certain limited life, but as to what time is the exact duration of its life, under the varying conditions of wiring application, is a matter too contentious to deal with here. But, sooner or later, under the ordinary atmospheric conditions, it deteriorates, becoming dry and brittle, so that cracks and air checks appear and present the chance for any collection of moisture in its vicinity to give rise to electrical faults. The acids and alkalies of the cements and plasters used in connection with building construction are also known to act upon rubber and the fibrous material used in insulating electric wires, so as to cause their deterioration and destruction. The rubber insulation should therefore be protected, as far as possible, against deterioration, and failing absolute protection, arrangements should be made to prevent its deterioration from causing injury outside the electrical conductors themselves. In this connection, does not the experiment with insulation in the form of a tube offer a feature of safety, and a supplementary possibility of increased durability that deserves to be worked out commercially?

Systems of Distribution.—Dealing for a moment with the plans upon which the wires may be installed, before coming to the actual modes of erection, we have to note that the term "circuit" as applied to electric light wiring implies the use of two distinct wires, which are usually laid close together, one being used as the "lead" and the other for the "return" of the current to the point of generation. Comparing them still with the familiar gas practice, which requires only the single pipe connection to the individual gas jet, where the gas is ignited in contact with the air, the idea of the construction required in electrical work can best be grasped by imagining it necessary to provide a second and supplementary system of piping, just as if an exhaust system of piping were necessary to collect the products of combustion, in order to return them to the gasometer. Electric circuits can be installed either on a "tree" principle or on a "centre of distribution" principle. In the former, the current may be taken as circulating in the wiring as the blood does in our bodies, passing from the larger arteries to smaller ones (branches) and ramifying (in circuits) throughout the system, like the branches of a tree, and according to the direct needs of the parts, eventually being returned towards the starting point, the heart, by the veins. By this method, as fuses are placed wherever a small wire joins a larger one, in order that the current-carrying capacity of the smaller wire may be protected, it often happens that the fuse boxes are placed in unlikely and inconvenient positions, and generally only on one pole, the positive lead, the exigencies of space and appearance prohibiting large and unsightly appliances. This principle was almost universal in the early days of wiring, and in some few cases is still adopted, but it is being, and should be, entirely superseded in favour of the second principle, that of "centres of distribution." Under this plan a number of main conductors pass off towards the various parts where supply is required, terminating at certain fixed and convenient points, from which as many of the small branches as may be required are run off to groups of, or even to each of, the individual outlet points. It is obvious that this principle provides convenient centres for the general assembly of safety fuses, which can be placed on both poles, and definite positions from which faults on any individual branch can be tested. In practice it permits the use of the minimum number of fuses required, and reduces the changes in the size of the conductors to the smallest number. It greatly simplifies the calculations as to the sizes of conductors required, besides making the work of installation easier of execution by lessening the number of joints required to be made (every joint in a conductor being a source of weakness), and reduces the possibility of inferior workmanship. Further, it gives the most constant voltage at the lamp terminals, with their corresponding advantage of increased life, without regard to how the lamps in different parts of the building may at different times be operated. This is, in fact, the best principle of distribution and control that can be adopted.

Practice.—Leaving theoretical and coming to actual practice, if we take the year 1889 as the date when central-station work really began to be energetically undertaken, we see that nearly 10 years have elapsed since the possibility of central electrical supply, and yet—shame to the electricians to have to own it—we cannot yet point to a permanent and satisfactory system of wiring that can be called as "standard," as iron piping can be termed in respect to gas practice. Prof. S. P. Thompson has, in his practical and epigrammatic way (in a paper read before the Society of Arts), said that what is wanted is a system of electrical conductors which will be "electric-tight," "water-tight," "gas-tight," "air-tight," "oil-tight," and "rat-tight," and doubtless with these qualities we shall attain that "tightness" which goes with first-class electric work. The fulfilment of these conditions would seem to indicate that the wires must be well arranged mechanically, and as in ordinary building construction they have to be fastened on walls and ceilings, pass under floors, and through brick walls and other partitions, the author would suggest that these "tight" requirements at once point to the value of a "tube" or "conduit" system of wiring, as providing a means of inserting and readily withdrawing the conducting wires, in addition to the protective value such a system of piping affords, as preventing disturbances of, and injury to, the conductors placed within it. A conduit system furthermore lends itself perfectly to the "distributing centre" method of installation.

Inasmuch as telegraphic experience preceded the application of electricity to lighting, electricians naturally followed the ideas prevalent in that class of work, and first employed such wires as were commercially available, and which were, comparatively to the requirements which had to be filled, but lightly insulated. Wires covered with cotton soaked in paraffin wax were used; whilst in the absence of any definite experience with the larger current units being handled, we can now see that, in the then state of the art, it was only to be expected that with these wires just tacked or stapled up in position, and passing without method or order through floors and along walls, "overheating" and "leakage" troubles were likely to result. An experiment has been here arranged by which it will be seen how easily two wires, connected with a source of electrical supply, and which are but lightly insulated, or in which the insulating covering has been damaged, can, when lying on damp wood, cause a fire. [Experiment shown.] You will thus see the quiet and insidious way in which an electric fire is caused, and how the conductors "eat out their vitals" and set fire to their surroundings in order to conceal their suicide. The moisture has acted as a conducting bridge between the two wires, with the result that what was at first a small leakage has rapidly become worse, resulting in the complete destruction, charring, and ultimate firing of the inflammable rubber or other insulating covering on the wire, and the firing of the wood or other combustible material in its immediate neighbourhood. From this experiment it is evident that all electrical conductors installed on this or similar lines should be in sight, or, if concealed, readily "accessible," or capable of easy removal for inspection or replacement. For if they are in any way fixed and "inaccessible," the faults which may arise on them are equally fixed and inaccessible. You will note also that the above results are possible in spite of the protection afforded by a three-ampere fuse, and further, that the leakage action could be taking place between the wires without having any lamps alight on the circuit.

The action which was taken from 1889 to 1890 by the fire offices, if not directly based on experience, must, however, in the light of present circumstances, be taken as effective. Rules were drawn up, and for some considerable time contractors felt the pleasures of what (if the author may be allowed to use the word) they now consider "stepmotherly" solicitude and attention. Then came the palmy days of "wood casing," and such insulated wires only as met with "approval" could be installed, whilst slate, asbestos, and other auxiliaries could not

be employed too lavishly. New editions of rules followed one another with startling rapidity, in order to keep up with the state of the art, and even to-day we still feel the effect of the many anomalies which exist from those times. Be it for want of authoritative encouragement and support, or be it British conservatism and apathy to try anything "new" when an apparently satisfactory method already exists, the fact remains that in England wood-casing construction still holds the general field. In the desire to obtain low-cost wiring prices of the material used have been forced down to the lowest point, and in the keen competition existing the only hope of reducing the cost of the installation must rest in lessening the cost of the workmanship. The boxing-in of wires and joints can evidently tend to the existence of slipshod and shoddy work, and work can be done that will for the moment be able to pass all the standards required by fire offices and central stations because no method of testing can determine how long such work will stand. The unscrupulous wiring contractor knows the difficulty of visual examination, and how seldom it can be effectively carried out, and is thus, if he chooses, placed in the position of competing with a reliable contractor by reducing the quality of his material or workmanship; and considering the inherent difficulty of exactly estimating the labour, the author thinks that it is these conditions which are answerable for the immense variations we see to-day between the tenders submitted for wiring work. In some cases the prices tendered vary from 100 to 200 per cent. on either side of the estimated figure.

Some advocates maintain that wood casing, although it cannot be called "permanent," is, under certain conditions, sufficiently satisfactory, and best of all, cheap. The author believes that its extended use has caused the art of wiring to so far turn off the right lines that further progress towards low-class wiring is now barred. He is inclined to think that the future will produce a system of wiring in which far more suitable, if at first more costly, material will be used, so as to enable the end in view to be accomplished more directly and with a simplified and reduced cost in labour. In Germany, for instance, wood casing is now prohibited, and it is also practically obsolete in the United States of America, where an enlarged sphere of electrical application has provided extended experience. Preference has now been given in both these countries to insulated conductors, which are run side by side at a predetermined distance upon porcelain knobs or cleats, the principle being to treat the conductors as if they were bare wires. Providing the wires are nowhere concealed, and the conditions are such that they are not likely to be touched or disturbed, this practice has been proved perfectly satisfactory, and less costly than wood-casing work.

The increasing demand in England for low-cost wiring has recently brought into use a system which can be compared with gas practice employing lead compo piping. The two conductors are insulated, laid side by side, and for mechanical protection are provided with a lead covering. This lead cover, it is advocated, provides a more effective protection than wood casing, so that the wire may be fastened directly up to walls and ceilings without further precautions. The flexibility of the wire, and the simplicity of this practice, may at first sight seem to recommend it, and perhaps extended use may be made of this material for surface work where conditions allow of its use, for then it can be readily inspected, and any change of the presupposed conditions that may be likely to injuriously affect the lead covering can be noted. The author's experience, however, with lead-covered electric wires directly embedded in plaster has been a painful and costly one. The lead covering usually employed is but a fraction of the thickness of ordinary compo pipe, and when utilised under electrical conditions seems to be liable to rapid deterioration in the strong chemical cements and plasters now commonly employed in building construction. The thin lead covering further presents but little opposition to possible mechanical damage, and once its integrity and waterproof qualities are destroyed, electrical faults soon follow. Where it is placed between floors and ceilings, it is not only liable to trouble at the point of the carpenter's nail, but is exposed to the capricious attention of the familiar house rodent; for just as rats and mice occasionally pay attention to lead-covered gas or water pipes, so they may exert their energies upon lead-covered electric wires, and nothing short of what may be a fateful experience to them and the property owner will enable them to discriminate between destroying the continuity of an electrical covering and that of a water-pipe. Some additional form of protecting shield would therefore appear desirable to the permanence of this class of wiring work. As affecting this question of surface wiring, however, and outside the possibility of accidental damage which such work must always present, is the rapidly growing feeling that the work of the present-day electrician is unsightly, and perhaps even fatal to any attempt at decorative effect. Knowing the uncertainty which must exist if his wires have to be concealed, the electrician has hitherto sought to gain *carte blanche* in respect to his action within the building he is wiring, and obtains permission to carry out his plans after his fellow-workmen—the builder, plasterer, pipe-fitter, and decorator—have left; this course, whilst naturally favourable to him, does not always redound to the complete satisfaction of his fellow-workmen. This experience is simply a repetition of what occurred upon the introduction of gas service, and was not satisfactorily removed until the introduction of iron gas-piping minimised the possible dangers arising from the gasfitter's work, and brought about the present standard practice of concealed work. To meet accidental injury from the nails, chisels, and saws of his fellow-workmen, the electrician is driven to use iron to resist iron, and to-day we note a considerable extension in the more mechanical and more costly practice of placing the electric wires within ordinary iron pipes. The author does not question the fact that good electrical work can be carried out with plain iron pipes, but emphatically urges his belief that this is only the intermediate stage we must pass through to secure a standard method of electric wiring.

Iron piping is undoubtedly suited to gaswork, but some of its characteristics must be modified to render it completely suitable for electrical work. When wires are run in plain iron pipes, the freedom of the system from trouble and accident depends entirely upon the perfection of the insulating coverings surrounding each wire, conditions which, as we have already seen, are by no means easily secured. It can be shown that any internal roughness in the pipe itself, or the slightest carelessness with the wire itself whilst it is being drawn into the pipe, can result in danger to the insulation of the wire. Every practical man knows that when an iron pipe is severed by means of the pipe-cutter, a jagged and sharp inwardly projecting "burr" is raised, and the inside diameter of the pipe is slightly lessened. A short run of plain pipe with one or two bends in it is here arranged, the lengths having been cut up and installed in the manner which would be adopted for gas work, and two wires will be pulled through them. [Experiment shown.] It is evident that the roughness of the edges within the pipe is sufficient to seriously damage the insulating covering of the wires, and unless this is found out at the time the wires will not have on them the perfect covering they were intended to have. The erection of plain iron piping for the reception of wires therefore implies that whenever the workman cuts his lengths he must rigorously care for and ream out the ends quite smooth. Here, then, is a condition which must be squarely faced in order to counteract any carelessness on the part of the workman. Experience shows that iron pipes exposed to the presence of moisture or changing atmospheric conditions are liable to "sweat" inside, and when such internal condensation of moisture occurs any defects in the insulating covering of the wires will rapidly develop. Any tests that we can now apply after completion of the wiring work will not indicate partial deterioration of the insulation, so that although breakdowns may not immediately result, "faults" can be left on the wires or in the pipe until the occurrence of the further conditions, which may cause them to show up. In fact, the plain iron being a conductor enables the pipe to act as a bridge by which the fault occurring in the insulation of one wire is transmitted throughout the system, to await the breaking down of the opposite wire at some other point. A series of experiments has been arranged to illustrate what may happen when such faults occur. [Experiment shown.]

The wires taken are the sizes employed as electrical mains for ordinary house supplies, and are protected by safety fuses of 50 to 100 ampere capacity. Reproducing the conditions which will result in connecting both conductors to the pipe, we see that the effect of the "short-circuit" caused may be to burn out the pipe, in spite of the protection supposed to be afforded by the fuses. You will note that the current which momentarily passed the 50-ampere fuse before causing it to operate made the pipe red hot, and nearly melted out a portion of the metal. By the current passing the 75-ampere fuse you will see that a hole is completely burnt out of the pipe. In the case of the 100-ampere fuse the effect is still more marked, and with the 150-ampere fuse the limit of illustration with this pipe is reached, inasmuch as the "short-circuit" effect of larger currents would leave no pipe at all. It is unnecessary to dwell upon the fact that the above possibilities may create a very serious fire risk in those buildings wherein such construction might be found. This same state of affairs can be reproduced on the smaller branches of a plain iron pipe system of wiring, if the original fuses protecting the wires have been accidentally enlarged through replacement by careless or uninitiated persons. In America some experiences of the above class led the fire underwriters to entirely prohibit the use of plain iron pipe for electrical work, but the author must, in fairness to the advocates of the plain iron pipe system, admit that the representation of those demanding lower-cost winding have, at the time being, led to a modification of the above rule, so as to admit the use of plain pipe, providing the wires are always drawn in after the erection of the pipe, and that the wires used are provided with a substantial additional fibrous braiding 1-32in. thick. This extra cotton braiding has to be provided for the purpose of enabling the insulation on the conductors to resist abrasion. Whilst technically, therefore, the use of plain iron pipe is allowed, the practical result of the

above stipulation is to force the contractors to prefer as the alternative method the use of an insulated iron pipe. Although an insulated iron pipe must necessarily cost more than plain iron pipe of equal size, if the wires used in connection with the latter have to be specially treated in respect to their covering the extra cost involved in this case is a set-off against that of the lined pipe, and the advantage of possible competition is secured.

But the question of an insulating lining brings us to the matter which is nearest to us. To prove the electrical value and utility of the "insulating lined conduit" which the members of this association will see manufactured at these works, we will repeat the short-circuit experiment made with plain iron pipe. In this case, however, instead of the 50 to 150-ampere fuses, we will insert those of 250 amperes capacity. [Experiment shown.] This time the result is not pyrotechnical, and examination of the tube will show that the "short-circuit effect" has been kept entirely within the tube. The insulating lining has, it is true, suffered somewhat from the intense internal heat, but has successfully resisted being "burnt out." The tube when cut open longitudinally has the appearance on the right-hand side of the burnt-out plain iron pipe. From an electrician's point of view, the insulated pipe is therefore advantageous, for, being "arc-proof," it safely confines within itself the dangerous fire effects which may result in consequence upon the deterioration of the insulation of the electrical conductors. The author explains the matter by stating that the insulating lining employed is sufficiently fire-resistant to preserve the insulation of the conductors intact from the metallic pipe, so as to cause the short-circuit rush of current to take place between the conductors themselves, until either the molten state of the conductors at the point of contact or the rupture of the fuse itself serves to break the continuity of the circuit and restore normal conditions.

Touching further upon the necessity of obtaining in any electrical conduit a perfectly smooth interior, an experiment has been arranged to show the relative friction of lined and unlined pipe, and which shows entirely in favour of the former. [Experiment shown.] The possibility of carelessness on the part of the installing wireman is also provided against by the choice of a sufficiently thick and suitable lining, for, upon examination of the samples before you, it will be found that, no matter how carelessly the lined pipe may have been cut, the inner edge of its iron armouring only embeds itself partly into the lining, and can in no instance cut through it so as to present an internal roughness which would abrade wires being drawn through the conduit. The insulating lining reduces to a minimum any condensation that can occur in an iron pipe, and as no rusting or corroding effect takes place in consequence of whatever moisture may get inside the conduit, it is in this respect superior to plain metallic pipe. The lined pipes are non-hygroscopic, and after being soaked in water will be found to give very high insulation resistance to any electrical conductor placed within them, and the insulation can be classed as permanent because it is everywhere under the protection of a substantial iron armouring, and is therefore capable of resisting mechanical damage.

Conclusion.—There are many other features of electric wiring practice which could be referred to, but which hardly come within the scope of this paper. The author hopes that he has successfully pointed out that a complete system of electric wiring which employs continuous tubes or "conduits" of armoured insulating material, has many points to recommend it; that such "electrical" tubes can with complete confidence be installed throughout a building in the same manner as gas or water pipes, and the conducting wires can be drawn through them afterwards. By this method the wires are insulated electrically from the materials—such as wood, plaster, stonework, gas and water pipes—employed in the building itself, with certainty and security. Further, that an insulating conduit system of wiring either guards against or makes satisfactory provision for any sort of electrical accident which may arise, fully meeting all the conditions required for complete immunity from fire risk and for personal safety—in fact, an insulating conduit system of wiring provides in the highest degree the cardinal points of good wiring, "safety," "durability," "convenience," "accessibility," and "economy."

The author has only to add that the material manufactured by this company is now securing wide recognition in the highest class of electrical installation work, and would thank the Association of County and Municipal Engineers for having had the privilege of bringing the question of electrical wiring practice before them.

PHYSICAL SOCIETY.

At an ordinary meeting of this society, held on May 13, 1898 (Mr. Shelford Bidwell, president, in the chair), a paper by **Prof. W. E. Ayrton** and **Mr. T. Mather**, on **"Galvanometers,"** was read by Prof. Ayrton. It is a sequel to *Proceedings* Physical Society, vol. x., p. 393, and to *Phil. Mag.*, vol. xxx., p. 58. The authors suggest that in future the comparative sensitiveness of galvanometers should be expressed in terms of the number of millimetre scale divisions per microampere, when the observed image or "spot" is 1m. from the mirror. Unit angular deflection is therefore one-two-thousandth of a radian. Further, for the periodic time—*i.e.*, the time between two transits of the "spot" across some fixed point on the scale, in the same direction—the standard should be 10 seconds. It is also proposed to reduce the factor of sensitiveness, as regards resistance, to the common basis of one ohm. The assumption is that, for a given galvanometer, the deflection per microampere is proportioned to the two-fifth power of the resistance of the windings. Tables accompanying the paper give complete data for a large number of galvanometers constructed during the past 10 years, and it is possible to trace the improvements in sensitiveness throughout that time. The most sensitive galvanometers are the oscillographs; they have very short periods, the moving parts are small, the controlling fields very strong. They are designed to indicate the character of rapidly-varying currents. An oscillograph, as improved by Mr. Duddell, was exhibited; its period is 0·0001 sec., and its factor of sensitiveness, according to the author's classification, is greater than any yet obtained. A distinction is drawn as to the use of the term "dead beat." Maxwell applies it to galvanometers in which the motion is "aperiodic"—*i.e.*, to those in which the suspended system, before coming to rest, passes only once through the position of equilibrium. This meaning is retained; it is not to be confused with "quick-moving" or "short period." A pendulum illustrating these distinctions was exhibited. As regards insulation of galvanometers and shunt boxes, the authors now apply the "guard-wire" principle of Mr. W. A. Price. The instrument to be insulated is enclosed in a metal case provided with a terminal, to which one end of the windings is connected. The second end of the windings passes out through an ebonite bush-piece. This arrangement is said to nullify leakage and to prevent electrostatic disturbance of the suspended system. In the second section of the paper the authors calculate the limiting sensitiveness of galvanometers of the "Thomson" type. The investigation is based upon Prof. Schuster's British Association (1894) paper. It takes into account the period of the suspended system and the specific magnetisation of the needle. Lastly, the authors discuss the relative merits of long and short periods—*i.e.*, the best "control" for galvanometers intended to indicate zero points in potentiometer operations. They conclude that if the control can be readily altered, and if the sensitiveness can be adjusted for the test, then for rapidity of working the "control" should be so adjusted that the sensitiveness is approximately two or three times greater than is absolutely needed for the desired accuracy.

Prof. Threlfall thought the authors' method of comparing galvanometers very misleading. The results obtained in their comparison of the oscillograph (3,310,000) and the suspended coil galvanometer (27) might be regarded as the *reductio ad absurdum* of the proposed system. The absurdity arose from the dissimilarity of the two instruments. Moreover, the proposed system ignored the fact that sensitiveness may be obtained by optical as well as by electromagnetic means. Optical sensitiveness, owing to its greater stability, was to be preferred to electromagnetic sensitiveness. The fundamental problem in the construction of galvanometers is an optical one; it is necessary to decide the mass and dimensions of the suspended parts so as to ensure (1) optical accuracy and (2) electromagnetic sensitiveness. Thus, to some extent the weight of the mirror determines the thickness of the suspension. As an instance of what might be done by optical methods, Prof. Threlfall referred to work done by himself and Mr. Brearley (*Phil. Mag.*, 1896) in which it was possible to measure to $1·48 \times 10^{-13}$ amperes, and, with special refinements, to 3×10^{-14} amperes. He had found that the best diameter for glass mirrors was 1·1cm., with a weight just under 0·5 grm. These were used with a scale at 276cm., read by a microscope to 0 04mm. The course of the light was: lamp, large lens, small scale, mirror, eye-piece. The period was 25 s conds, and the resistance 50,000 ohms. Even better results could be obtained by using mirrors of quartz or of blood-stone. Quartz is incomparably to be preferred to glass. Such figures indicated what could be done by optical sensitiveness, the sensitiveness that the authors ignored. It was pointed out by Prof. Threlfall that the controlling field for galvanometers of the "Thomson" type should be straight and uniform. This was best secured by using two magnets, one above and one below the needles.

Prof. Perry said the authors had not asserted that a galvanometer with higher figure of merit, according to their classification, was superior to another of lower figure. It must be agreed that the figure they obtain is a very valuable datum for the comparison of instruments designed for similar purposes—for instance, in classifying those used by Prof. Threlfall Mr. Duddell was to be congratulated on the extreme sensitiveness and small period of his oscillograph.

Prof. Ayrton, referring to Prof. Threlfall's *reductio ad absurdum*, admitted that the criticism would carry some conviction if the two instruments were of different kinds; if, for instance, one possessed a suspended needle and the other a suspended coil. But the argument failed, because both instruments were of the suspended-coil type. In one of them Mr. Duddell had developed the advantages to be gained by reducing the air gap. To form an opinion of electromagnetic improvements in galvanometers, it was necessary to reduce the results of all instruments to some system of classification. There was no objection, after that, to adding a good mirror and reading by a good microscope.

The **President** proposed votes of thanks to the authors, and the meeting adjourned until May 27.

LIGHT RAILWAYS.

Application is to be made to construct the London, Barnet, Edgware, and Enfield light railway.

The preamble of the Usk Valley Railway Bill has been proved before the Select Committee of the House of Commons.

An enquiry was held into the proposed Anglesey light railway last week. The Commissioners reserved their decision.

At the recent enquiry at Alfriston into the proposed Cuckmere Valley light railway, the opposition to the scheme gained the day.

The Friern Barnet Urban District Council have instructed their surveyor to report upon the proposed light railway scheme so far as it would affect the roads in the Council's district.

The Upper District Committee of the county of Renfrew have resolved to request a conference with representatives of the burgh of Paisley regarding the proposal of the British Electric Traction Company to construct a tramway on the Beith-road between the burghs of Paisley and Johnstone.

At a special meeting of the shareholders of the Glasgow and South-Western Railway, a proposal to apply to the Light Railway Commissioners for a light railway along the Ayrshire coast between the towns of Girvan and Ayr was adopted. The capital to be raised under the order for the works is £120,000, with borrowing powers amounting to £40,000.

With regard to the draft order of the Light Railway Commissioners authorising the construction of a light railway from Porthywaen to Llangynog, the Commissioners, in authorising the Denbighshire and Montgomeryshire County Council to advance a loan of £3,000 to the Tanat Valley Railway Company desired the County Council to submit any observations on the draft order transmitted before the order was finally settled. The Denbigh County Council agreed that no observations on the draft were necessary, inasmuch as in the event of any advance being made the Council were empowered to impose such conditions as they might then deem advisable.

At the last meeting of the Gillingham District Council a letter from the promoters of the light railway scheme of the district, pointing out what alterations had been arranged in the original scheme by the Commissioners, was discussed. The promoters were prepared to proceed with the remainder of the scheme, and the conditions as to purchase, etc., should remain. They would be willing to contribute £2,000 towards the improvements if the Council agreed to carry them out in five years. A letter was also read from the Brompton, Gillingham, and District Civic Union calling on the Council to oppose the scheme and take the necessary steps to lay down a plant of their own for electric trams. Ultimately the scheme was approved, on the understanding that the promoters took the line to Gad's Hill and provided sufficient cars for workmen who took tickets.

SOUTHAMPTON ELECTRICITY WORKS.

We give herewith the revenue account, balance-sheet, and statement of electricity generated, sold, etc., from the accounts of the Southampton Corporation for the year ending March 31, 1898, which have just been issued:

REVENUE ACCOUNT.

Dr.	£	s.	d.	£	s.	d.
Coal	£956	4	1			
Oil, waste, water, and engine-room stores	109	15	6			
Wages	410	11	3			
Repairs and maintenance: buildings, 10s.; engines and boilers, £37. 9s. 5d.; dynamos, £4. 18s. 1d.; other machinery, £2. 2s. 3d.; accumulators, £35. 8s. 9d.; lamps, £1. 8s. 4d.	81	7	8			
				1,557	18	6
Wages	97	10	0			
Repairs, maintenance, and renewals of mains	32	19	3			
Repairs, maintenance, and renewals of meters	2	15	0			
Clothing	8	8	5			
				141	12	8
Rents	2	16	0			
Rates and taxes	96	15	6			
				99	11	6
Salaries—engineer's department	377	0	11			
Accountant and collector, and clerical staff	99	7	0			
Stationery and printing	52	18	3			
General establishment charges	47	5	7			
				576	11	9
Insurances	87	13	9			
Certification of meters		13	4			
				88	7	1
Bad debt				6	11	6
Auditing				8	8	0
				2 479	1	0
Amount carried to net revenue account				1,912	12	3
				£4,391	13	3

Cr.	£	s.	d.
Sale of current per meter	4,275	0	0
Sale under contracts	1	4	6
	4,276	4	6
Rental of meters	85	13	3
Rents receivable, £25; discounts, £3. 4s.; testing fees, £1. 11s. 6d.	29	15	6
	£4,391	13	3

GENERAL BALANCE-SHEET.

Liabilities.	£	s.	d.
Capital account—amount received	56,064	0	0
Sundry creditors	1,010	4	1
Sinking fund account	2,543	1	5
Bank overdraft—revenue account	1,265	5	10
	£60,882	11	4

Assets.	£	s.	d.
Capital account—amount expended	30,918	8	[illegible]
Stores on hand at March 31, 1898: coal, £12. 2s. 4d.; oil, waste, and engine-room stores, £16. 16s. 11d.	28	19	3
Sundry debtors for current supplied to March 31, 1898	1,331	13	2
Sundry debtors for contracts in course of completion	12,206	18	6
Other debtors	73	10	8
Securities held (consolidated loans fund account)	2,034	9	2
Cash on deposit, £12,500; capital account, £592. 17s. 9d.; in hand, £7. 13s. 8d.	13,100	11	5
Suspense account	1,188	0	9
	£60 882	11	4

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		228,227
Quantity sold: By contract	94·5	191,868
Quantity sold: By meter	191,773·5	
Quantity used on works		5,223
Total quantity accounted for		197,091
Quantities used in distribution and batteries		31,136
Total maximum supply demanded (kilowatts)		262

LEGAL INTELLIGENCE.

HAMMOND v. THE ELECTRICITY SUPPLY COMPANY FOR SPAIN, LIMITED.

This was a motion brought in the High Court of Justice (Chancery Division), before Mr. Justice North, on the part of Mr. Robert Hammond, the plaintiff, to restrain registration of a transfer of shares in the defendant company, of which he claimed to be beneficial owner. The defendants, other than the company, were Don Pedro Pastor y Landero, the transferor, and Mr. R. C. Wyatt, the transferee. Owing to the fact that the Spanish Government would not permit service of a concurrent writ on Don Pedro Pastor y Landero, who is in Spain, it appeared the plaintiff had not been able to bring him before the Court, and the motion therefore stood over.

Mr. Kirby was for the plaintiff, Mr. Martelli for the defendant Wyatt, and Mr. K. H. Leach for the company.—*The Times.*

HULL ELECTRICIAN'S CLAIM.

Before his Honour Deputy-Judge Thomas, at the Goole County Court, Messrs. Timm and Sons, flour millers, Goole, were sued by Mr. Kitchen, electrician, Hull, for £15. 2s. 4d. for work in connection with the installation of electric light in defendants' mill.

The point in dispute was as to whether the refixing of certain old lines, necessary in order to connect the new wires with the old ones, was included in the contract.

His **Honour** found for the plaintiff for the full amount, with costs.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Hammersmith.—The Vestry invite tenders for the supply and erection of additional electrical plant. Tenders by June 8.

Bury St. Edmunds.—The Town Council invite tenders for the supply and erection of electrical plant. Tenders by June 13.

Bray.—The Commissioners invite tenders for the supply of the materials required at their electricity works for the ensuing year. Tenders by June 6.

Bedford.—The Urban Sanitary Authority invite tenders for the construction of an underground sub-station. Specifications, etc., may be obtained at the Electricity Works. Tenders by May 31.

Salford.—The Electric Light Committee of the county borough invite tenders for accumulators; motor-generators, balancing machinery, and boosters; switchboards; cables; alternating current transformers. Tenders by June 6.

Madras.—The Secretary of State for India in Council announces that the time allowed for the receipt of tenders by the Chief Engineer for Irrigation, Madras, for the utilisation of water

power of the Periyar Lake has been extended from Oct. 31, 1897, to July 1, 1898.

Watford.—The Council invite tenders for the erection of an electric light station adjoining the new sewage works at Watford. Specifications, etc., may be obtained from the architects, Messrs. Gordon, Lowther, and Gunton, Finsbury House, Blomfield-street, E.C. Tenders by June 8.

Glasgow.—The Corporation invite tenders for the brick and mason work of the new generating station to be erected at Port-Dundas. Plans, etc., can be obtained from Mr. Andrew Myles, architect, 143, West Regent-street, Glasgow, on payment of £2. 2s., which will be returned on receipt of a bona fide tender. Tenders by June 1.

Cape Colony.—The Town Council of East London, Cape Colony, is prepared to receive tenders for the erection of buildings and the supply of electric lighting machinery, electric tramcars, plant, rails, etc., and for their maintenance for six months from completion. Full particulars will be found in our advertisement columns. Tenders by June 28.

Belfast.—The Harbour Commissioners invite tenders for the supply of three belt-driven, continuous-current, series-wound dynamos, capable of giving 15 amperes, 2,850 volts, at a speed of not exceeding 800 revolutions per minute for 18 hours' continuous running, without undue heating. Specifications, etc., may be obtained from the harbour engineer, Mr. G. F. L. Giles. Tenders by June 6.

London, S.W.—The London County Council invite tenders for supply of engines, dynamos, accumulators, switchboards, the feeders, distributors, and service mains, and all accessories, to be fixed complete in buildings at the Crossness outfall works, near Erith, Kent. Specifications, etc., may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W., upon payment of £1, to be returned to bona fide tenderers. Tenders by June 21.

Kingston-on-Thames.—The Committee of the Kingston-on-Thames Workmen's Club and Institute invite tenders for the fitting-up of an installation for electric light at their club premises, Fairfield-road, Kingston-on-Thames. Specifications, etc., can be obtained at the office of the Consulting Engineer, Electric Light Works, Down Hall-road, Kingston, between 10 a.m. and 5 p.m., on deposit of £1, which will be returned on receipt of a bona fide tender. Tenders by June 6.

London, S.E.—The Electric Lighting Committee of the Vestry of St. Mary, Newington, invite tenders for the supply and erection of engines, generators, and public lighting plant for the Vestry's electric lighting station in Penrose-street, Walworth. Specifications, etc., can be obtained at the offices of the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of a fee of £5. 5s., which sum will be returned on the receipt of a bona fide tender. Tenders by June 6.

Taunton.—The Corporation invite tenders for the supply and erection of (Section A) certain engines and alternator, exchange of existing alternators, and exchange of transformers; (B) rectifiers and alterations and additions to high-tension switchboard. Specifications, etc., to be obtained at the Municipal Buildings, Taunton, or at the offices of the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of a fee of £3. 3s., which sum will be returned on receipt of a bona fide tender. Tenders by June 6.

London, S.W.—The London County Council invite tenders for providing and fixing cables, wires, conductors, casing, pendants, brackets, watertight and other fittings, columns, lanterns, lamps, switches and switchboards, distributing boards, fuses, cut-outs, etc., which may be necessary for the lighting by electricity of the Crossness pumping station and works near Erith, Kent. Specifications, etc., may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W., upon payment of £1, which will be returned to bona fide tenderers. Tenders by June 21.

Coventry.—The Electric Lighting Committee invite tenders for the electric mains, switchboards, arc lamps, posts, and apparatus: (Section A) high-tension feeders on a solid system, and low-tension armoured distributors, laid and jointed complete (indiarubber-covered cables will not be considered); (B) supply and erection of switch-gear, etc., in sub-stations; (C) public arc lighting (about 40 alternating arc lamps, posts, transformers, etc.); the whole bound up in one specification. Tenderers are at liberty to tender for the whole or for either section separately. Specification, etc., may be obtained from Mr. Gilbert S. Ram, city electrical engineer, Coventry. Tenders by June 7.

Victoria (Australia).—Tenders are invited by the Council of the city of Hawthorn for the supply and erection, or for the supply only, of: (Section A) buildings only; (B) boilers, water-heater, pumps; (C) engines, dynamos, switchboard, mains, sub-mains, transformers, meters, arc lamps, insulators, testing instruments; (D) supply of poles and their erection; running of the plant for three years. Specifications and forms of tender can be obtained at the office of the Agent-General for Victoria, Lieut.-General Sir Andrew Clarke, G.C.C.M., Victoria Office 15, Victoria-street, Westminster, London, S.W., on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Tender for Electric Lighting," and addressed to the Mayor of Hawthorn, Victoria, Australia, on June 24, at 5 p.m.

RESULTS OF TENDERS.

Salford.—The Town Council have accepted the tender of John Holt, at £28,161, for the erection of a generating station.

Ipswich.—The following tenders have been received by the Guardians for an electric light installation at the new workhouse, Woodbridge-road:

Laing, Wharton, and Down	£3,585
Edmundsons' Electricity Corporation	3,218
Crompton and Co., Chelmsford (accepted)	3,035

Engineer's estimate, £2,750.

BUSINESS NOTES.

Douglas.—Electric lighting, to be under municipal control, is talked of.

Western and Brazilian Submarine Telegraph Company.—The traffic receipts for the past week were £2,259.

Bournemouth.—The question of the appointment of an inspector has been deferred till the Council's electrical installation is completed.

Norwich.—The Surrey-street route has been struck out of the Electric Tramways Bill now before the Committee of the House of Commons.

Leicester.—The Finance Committee of the Town Council recommend that a sum of £33,719 be set apart out of the proceeds of the recent loan for electricity works.

Chiswick.—Mr. Cutler and Mr. Bilton have been deputed by the District Council to interview Messrs. Bourne and Grant with reference to the electric light supply.

Sutton Coldfield.—The Town Council have decided to oppose the grant of a license to the Birmingham Installation Company, as they intend to establish a municipal electric supply.

Sunderland.—The Town Council have resolved to apply to the Local Government Board for £26,000 for extensions to the electric supply station and additions to the plant and mains.

Ossett.—The Town Council have resolved to visit and inspect the combined plant at Shoreditch with a view of putting down an electric lighting plant in conjunction with a refuse destructor.

Mitchelstown.—The Board of Trade, after fully considering the report of the inspector appointed to enquire into the electric light provisional order, have decided not to proceed further with the same.

Waterloo.—The Waterloo-with-Seaforth Urban District Council have entered into a contract with Messrs. Waring and Gillow, Limited, of Liverpool, for an electric light installation at the town hall.

Detroit Telephone Company.—The directors have declared a quarterly dividend of 2 per cent., being at the rate of 8 per cent. per annum, payable to holders of ordinary shares on the register on April 30.

Maidstone.—The Urban District Council have appointed a small sub-committee to visit Norwich and Leyton with a view of inspecting the combined dust destructor and electric lighting station at those places.

Brazilian Submarine Telegraph Company, Limited.—The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, tax free, for the quarter ended March 31, payable on June 24.

Cowper-Coles Parabolic Reflector.—We are informed that a sole license has been granted to Messrs. Sautter, Harle, and Co., of Paris, for manufacturing parabolic reflectors by this process for searchlights in France, Russia, and Spain.

Bangor.—The electric lighting scheme adopted by the City Council is to extend to Upper Bangor, and for this purpose application is to be made to the Local Government Board for power to borrow a further sum of £3,500, making a total of £13,500.

New Mains.—The London County Council have agreed to the construction of new works, mains, etc., by the Metropolitan Electric Supply Company, the House-to-House Electric Supply Company, and the Crystal Palace District Electric Supply Company.

Barnsley.—Mr. Tyas has been instructed by the Council to visit Wakefield and examine the deposited plans of the proposed electric lighting syndicate, and in the event of it being found that Darfield was included within the prescribed area that he prepare to oppose it.

St. James's and Pall Mall Electric Light Company, Limited.—The London County Council have authorised the construction of a chimney-shaft addition to the company's generating station and works in Carnaby-street, Regent-street, St. James's.

Holborn Tramways.—The London County Council have given an official notification of the withdrawal of their Bill to construct tramways in the Holborn district, in Clerkenwell, Islington, Bloomsbury, Shoreditch, and Bethnal Green. The estimated cost of these extensions was £32,000.

Hackney.—The Vestry elections have resulted in a Progressive gain of six votes. It will be remembered that the voting was equal on the point whether the electric lighting should be undertaken by the Vestry or by a private company. We may assume that it is now practically certain that the former course will be taken.

Newington.—At a meeting of the Vestry on May 25, it was proposed that the Electric Lighting Committee for the ensuing year consist of the following members: T. Bryan, T. Chapman,

W. Edwards, J. G. Emmett, C. Hibble, J. Hibble, S. Lane, J. C. Mather, G. Newman, W. Revitt, H. Skinner, and A. E. Smithers.

Salford.—The T.C. have adopted the plans of Mr. John Holt for the erection of a new generating station on land in Strawberry-road at an estimated cost of £28,161. This sum does not include machinery. The building will accommodate 12,000 h.p. when finished. Plans are being prepared for generating the current for electric traction.

Sheffield.—The result of the poll of the ratepayers taken this week with a view to ascertain whether they are in favour of the Corporation purchasing the undertaking of the Sheffield Electric Light and Power Company, is as follows: for the Corporation completing the purchase, 28,130; against, 1,965. There were 1,764 spoilt papers.

Lancaster.—At the last meeting of the Town Council it was reported that the electricity profits had been £598 during the past year, which amount had been handed over to the borough fund in relief of the rates. The gas profits were less by £470 than last year, owing to decreased consumption, due to the extension of electricity.

Gloucester.—At the last meeting of the Gloucester City Council, reference was made to the electric light question. With respect to a desirable site taken by a certain firm on a lease of a term of years, and desiring £500 to give up possession, the committee announced that they had got the amount reduced to £325, and recommended that the terms be agreed to.

Heaton Norris.—With reference to the proposals from the Manchester Corporation with respect to the taking over of the tramways and the supply of electric power from the Corporation, Heaton Norris will act with Stockport and Levenshulme. A committee is to draw up proposals to the Manchester Corporation, which will first be submitted to the Council.

Westgate.—A Board of Trade enquiry was held at Westgate on Friday last by Major P. Cardew, R.E., into an application of the Isle of Thanet Rural District Council for a provisional order, under the Electric Lighting Acts, 1882 and 1888, to authorise them to supply electricity for all public and private purposes within the contributory place of Westgate-on-Sea.

Fenton.—The British Electric Traction Company have written to the District Council that the question of obtaining setts for the completion of the Potteries extension tramways was a matter of the gravest difficulty. It appears that the local authorities object to the setts proposed by the company as unsuitable to the traffic of the district. The Highways Committee is considering the matter.

British Aluminium Company, Limited.—An issue is being made by this Company of £100,000 5 per cent. debentures, repayable at par on Jan. 1, 1900, and redeemable at any previous time at £105 per cent. The Company was registered in 1894 with a fully-issued share capital of £300,000. The balance-sheet for the year ended Dec. 31, 1897—the first complete year of trading—shows a gross profit of £23,644.

Kidderminster.—The electric tramway was opened on the 25th inst. The Corporation have resolved to sell to the British Electric Traction Company the power possessed by them under the electric lighting order obtained seven years since, the company undertaking to at once construct works for supplying electric light for town purposes. The Corporation have the option of repurchase of the power and works at the end of a stated period.

Heckmondwike.—At a meeting of the District Council on the 25th inst. a letter was submitted from the British Electric Traction Company, Limited, London, stating that they proposed to take the necessary preliminary steps with a view to obtaining powers for constructing a tramway connecting Ravensthorpe, Dewsbury, Staincliffe, Heckmondwike, Liversedge, and Cleckheaton. They propose to proceed under the Light Railways Act of 1896.

Poplar.—The Guardians have decided, on the recommendation of the Electric Lighting Committee, to adopt the scheme for the provision of electric light at the workhouse as prepared by Mr. F. J. Warden-Stevens, and submitted in his report of September last; to instruct Mr. Warden-Stevens to prepare the necessary plans and specifications of working, and to apply to the Local Government Board for a loan of £9,000, repayable in 30 years, for the purposes of defraying the cost of the work.

Bolton.—The electricity undertaking is now earning a profit for the town. The profit during the past year was £917. During the year £10,000 has been expended in improving and adding to the works, and the committee are satisfied that in time they would be able to relieve the rates very considerably. In reply to a suggestion at the last meeting of the Council that the price of electricity fittings be reduced, the Chairman said they did not want to unduly compete with private traders and work without profit.

Stockport.—The General Purposes Committee of the Corporation considered on Friday last a proposal for the establishment of a general system of electric tramways throughout the borough and the important districts adjoining. A resolution was carried to the effect that an omnibus Act should be applied for to give the Corporation powers to establish such a system of tramways as may be thought desirable. A committee was appointed to negotiate on the whole subject, and especially as to the taking over of existing lines.

Gateshead.—At a meeting held some days ago a committee was formed "to collect and impart information, by public meeting or otherwise, on the municipal working of tramways, gas, water, electric lighting," etc. As an outcome of this a meeting of the committee was held on the 25th inst., at which a resolution was passed to the effect that those present decided in favour of supporting the municipalisation of the Gateshead tramways, and pledge themselves to do everything in their power to effect that purpose.

Fatal Electric Accident.—Edward Fell, a foreman at the Chelmsford Electric Lighting Company's works, was killed while attending to the underground wires in a transformer chamber in Tindal-street. He was lying at full length by the side of the wires, and reaching down came in contact with one of the wires, and, the current then being on, he received such a shock that death must have been instantaneous. His right thumb was fearfully burnt and mutilated. Deceased, who was about 45 years of age, was married, but had no children. He had been with the lighting company for some years.

West African Telegraph Company.—The report for 1897 presented to the general meeting on the 26th inst. states that the Company's revenue for the 12 months amounted to £64,723, against which £21,213 is charged for ordinary expenses and £18,780 for expenditure relating to repairs of cables, etc. After providing £860 for income tax and £225 for revaluation of currency assets, there remains a balance of £23,645, to which is added £459 brought forward, making a total available balance of £24,104. Of this sum £10,099 is to be used for interest on debentures and £13,633 for sinking fund, leaving a balance of £372 to be carried forward.

Appointment Vacant.—The Corporation of Londonderry require an electrical engineer to their lighting station. Applicants must have had training in mechanical and electrical engineering, and preference will be given to those experienced in high-tension continuous-current series arc lighting systems, with Brockie-Pell arc lamps. Salary, £160 per annum. Candidates to state age, experience, how soon they will be prepared to take up duties, and to enclose copies of not more than three recent testimonials. Applications, endorsed "Electrical Engineer," to be lodged with Sir R. Newman Chambers, town clerk, Guildhall, Londonderry, by 31st inst. Personal canvassing will disqualify.

Islington.—At an extraordinary meeting of the Vestry to be held to-day, the following will be proposed as members of the Electric Lighting Committee: W. Harris (Tufnell Ward), A. Walkley (Upper Holloway), G. T. Wilson (Tollington), F. Chatterton, F. W. Hales, and F. G. Watkinson (Lower Holloway), W. Beale, E Fitzgerald, R. Gordon, A. Palace, G. E. Price, and J. E. Quayle (West Highbury), F. H. Varley and Geo. Wright (East Highbury), A. J. Fernhead and W. T. Stainton (Thornhill), S. Lambert (Barnsbury), T. Andrew, R. S. Cufflin, and T. W. Vine (St. Mary), A. S. Dobito and W. H. Whadcoat (Canonbury), H. W. Callender, J. W. Smyth, and J. V. Taaffe (St. Peter's).

Huddersfield.—The County Borough Council have instructed the tramways manager and borough electrical engineer to prepare and submit a report as to the application of the electric traction on one or more of the sections, having regard to the utilisation of the present rolling-stock and capital expenditure. The Electric Lighting Committee's report shows that the number of consumers of the electric current during May was 661, being an increase of 11 on the previous month; the number of lamps connected was 44,757, an increase of 710. The committee have received the formal permission of the Board of Trade to alter the standard pressure upon the low-tension mains in the central portion of the town from 100 to 200 volts.

Bridlington.—The electric lighting of the new spa was formally opened last week. The works consist of one of Crossley's 30 h.p. gas-engines of the latest type, which drives a powerful dynamo with a working pressure of 110 volts. This supplies 24 arc lamps of 1,000 c.p. each from the firm of the Brush Electrical Engineering Company, of London and Edinburgh. In addition to these there are 50 incandescent lamps of 60 c.p. each. The cable connecting the various lamps was supplied by the British Insulating Wire Company, of Prescot, Lancashire. The whole of the installation has been most successfully carried out under the personal supervision of Mr. W. Johnson, the consulting engineer of the Electric Light and Power Company, Sheffield.

Personal.—Mr. Jonas, who has been employed by Messrs. Ferranti, of Manchester, about two years, and before then was in the service of the Newcastle Electrical Supply Company, has been appointed electrician to the Dewsbury Corporation.—Mr. Archibald Sharp, A.M.I.C.E., has resigned his appointment at the Central Technical College, and has taken offices at 47, Victoria-street, Westminster, where he will carry on the profession of a consulting engineer. He will be open to carry out trials and experiments on existing plants, and to give advice regarding inventions. Among the subjects with which he is specially acquainted may be mentioned: development and transmission of power; heating, lighting, and ventilation; strength of materials of construction; bicycle design.—Mr. J. W. Garside, Brighouse, has been appointed electrical engineer to the Brighouse Town Council.

Hastings.—The Council have approved of a notice from the Hastings and St. Leonards-on-Sea Electric Light Company, Limited, of the intention of the company to carry a $^{7}/_{16}$ low-tension armoured diatrine cable from the proposed sub-station in the enclosure opposite St. John's Church, down Mase-hill to a point near St. Leonards Lodge, such main to be laid in the roadway at a depth of about 2ft. and about 3ft. from the kerb, subject to the arrangements for the erection of the proposed sub-station being carried into effect, to the main being laid under the footpath wherever there was slab paving instead of under the roadway as proposed, to the work being carried out to the satisfaction of the borough engineer, and to the company giving the usual undertaking not to remove the cover of any inspection box to be con-

structed in connection with the main except between the hours of 10 p.m. and 9 a.m., unless in case of actual emergency.

Devon Agricultural Association.—At the Devon Agricultural Association's show, which was opened last week at Newton Abbot, Messrs. Lord and Shand, of Plymouth, exhibited a number of electric motors driving a variety of machines, agricultural and domestic. There were electrically-driven cream-separators, chaff-cutters, coke-crushers, and horse-clippers. The latter present the advantage that only one hand is required to operate them. The domestic machinery was represented by ventilating fans, plate polishers, and sewing machines. There were also smaller exhibits, such as curling tongs' heaters, and a variety of lighting fittings and bells. We are informed that the power was obtained from a Taunton dynamo driven by a Hornsby-Ackroyd oil-engine, exhibited by Messrs. Beare and Son's agents at Newton Abbot. The current was supplied to two 1½-h.p. Taunton motors, manufactured by the Newton Electrical Works, Limited, and 10 Lundel motors of various sizes, manufactured by Messrs. Veritys, Limited.

Blackpool.—The following is from the electrical engineer's report for the year ended March 31 last, for which we are indebted to the *Blackpool Times*: "The estimated revenue for the year was £12,358, the expenditure £6,898, and the interest and sinking fund on capital £3,687, plus £473 interest on public lighting capital, leaving a net estimated profit of £1,300. The actual revenue from supply and rentals was £12,631, and from other sources (exclusive of public lighting) £197, making a total of £12,827. The expenditure on working account was £7,152, and the amount set aside for interest and sinking fund was £3,856. The net actual profit was, therefore, £1,819. The sum of £1,300, the estimated profit for the year, is payable to the rates account in accordance with the Corporation's estimate of last year. A further sum of £405 is also due for the interest on the suspense account for the replacement of old cables. A net amount of £114 is thus still available, and I would propose that this be added to our reserve fund."—An enquiry is announced for Tuesday next into the proposal to borrow £40,000 for electrical extensions.

Fulham.—The report of the Lighting, Electric Lighting, and Dust Destructor Committee states that the chairman, vice-chairman, and Messrs. Avern Thomas, Tapp, Drew, R. Gibbs, Adams, Barker, Sayer, Davies, and Green have been appointed as a sub-committee to consider the appointment of a consulting electrical engineer. That in regard to the proposed appointment of a consulting electrical engineer, the committee concur in the resolution passed by the Law and Parliamentary Committee—namely, "That, subject to an agreement as to terms of appointment, the Vestry appoint Mr. F. Hastings Medhurst, B.Sc., M.I.E.E., as their consulting electrical engineer to carry out the scheme for the installation of electric light within the parish as proposed by him to the Vestry; that it be referred to the solicitor to submit to the next meeting of the Law and Parliamentary Committee draft proposed terms of the appointment"—subject, however, to the appointment of a clerk of the works, who shall be paid by, and be under the control of, the Vestry, subject to his instructions passing through the hands of the electrical engineer himself.

Drake and Gorham Syndicate.—We are informed that in order to deal with the motive power transmission schemes and light railways and tramways which are brought to Messrs. Drake and Gorham in the course of their business, they have formed a powerful syndicate to deal with the preliminaries, and arrangements are being made for a company with a capital of about £250,000. Mr. J. F. Albright, late managing director of Crompton and Co., has joined the syndicate as joint managing director with Mr. Drake, and the syndicate is already in negotiation for acquiring several important schemes for electric traction, power transmission, etc. To avoid misunderstanding, we are asked to state that, while the name of the syndicate is the Drake and Gorham Electric Power and Traction (Pioneer) Syndicate, the business and organisation are quite separate from Messrs. Drake and Gorham's own business, and the syndicate will deal direct with any persons, firms, or local authorities who may wish to negotiate for the promotion or financing of electric traction or power schemes. Offices have been taken at 66, Victoria-street, Westminster, to which all enquiries should be addressed.

Stafford.—At the quarterly meeting of the Town Council, a recommendation of the Gas and Electricity Committee that a bonus be paid to Mr. Bell of £250 in consideration of the extra work which had fallen on him through the establishment of the electric works was carried. The Gas and Electricity Committee presented their annual report, from which it appeared that in the electricity department the increase in the sale of current had been very remarkable, being about 27 per cent. There was now the equivalent of 6,200 8-c.p. lamps connected, as against 5,003 last year. The low tariff of charges fixed last May had seriously affected the revenue. The total receipts were £1,292 and the total expenses £765, leaving a gross profit of £527. Adding £897. 16s. 3d. brought forward, the total sum standing to the credit of the electric department was £1,424. 18s. 9d., out of which £555 19s. 5d. had been paid for interest, £936 9s. 6d. in repayment of loan, and £432 9s. 10d. carried forward. The total amount borrowed was £20,000, and the sum repaid was £1,271. 13s., the debt on capital account now being £18,728. 7s. The electric mains were now practically at the limit of their capacity, but the boilers, engines, and dynamos were ample for a considerably greater demand, and the whole installation was in the highest state of efficiency.

Birmingham.—The *Birmingham Daily Post* understands that, as the result of communications between the Public Works Committee of the City Council and Mr. Ross (chairman of the City of Birmingham Tramways Company), the latter no longer adheres to his plea that the company received "verbal permission" to proceed with their preparations for the equipment of certain routes with overhead electric traction. A new proposal on the part of the tramway company has been under consideration—namely, that the company should be permitted to instal overhead electric traction upon the Sparkbrook and Small Heath routes, as an experiment, for a period of four years. The committee have expressed themselves favourably with regard to this suggestion, and will recommend its approval by the Council. Meanwhile the offer of another company to lay down lines with underground traction upon certain new routes has been formally received from Messrs. Dick, Kerr, and Co., of Glasgow, and will be brought under the consideration of the Public Works Committee in due course. At a meeting of the General Purposes Committee on the 25th inst. the report of the sub-committee appointed to consider the projected purchase of the electric lighting undertaking was fully discussed. It was resolved to recommend the Council to accept the terms provisionally indicated on behalf of the company in whom the electric lighting is at present vested. These terms, as stated in our last issue, fix the price of the £5 shares at £10. 10s., their value in the open market.

Brighton.—The Works Committee's report, which has been adopted by the Town Council, states that they have had under consideration the circumstances with regard to Volk's railway, and presented a report relative thereto from the surveyor (Mr. May), who recommended that certain works be done, at an estimated cost of £1,500 (to be paid for by Mr. Volk), exclusive of the cost of a gap and steps to the beach, which would be necessary in any case for the safety of the public, whether the railway is there or not, and the cost thereof (£190) the surveyor thought should be borne by the Corporation. The committee approved the surveyor's report. They thought that the present time was one convenient for the reconsideration of the whole of the existing arrangement between Mr. Volk and the Corporation, and they had been in communication with Mr. Volk through their sub-committee and found him willing to assent to any terms which the Council considered reasonable with regard to the reconstruction and continuance of the railway. They recommended that the Corporation grant a lease to Mr. Volk for a period of 21 years of the arch now in his occupation, and a license for the same period to construct and maintain the railway on the beach in accordance with the surveyor's report, at a rent for the whole of £120 per annum, subject to certain conditions which provide, among other things, that the railway is to be maintained and kept in working order; damage by storm to be repaired by Mr. Volk as quickly as possible and the lines restored; and that at the expiration or other sooner determination of the lease and license the line, together with the rolling stock and all plant connected with the undertaking, to become the property of the Corporation.

PROVISIONAL PATENTS, 1898.

MAY 16.

11153. **Improvements in electric arc lamps.** Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

11154. **Improvements in self-regulating driving pulleys applicable to the driving of a dynamo from a railway carriage axle and for other purposes.** Edwin James Preston (of the firm of J. Stone and Co.), George English Jakeman, and Alfred Ernest Kennard, 77, Chancery-lane, London.

11155. **Improvements in secondary batteries or accumulators.** Frank King, 47, Lincoln's-inn-fields, London.

11157. **Improvements in alternating-current motors.** Walter Langdon-Davies, 24, Southampton-buildings, Chancery-lane, London.

MAY 17.

11175. **Improvements in switches for electric circuits.** Cecil Burman Callow and Justus Eck, 5, Priory-road, Bedford-park, London.

11185. **Improvements in starting devices for monophase electric motors.** Edmund Basil Wedmore, City and Guilds Technical College, Finsbury, London.

11255. **An improved means or apparatus for reducing or extinguishing the electric arc formed on breaking electric circuits.** Robert Henry Fowler, Charles James Hall, and Richelieu Acock, 37, Essex-street, Strand, London.

11282. **Improvements in electric check clocks or alarm signal apparatus.** Hans Reich, 46, Lincoln's-inn-fields, London.

11290. **Improvements in electric arc lamps.** P. R. Jackson and Co., Limited, and Louis Carl Henry Mensing, 166, Fleet-street, London.

11292. **A new and improved electrical gas lighter.** Joseph de Meza, 20, High Holborn, London.

MAY 18.

11302. **Improvements in or connected with electrical switches.** Arthur Brier, 5, John Dalton-street, Manchester.

11340. **Improvements in or connected with electric batteries.** Ernst August Jahncke, 78, Fleet-street, London.

11307. Improvements and modifications in the construction of amperemeters, voltmeters, wattmeters, or the like. Alexander Spark, 4, Belmont-street, Aberdeen.

11320. Improvements in electrical ignition apparatus for gas burners. Ridley James Urquhart, 57, Barton-arcade, Manchester. (The Actien-Gesellschaft für Fabrication von Broncewaaren und Zinkguss, vorm. J. C. Spinn und Sohn und Stanislaus Johann von Romocki, Germany).

11326. Improvements in adjustable cord reels for electric leads and other similar purposes. Wilson Henry Sturge, 12, Cherry-street, Birmingham.

11353. Improvements in or connected with commutators for dynamo-electric machines and electric motors. Charles Joseph Ferguson and George Thomas Ferrell, 4, South-street, Finsbury, London.

11360. Improvements in globe holders for enclosed electric arc lamps. Karl Weinert, 40, Chancery-lane, London. (Complete specification.)

May 19.

11416. Improved method of and apparatus for signalling or advertising by electricity. Alexandre Ginisty and Valentin Metz, 9, Warwick-court, Gray's-inn, London.

11426. Improvements in electrically-propelled vehicles. The Honourable Reginald Thomas Dudley Brougham and Walter Charles Bersey, 24, Southampton-buildings, Chancery-lane, London.

11429. Improvements in electrically-propelled road vehicles. Octave Patin, 4, South-street, Finsbury, London.

11433. Improvements in prepayment electricity meters. Francis Fane Yeatman, 60, Queen Victoria-street, London.

11438. Improvements in electrical furnaces. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings Chancery-lane, London. (Siemens und Halske Actien-Gesellschaft, Germany.) (Complete specification.)

11440. Improvements in dynamos. Gustav Unterberg, 40, Chancery-lane, London. (Complete specification.)

May 20.

11455. An improvement in automatic electric circuit breakers and restorers. George Edwin Fletcher, The Homestead, Cale Green, Stockport.

11498. An improvement in holders for electric glow lamps. Henry Charles Gover and Charles Faraday Proctor, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

11499. Improvements in resistance switches. Henry Charles Gover, Charles Faraday Proctor, and Alfred Hewson Bate, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

11506. Improvements in or connected with telephones. Jules Ernest Othon Kumberg, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

11518. Improvements in electrical lighting devices for kerosene and other burners. Svend Martin Meyer, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

11519. Improvements in electric brakes. Harry Phillips Davis, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Oct. 22, 1897, being date of application in United States.)

11525. Improvements in and connected with electrical switches. Edward John Wade and the Electric Motive Power Company, 16, Elm-street, Gray's-inn-road, London.

SPECIFICATIONS PUBLISHED.

1896.

12390.* Watt or ampere hour meter. Staveley and ors. (Amended specification.)

1897.

10197. Dynamo and like electrical contact breakers. Boudreaux.

14187. Telephonic systems. Lake. (Von Szvetics.)

24254. Ampere-hour electric meters. Hummel.

15159. Arc lamps. Duflos.

22897. Cut-outs for electric lighting and other purposes. Taylor.

23329. Substances to prevent polarisation in electric batteries. Platner.

28159. Means for use in lighting railway cars or carriages by electricity, and for regulating the current for the same. Watkins. (The American Railway Electric Light Company.)

1898.

2967. Electro-depositing anodes. Haas.

5449. Oscillographs or apparatus for indicating or recording rapidly varying electric currents or potential differences. Duddell.

5912. Electrical galvanic batteries. Laura.

5934. Conduits for electric conductors. Bate.

6923. Phonographs. Gross.

TRAFFIC RECEIPTS.

Liverpool Overhead Railway.—The traffic receipts for the week ended May 22 were £1,416, as compared with £1,386 in same week of 1897, being an increase of £30.

Birmingham Tramways.—The traffic receipts for the week ending May 21 were £3,597. 15s. 3d., as compared with £3,745. 5s. 6d. for same week in 1897, being an increase of £147. 10s. 3d.

Dover Tramways.—The traffic receipts for the week ending May 21 were £127. 16s. 5d. The total receipts for the year 1898 are £2,209. 19s. 1d. The mileage open at present is 3 miles.

Bristol Tramways.—The traffic returns for the week ending May 20 were £2,696. 13s. 9d., compared with £2,483. 19s. 1d. for same period of last year, being an increase of £212. 4s. 8d.

South Staffordshire Tramways.—The traffic returns for the week ending May 20 were £576. 19s. 7d., as compared with £618. 12s. 1d. in same week of 1897. The aggregate receipts for the year are £11,844. 10s. 9d., as against £11,933. 4s. 7d. in the same period of the previous year.

City and South London Railway.—The returns for the week ended May 22 were £987, compared with £958 for same week of 1897, being an increase of £29. The total receipts for the half-year amount to £21,666, compared with £21,461 for the same period last year, being an increase of £205.

Dublin S.D. Tramways.—The traffic receipts for the week ending May 20 were £563. 3s. 4d., as compared with £669. 17s. 10d. in the corresponding week in the previous year, being a decrease of £106. 14s. 6d. The number of passengers carried was 88,163 in 1898 and 95,616 in 1897. The aggregate returns up to date are £8,921. 1s. 1d., as compared with £9,367. 15s. 9d. last year, being a decrease of £446. 14s. 8d. The mileage open is the same as last year—viz., 8 miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	10-10½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	15½-16
—— 6 p.c. Cm. Pf., 30,001-40,000 (1ss. at £2. 10s. pm., all pd.)	4	7-8
Brush Company, Ordinary	3	[illegible]
—— Non. Cum., 6 per cent. Pref.	2	2¼-2½
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	101-104
Callender's Cable Company, Debentures	100	110-112
—— Ordinary	5	9-10
Central London Railway, Ordinary	10	10-10½
——	6	6-6½
—— Pref. Half-Shares	1	1¼-1½
—— " "	5	4¼-4½
Charing Cross and Strand	5	12-13
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	8½-9½
—— 4½ per cent. Debentures	100	115-117
City of London, Ordinary	10	26½-27½
—— Prov. Cert. 90,001-100,000	5	[illegible]
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	129-134
City and South London Railway, Consolidated Ordinary	100	67-70
—— 4 per cent. Debenture Stock	100	126-128
—— 5 per cent. Pref. Shares	10	12-13
—— " " " '96	10	13½-14½
County of London and Brush Provincial Co., Ordinary	10	13-14
—— " "	4	6½-7½
—— 6 per cent. Cum. Pref.	10	15-16
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
—— 5 per cent. Debentures	—	90-95
Crystal Palace District, Ordinary 5 per cent. Stock	100	125-130
—— Preference 5 per cent. Stock	100	143-145
Edison and Swan United Ordinary	3	[illegible]
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	103-105
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	3	[illegible]
Electric Construction, Limited	2	[illegible]
—— 7 per cent. Cumulative Pref.	2	[illegible]
—— 4 per cent. Perp. 1st Mort. Deb.	100	106-108
Elmore's Copper Depositing	1	[illegible]
Elmore's Wire Company	2	[illegible]
W. T. Henley's Telegraph Works, Ordinary	10	21½-22½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-112
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	11-12
India Rubber and Gutta Percha Works	10	21-22
—— 4½ per cent. Debentures	100	102-106
Kensington and Knightsbridge Ordinary	5	12-13
—— 6 per cent. Pref.	5	8-8½
London Electric Supply, Ordinary	5	[illegible]
Metropolitan Electric Supply, Limited, Ordinary	10	16½-17½
—— 4½ per cent. First Mortgage Debenture Stock	100	117-121
National Telephone, Ordinary	5	[illegible]
—— 6 per cent. Cum. First Pref.	10	14-15
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	[illegible]
—— 3½ per cent. Deb. Stock, Red.	100	100-104
Notting Hill Company	10	13½-14½
Oriental, Limited, £1 shares	1	[illegible]
—— £5 Shares	5	[illegible]
—— £4½ shares	4	[illegible]
Oriental Telephone and Electric Company	1¼	[illegible]
Royal Electrical Company of Montreal	—	143-145
—— 4½ per cent. First Shares Mortgage Debentures	100	103-105
South London Electric Supply, Ordinary	2	[illegible]
St James's and Pall Mall, Limited, Ordinary	5	10-11
—— 7 per cent. Pref.	5	10-11
—— 4 per cent. Deb. Stock, Red.	100	107-110
Telegraph Construction and Maintenance	12	36-37
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	100	133-136
Westminster Electric Supply, Ordinary	5	13½-14½
Yorkshire House-to-House	5	[illegible]

and we may expect that the influence of those interested in motor vehicles will be as effective. One thing, however, it is easy to do—condemn, but it is far more difficult to say how to remedy. The multiplicity of surfaces arise from the desire of engineers to find the best material to use.

Electric Dentistry.—Sound advice is given in *L'Etincelle Electrique* to dentists who use the electric current in their operations. The American practice of taking the current from the public supply is justly condemned, and operators are enjoined to use a battery, and have the same recharged by those whose business it is to understand these matters. An American dentist who uses a little hammer which is connected with the electric light supply to dislocate his patient's tooth, may give him some day a much larger shock than he intended, and the public electrocutioner will be cheated out of some of his future victims by executions of a private character more or less undeserved.

Electricity v. Gas.—*Indian Engineering* says: "The installation of an electric lighting system is an improvement which will place Colombo, so far as street illumination is concerned, far in advance of any Indian city. It is a blot upon Indian enterprise that electric lighting should have made so little progress in this country. In spite of the great improvements made in the use of gas as an illuminant during recent years, the superior efficacy of electricity has been incontestably demonstrated; and in shops and private houses in a tropical climate, where coolness and pure air are primary considerations, the relative merits of the electric light and of gas are too obvious to need emphasising."

Wireless Telegraphy.—When the history of wireless telegraphy comes to be written it will be found not to be quite of so recent conception as it is popularly supposed to be. Experiments are being carried out under newspaper auspices by Mr. C. Dolbear, son of the well-known professor. The experiments have been successful over a distance of something like 1,500ft., but to us the interest is more in the fact that America is taking up the subject, and will probably push it with characteristic energy to some practical purpose. Prof. Slaby also has been experimenting, and is said to have sent intelligible Morse signals 13½ miles, using two balloons filled with hydrogen to elevate the end of the conductors to the height of 1,000ft. in the air.

Motorcars.—The difference between the development of motor traction in England and France is well shown by the list of vehicles which entered for the late trials at Liverpool and which are entered for the Paris trials on June 12. We have before us for the latter exhibition 26 vehicles, of which 16 are electric, as against one electric at Liverpool. The French trials, according to the programme, will be very exhaustive, and should result in very largely increasing our knowledge upon the subject. It will easily be seen that while something has to be learned from one electrical car, the probability is that a very great deal may be learned when there are 16 competing. It may be pointed out, however, that of these 16 vehicles several are by the same maker.

As Usual.—It is laughable to find the same methods successfully pursued through the never-ending years. In business it is quite common to hear the remark, "Well, if you will not take it at that price, So-and-So will," and to find one firm played off against the other. This game is being played to perfection in the case of the application of electric traction to the Metropolitan and District lines. No doubt the installation will come in good time, but till the two parties are agreed as to the exact terms, we must expect rumours, more or less vague, to the effect that negotiations are "off" with the one and that others are nibbling to obtain the work. Negotiations too often take the form of attempting, not to obtain what is fair, but who can get the better of the other.

Human Accumulators.—Such is the name of a couple of clever tricksters performing at the Oxford and Tivoli Music Halls. They play apparently very dangerously with fire and various other illuminants. Whether they also endanger the future state of their soul is a question for them to decide. It certainly seems a—well, out of respect to the Libel Act we will say astonishing that if 0·15 ampere is sufficient to electrocute a man, a 10in. carbon held in the naked hand by each of the performers, and the subsequent production of a very strong arc light of at least 10 amperes, will leave them unscathed if they are not connected with an apparatus. They say they are not. Moreover, the current is—always according to their statement—generated and supplied by their own little selves, without the aid of any coils whatsoever. However, they produce a pretty effect.

Ceramic Ware.—We have been favoured with specimens of china which has been treated by a new electric process. We understand that the process has been patented by Messrs. F. J. Shippey Bros., and is for photographing on china and treating the ware in a new way. By this process, after the photograph has been applied to the material, the photograph is put under a specially-prepared glaze and burnt in. A great deal of the beauty and success of the system depends, we understand, upon the use of the electric furnace, as by using it a much higher temperature can be obtained, and the heat can be better regulated. Certainly the samples which have been shown to us must be pronounced excellent; and as the process can be applied to all kinds of ware, and is not at all costly, it ought to be commercially successful. Messrs. Shippey Bros. have seen many ups and downs in the business world, and we trust their last venture may prove equal to their expectation.

Cost of Energy.—The French Commission which we have noticed from time to time on this subject, has collected some figures with regard to the cost of energy at various places. Thus we are told that at Neuchâtel the cost varies considerably, as, indeed, it does in most places, with the number of horse-power taken. The price per horse-power per year when 40 h.p. are taken is 164fr., a little over £6 per horse-power. When only $\frac{1}{10}$ h.p., the cost is at the rate of 400fr., that is about £16 per horse-power per year. At Chambêry the charge is at the rate of about £14 for 1 h.p., decreasing to £8 per horse-power when 40 h.p. is taken. At La Goule a ¼ h.p. is supplied at the rate of a little over £21 per horse-power per year, decreasing when from 2 h.p. to 12 h.p. is taken to £13 per horse-power per year. It ought to be noticed that the horse-power equivalent in these figures is 736 watts, as against 746 usual in this country. It is unnecessary to discuss these and the other figures given because they merely indicate that the cost varies with the conditions of supply, as must necessarily be the case.

Electric Dark-Room.—We have seen a new lamp for photographers' dark-rooms at Messrs. Allan and Adamson's, Tabernacle-street. This firm has a studio in which the whole process of taking a portrait, developing the negative, and printing the picture is executed by electric light, thus enabling a portrait to be taken and finished right off at any season and in any weather. For London especially this ought to be of the greatest value. The photographs are taken by means of a row of incandescent lamps placed inside an umbrella-shaped frame. This apparatus is similar

to the one already described by us, only the lights are of much larger power. We were successful in obtaining a very excellent snapshot by it with an ordinary hand camera. The installation in the dark-room comprises two 8-c.p. lamps, which can be switched on and off by means of plugs placed near the developing sink. One of the lamps is bare (white light), the other is encased in a round globe, the lower part of which is coated with two ruby and one canary celluloid coverings. This admits only red light, but a different red light from the usual mystic gloom of the dark-room, with its attendant mishaps of spilt solutions and broken glasses, etc. It must be worth a great deal to be able to see properly and yet be sure of the safety of the most delicate plates. Some of the prints were taken by the ordinary 8-c.p. lamp in three minutes.

Electrosynthesis.—Mr. William G. Mixter in the *Amer. J. Sci.*, 1897, notes that mixtures which readily explode when subjected to an ordinary electric spark may not do so under the influence of the electric glow in an ozonising tube. Thus, oxygen and hydrogen in the ratio 1 : 2 at 235mm. pressure did not explode, but combined slowly. Various explosive mixtures were therefore subjected to the glow discharge in eudiometer tubes and the rates of combination determined, but as no determinations of the current strength were taken, the relation between the rate of combination and the quantity of electricity discharged was not obtained. Hydrogen and oxygen were found to slowly combine, carbonic oxide and oxygen combined more rapidly, and even when perfectly dry combined slowly. Methane and oxygen combine in a manner consistent with complete combustion, but in the case of mixtures of acetylene with oxygen, ethylene with oxygen, and ethane with oxygen, the quantity of the latter gas used is less than that required for complete combustion, whilst small quantities of the hydrocarbons were decomposed with the formation of acetylene. Very little ozone is formed during the discharge, and the oxidation cannot be due to its formation. The author does not consider the combination to be due to the union of ions, but to the interaction of the molecules themselves, which are made active by the glow discharge.—*Jour. Chem. Soc.*

Certainly.—Some sharp criticisms have been heard because in some recent battles the doctors were not supplied by Röntgen ray apparatus, but, of course, this is only a characteristic of the national temperament. One of the first examples of this grumbling spirit in connection with galvanism is to be found in the "Percy Anecdotes" as follows: "One of the most curious applications of galvanism to the useful purposes of life is its recent employment as a means of distinguishing bad teeth from good. The test which galvanism has now supplied to remedy the frequent mistakes made by dentists, who, instead of ridding you of a bad tooth, will draw the best you have in your head, is considered to be one of infallible certainty in its application. The method is thus described by Prof. Aldini, the nephew of Galvani. 'He (the dentist), first insulates the patient, and then places in his hands an electric chain; he then applies a small piece of wire and draws it gradually over the surface of the tooth; he then applies it to the next tooth in the same manner and proceeds in the like method with the rest, until he comes to the diseased tooth, which is discovered by violent pain being produced, and an involuntary emotion in the body. It has always been remarked, when the tooth is extracted, that it exhibited a careous part, which in its proper situation was not visible.' Need we add, that after the discovery of so simple a test, drawing a wrong tooth ought to be made felony at least."

Electrolysis in Tramway Work.—Mr. Herrick discusses this subject in the current number of the *Engineering Magazine*, and, without saying much that is new, says what he has to say very clearly. He comes to the conclusion that "there is no panacea for the evils arising from electrolysis, but there are general treatments which greatly relieve the condition. That is true. Mr. Herrick states his remedies as, "first, to connect the rail to the water-pipe at points where the pipe is positive to the rail; second, to use feeders, preferably by connecting the pipe at this point directly back to the station. Another method is to take the current from the water-mains through a dynamo whose potential is negatively lower than the rail-return dynamos, or the return through the ground and water-pipes may be fed through the armature of a low-potential machine, keeping this system electrically negative to the rail, so that the current does not leave the water-pipe system, but naturally returns through this generator as the lowest potential point in the system. The excellency of the bonding of the track and the proper placing of ground return feeders is the most practicable and direct method of reducing electrolysis. If care and attention are given to these details, electrolysis can be reduced in most instances to a negligible quantity. This can be assured also by a few subsidiary feeders connected to the water-pipe system." All this can be summed up, So arrange your circuit that no electrolytic action of a harmful nature can take place.

More Szczepanik.—This time it is photography and electricity applied to weaving. The Vienna correspondent of the *Daily Chronicle* has interviewed this latest specimen of the genus genius, and has another astonishing tale to tell. By means of a photograph about 4ft. square the design for a Jacquard loom is reproduced with all its squares; the stencils have become unnecessary, the tedious work of a year or two is accomplished in a quarter of an hour, and, further, by the use of electricity the inventive Pole sets in motion not only the punching levers, but also the threads in the loom itself; in short, he weaves direct from the original design plate (as we may name this substitute for the Jacquard stencil). But the inventor is not only an inventor, he is a philanthropist first. Hear him! Hear him! The *Daily Chronicle* reporter asked a question natural under these circumstances: "What need of this punching machine at all if you can weave direct from the original design plate?" "It is clear," answered Herr Szczepanik, "that it would be most difficult all at once to abolish all the looms now in use, thus annihilating the great capital invested in them. Accordingly, economic considerations induced me to devise a middle course, that of the stencil-punching machine, in order immediately to enable the manufacturer to produce more cheaply, and to afford him an opportunity of introducing the electric looms gradually." Like his telectroscope, the first appearance to the public of this new wonder is also reserved for the Paris Exhibition. So the gentleman with the jaw-breaking name has yet about two years in which to enjoy his fame, in case the machine does not work as well as it can be described on the proverbially patient paper.

Cape-Cairo Land Telegraph.—We do not know the value of any claim for the conception of a Cape-Cairo land telegraph, but we do know that the rapid march of events in South Africa seem now to have rendered practicable what the best authorities thought impracticable 20 years ago. It was in July, 1878, after Mr. J. Sievewright recommended the consideration, that the present writer asked Prof. A. H. Keane, whom it was thought knew as much about the interior of Africa as anyone, to examine the question, and the professor's answer was decidedly unfavourable. Twenty years have, as we say, led to an almost total reconstruction of the map of Africa, and in

that time British domination has made itself felt through almost every mile from the Cape to Cairo so that the telegraph line would not have to pass through the territory of hostile tribes. The immediate cause of these remarks is the following, from Saturday's *Times*: "Mr. H. B. T. Strangways, writing from Shapwick, Somerset, with reference to the leading article in the *Times* of May 20 on the scheme for a telegraph line from the Cape to Cairo, claims credit for having conceived the design. He says: 'In respect to the courage of risking large sums I have no claim; that credit is due to the Right Hon. Cecil Rhodes. But as to the 'conception,' I shall be very much obliged if you will permit me to remind you that in your issues of Sept. 30, 1876, and Feb. 15, 1879, you were good enough to publish letters from me recommending the construction of that line of telegraph. The construction of the Central Australian telegraph was due to my action; and I desire to maintain my claim to the 'conception' of a design of which you write so favourably.'"

Fuses.—Mr. J. Fischer-Hinnen, in *L'Eclairage Electrique*, has described, according to the *Abstracts* of the Institution of Civil Engineers, a new system of fuses. The abstract states: "Apparatus to secure the safety of electric generators in case of overload or short-circuit are of great importance. Broadly, there are two kinds—mechanical circuit breakers and fuses. The use of the former class is somewhat restricted and confined to special cases, that of the latter is much more general on account of cheapness and greater simplicity. Difficulties are met with in designing fuses for other than low pressures, especially when they have to act in a confined space, as, for instance, on electric tramcars. To meet such cases the author has devised a fuse in which the fusible wire is carried in a helical groove nearly an inch deep formed on the surface of a porcelain cylinder. One end of the wire is attached to a ring forming one terminal, and serving also to support the cylinder, the other to a disc of soft iron at the top, which is attached to a soft-iron bolt passing down the axis of the cylinder and having at its other end a similar disc, serving also as the second terminal. This construction gives a great length of wire in a small space, and the deep grooves hinder the arc from forming on fusion. The chief feature, however, is the magnetic blow-out secured by the current in the fuse magnetising the soft iron, the field being in such a direction as to tend to force the wire or the arc, if formed, towards the interior. In order to test the apparatus, a fuse designed for 30 amperes at 1,500 volts was surrounded with tinfoil reaching nearly to the terminals. On blowing the fuse, instead of the current arcing on to the foil, the foil did not even show the least trace of metallic vapour."

London Technical Education.—The current number of the official circular of the Technical Education Board of the London Council contains some very interesting information. It has, for example, a *résumé* of the work of the late International Congress on Commercial Education at Antwerp. Of course, it takes a long time for any good result to emanate from these congresses, but they are peculiarly beneficial in bringing together the foremost educationalists of the day so that they may interchange views and thus consolidate ideas. It is now many years ago since in a paper read at one of the late Social Science Congresses we put forward views which have been generally adopted, but there seems to have been no one to have determined or attempted to determine the line of demarcation between what may be termed technical education and practical education. We incline to the opinion that a good many of our educationalists intermingle the two and attempt to give in the schools a good deal of what should remain to be learnt in the shops. However, the congress at Antwerp did not deal much with technical matters, but confined its attention to what may be termed purely commercial subjects, such as asking to what extent should special commercial instruction be given in secondary schools. Our reason for mentioning just previously technical education is to say that what holds good in respect to technics holds good in respect to commercial questions, and that purely commercial training should be left till after school age, and not be admitted at all into the schools. The attention that should be given there should certainly be of a kind to be of service in after life, and, in fact, so to speak, form the tools which the student will have to use in after life.

The New York Exhibition.—We understand from *Electrical Age* that a series of eight historical wax tableaux, designed to mark some of the successive stages of electrical development, will be a feature in the concert hall of this exhibition. The series will include: the first recognition of an electric effect, when the Syrian woman, centuries before our era, wonderfully perceived light objects flying to her amber spindle; the mariner's compass, ascribed to the Chinese and Italians, but probably to be credited to the Finns, in the eleventh century; the earth a great magnet—William Gilbert explaining the Terella to Queen Elizabeth, 1600; the first conductors or circuits; Stephen Gray, a Charterhouse pensioner in London (1720) experimenting on the conduction of electricity; the Leyden jar, showing the bottling of electricity and the terrible shock to Dean Von Kleist, canon of the cathedral in Cumin, in Pomerania, 1746; the identity of lightning and electricity, when Benjamin Franklin drew down the lightning from the skies, 1752; the beginnings of the modern primary battery or voltaic cell, with Galvani's famous frog experiment, 1791; and the beginnings of modern dynamo-electric machinery, showing Michael Faraday's famous experiment, 1831. These tableaux are accompanied by a selection from Dr. Park Benjamin's celebrated library of early philosophical, technical, and electrical books, each illustrating some feature or stage of electrical evolution. We should like to have seen some more recent steps illustrated, such as Mr. T. Alva Edison demonstrating the advantages of long magnets with great moments for dynamos; Prof. W. E. Ayrton beside a motor in which the armature reaction assists the field; and finally, perhaps, Mr. J. Swinburne demonstrating the advantages of the Hedgehog transformer.

Lord Rayleigh on Heat.—In the third and last of his lectures upon heat, given at the Royal Institution Lord Rayleigh, says the *Times*, began by discussing the conditions that governed condensation and the deposition of vapour, and pointed out how the presence of motes to serve as nuclei of condensation affected the formation of cloud. He then referred to some of the phenomena visible at the change of state from liquid to solid, and showed how aggregation round a solid particle of the salt dropped into supersaturated solutions of acetate of soda went on at rates corresponding with the degree of supersaturation. He then turned to the further discussion of Carnot's theories respecting the efficiency of reversible heat-engines, and pointed out that it carried with it a definition of absolute temperature independent of any particular kind of matter. The conditions of obtaining this theoretical efficiency were next considered, and it was stated that the highest efficiency yet known in practice was about ·2, or, in other words, that only one-fifth of the heat taken from the boiler was converted into work. This very moderate efficiency might be increased by the use of higher working temperatures, but it was difficult to do this with water or with other liquids having higher boiling points. The difficulty was evaded

in another form of heat-engine—the gas-engine, in which the heat was developed in the cylinder itself. Good gas-engines gave an efficiency of ·25, and it might be expected that this would in time be raised. The lecturer proceeded to mention some wider applications of the theory of the dissipation of heat—*e.g.*, to chemical and quasi-chemical actions—and referred to Van t'Hoff's investigations in osmotic pressure. He concluded with some remarks on the results of distilling mixtures containing more than one body—alcohol and water, for example.

Motorcars in France.—According to the *Moniteur Industriel*, the Chemin de fer du Nord is about to introduce electric motorcars to supplement its suburban traffic. These cars are also to be used on trains travelling a longer distance. This will avoid frequent stoppages of ordinary trains, as the electric car will be uncoupled at the first stopping place, whence it will proceed by itself to the minor stations, leaving the train free from the delays now incurred at unimportant platforms, and thus accelerating its speed. These motorcars will serve in the first line as postal cars, but they have accommodation for eight first, 12 second, and 30 third-class passengers. In another type, 12 passengers only are provided for besides the compartment for the electrician and his apparatus. The carriage rests on two axletrees, and is worked by a four-pole dynamo, which is fixed on the hind axletree. The collector is placed in the electrician's compartment. The power is supplied by an accumulator battery suspended between the two axletrees, and may be augmented by elements placed in two boxes under the floor of the carriage. The total weight is 15,540 kg., divided as follows: framework and boxes, 5,365 kg.; two axletrees and wheels, 1,500 kg.; electric motor, 1,825 kg.; collector, 650 kg.; accumulator, 4,800 kg.; brakes, 300 kg.; passengers, 900 kg. The medium force developed by the dynamo is of an average of 160 kg. at the circumference of the wheel, but may rise to 285 kg. during the run. Trials showed this to correspond with 0·80 kg. per ampere, which would make the 160 kg. equal to 200 amperes. The collector is completely separated from the dynamo, and is worked by a special motor running synchronously with the same. It is under the control of the electrician, and its movements can be easily directed by him during the run. There are three two-pole interruptors, one to charge and one to discharge the battery, one for excitation separated from the inductor, and a commutator to regulate the speed connected with a commutator commanding a rheostat, which is fixed upon the roof of the carriage. The accumulator battery consists of 40 elements. In addition to that, one of the boxes above mentioned may be furnished with 12 and the other with six similar elements. The total weight will then be increased by 2,200 kg., but the power will also rise by 30 per cent. The signal lights and the interior of the compartments are lit by incandescent globes. The same arrangements hold good for the motors built to accommodate 50 passengers, but the weights are 12,500 kg. for the carriage and wheels, 3,500 kg. for the passengers, 2,600 kg. is allowed for maximum weight of luggage, and 5,500 kg. for accumulators, etc., giving a total of 24,000 kg.

Electric Sparks and Fire-Damp.—The French correspondent of the *Electrical World* summarises as follows the experiments of MM. Couriot and Meunier, which show that mixtures of air and fire-damp are not ignited by an incandescent metallic filament, but that they are exploded by the spark at the rupture of such a conductor. There are other circumstances under which a spark can take place in the mixture without causing an explosion. After having demonstrated that mixtures of 9·5 per cent. of methane with air are the most explosive it was considered reasonable to experiment only with these mixtures, for it is certain that the conditions under which their explosion may be avoided are sufficient to prevent the explosion of other less dangerous mixtures. In the first experiments the tension of the current was kept constant at that of the mains of the Ville de Paris Electric Light Supply—about 110 volts. Lower voltages were obtained by shunts in the circuit. From the results thus observed the following principles were deduced: Rule of shunts—to avoid explosion it is necessary to connect by a secondary conductor the two points of the circuit between which the spark is formed. This condition is necessary because, by the use of a shunt, it is possible to melt piano wire in a 9·5 per cent. methane mixture without starting an explosion, while without the shunt this always produced ignition of the mixture. This condition does not always suffice. The conductors bringing the current to the laboratory for the experiments were in shunt upon the whole lighting system of the station. Secondary conductors employed in the apparatus itself were not always sufficient to prevent an explosion. There is therefore an opportunity here for further research to discover the other conditions that should be observed in connection with the first. The experimental method is as follows: The explosion chamber is placed in series with an ammeter, and around it are shunted a voltmeter and the shunt connection to the instruments serving to give the resistance of the two branches of the circuit. The current flowing in the system is increased until the wire in the explosion chamber melts and forms an arc. The resistance of the shunt, beginning low, is then increased until, after successive experiments, an explosion takes place. When the ratio of the resistances is high—that is, when the resistance of the shunt is much higher than that of the explosion-chamber circuit—an explosion always takes place. MM. Couriot and Meunier used in one case a 110-volt lamp, passing a current of about one ampere as the shunt, and a copper wire of three ohms resistance to form the circuit containing the explosion apparatus. At all values of the total current between 4·5 and 7·6 amperes explosion invariably occurred, while a shunt of copper wire in parallel with the lamp shunt entirely obviated it. As a corollary of the principle of shunts enunciated and of these facts, it can be deduced that the spark produced in a simple circuit, of which the rupture causes the complete extinction of the current, invariably and necessarily causes an explosion. To determine the lower limit of the intensity of current to which this principle is applicable, it is necessary to use decreasing currents, but the practical difficulty of procuring metallic filaments small enough to fuse under the action of these small currents presents itself. With silver wires $\frac{1}{5}$mm. diameter, the almost invisible sparks due to their rupture under a current of 1·9 amperes is sufficient to start a detonation. By using lamps a rupture of the filament can take place with much smaller currents. The explosion is most easily avoided when the ratio between the resistance of the exploder circuit and that of the shunt approaches unity. When the resistance of the shunt becomes less than that of the other circuit a point is reached at which the explosions begin anew. There are, then, two limits of this ratio, one above and the other below unity, between which explosions can be avoided when the current strength involved does not surpass a certain limit. With the apparatus arranged so that the two circuits are of equal resistance, it was found that to avoid the explosion of the most dangerous proportions of air and methane the current should not exceed 11·5 amperes when the resistance of each branch is 0·75 ohm, 5·6 amperes for 3·3 ohms, and 4·1 amperes for 4·4 ohms.

ELECTRIC SIGNALLING WITHOUT CONNECTING WIRES.

BY EDWIN EDSER, A.R.C.S., F.PH.S.

The subject here treated of is that popularly known as "wireless telegraphy." It will become evident as we proceed that wires may form an indispensable part of the apparatus used in certain systems, and therefore the above heading, due to Prof. Lodge, has been adopted. I do not propose to consider the practical utility of such a method of signalling. That many think some useful sphere may be found for it is sufficiently evident from the attitude of the Post Office authorities. It is simply intended in this article to give a popular account of the theory which must underlie, to a greater or less extent, any systems of establishing electrical communication between distant stations without the aid of connecting wires.

Only a few words are necessary in regard to the history of the development of electrical science, which has rendered such a system possible. Faraday unquestionably laid the corner-stone in his researches on the induction of currents, and Maxwell's electromagnetic theory, which has been so ably developed mathematically by Mr. Oliver Heaviside and others, may be justly considered to constitute the necessary scaffolding. But to Prof. Oliver Lodge, jointly with the late Dr. Hertz, belongs the honour of realising the experimental conditions which leave the edifice in its present state of partial completion. Not that we may neglect the work of Signor Marconi; to successfully popularise such a subject, and awaken in the public an interest as nearly bordering on enthusiasm as that which exists at the present time, appears little short of the miraculous, when we consider the popular attitude towards the electromagnetic theory a few years ago.

Let two coils of wire be placed, with their planes parallel to each other, at a short distance apart. Then, that any variation of the current in one coil will produce an E.M.F. round the other has been clearly recognised by electrical engineers, at least since Messrs. Gaulard and Gibbs introduced the transformer system; in fact, the two coils may be said to constitute a transformer with an air core. Mr. Preece's experiment of placing two long wires parallel to each other, at a considerable distance apart, and observing the current produced in one wire when that in the other is suddenly interrupted or reversed, is a variation of the same experiment on a larger scale. In neither instance are we concerned with electrical oscillations, properly so called.

It here becomes necessary to determine the conditions under which electrical oscillations may be produced. To aid us in this, a mechanical analogy will first be considered. Suppose a weight to be suspended, by means of an elastic filament, below the surface of a viscous liquid. There will, of course, be a position of equilibrium, where the tension of the filament is equal to the pull of gravity on the weight. When the weight is above this position, the downward pull of gravity will be greater than the upward pull due to strain in the suspension, whilst below the position of equilibrium the upward pull will preponderate. Now suppose the weight to be displaced downwards and then held stationary. The potential energy of the system will be increased, owing to the strain of the suspension. If the weight is released, it will commence to move so as to decrease the potential energy of the system—*i.e.*, toward its equilibrium position. If there were no friction, when the weight had reached its position of equilibrium, it would be moving with such a velocity that its kinetic energy would be just equal to the potential energy of the initial strain. As the weight continued to ascend, the kinetic energy would be converted into potential energy, until a position would at last be reached where the system would once more possess no energy other than potential. This conversion of potential energy into kinetic and back once more into potential would then continue, the weight oscillating about its position of equilibrium interminably. Where there is friction, however, part of the potential energy possessed by the weight at the extremity of one of its oscillations will have been converted into heat before the position of equilibrium is reached.
The kinetic energy possessed by the moving weight a
position will therefore be less than its initial pot
energy, and the extent of the next excursion wi
smaller. Hence the oscillations will gradually die
It is obvious that if the viscosity of the liquid be equ
or greater than a certain critical value, *all* the i
potential energy will be converted into heat befor
weight reaches its equilibrium position. In this cas
weight will move with a gradually decreasing veloci
to the position of equilibrium, but will never pass it.
oscillations will therefore be produced, the motion o
weight is *dead beat*.

Compare with the above the action of the foll
electrical system. Let the outer coating of a Leyd
be connected through a coil of a number of turns of
with a knob, C, placed in the vicinity of another kn
directly connected with the inner coating, B, of th
As the jar is charged, the potential energy of the c
increases. If now C be placed sufficiently near to D
spark to pass, electricity will at once commence to
round the circuit, A F C, so as to reduce the pot
energy of the charge to a minimum. Two factors
now be taken account of. The first is the dissipati
energy in the wires as heat; the rate of dissipation w
any instant, be equal to the product of the square o
current into the resistance of the circuit. The s

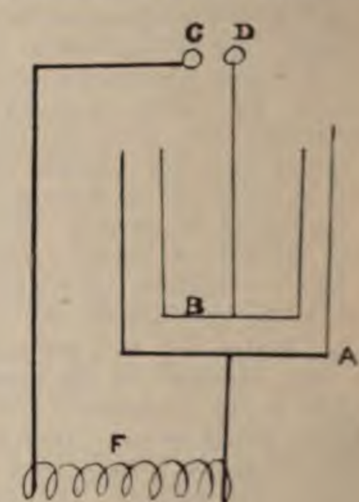

FIG. 1.

factor is the kinetic energy of the current. A
now well known, an electric current flowing rou
circuit possessing induction, acts as if it possessed iner
i.e., an impressed E.M.F. will not at once pr
the corresponding current given by Ohm's law, a
the impressed E.M.F. is suddenly removed the cu
will tend still to go on flowing. Consequently, whe
electric current produced has reduced this differen
potential between A and B to zero, it will still con
to flow, in virtue of its kinetic energy, unless the pot
energy of the initial charge has been entirely dissipa
heating the wires of the circuit. The charge of the L
jar will therefore become reversed, and electrical o
tions will be produced. In the present problem, the
ance of the conducting wires plays the same part a
viscosity of the liquid in the previously-described mech
analogue, whilst the self-induction of the coil corres
to the inertia of the weight. In order, therefore, to
electrical oscillations, the resistance of the wire
must be kept as small as possible. If R be the va
this resistance, K being the capacity of the Leyde
and L the coefficient of self-induction of the coil, the
electrical oscillations to be produced, R must have a
numerically less than $2\sqrt{\frac{L}{K}}$.

Supposing, then, that the resistance of the circuit i
than the above critical value, and that electrical oscill
are produced when a spark passes between C and
remains to determine the period of these oscillations.
can be done in a very simple manner (when the resi
of the circuit is so small as to be negligible) by equ
the potential energy of the charge at the extremity

on to the kinetic energy of the current at the ; when the potential difference between the coatings ar is reduced to zero. To fix our ideas, first take) of the weight suspended from the end of an elastic t.

ming that the vibration produced is a simple ic one, the position, D, of the weight (supposed brating along A B) at any instant can be determined ining a radius, A C, to revolve uniformly at such a that one revolution is performed in the time, T, 1 for a complete vibration of the weight, and drawing m the instantaneous position of C, perpendicular to When A C coincides with A B the weight will be at emity of its vibration at a distance A B from its of equilibrium. Let F be the force necessary to the length of the elastic filament by unity. Then e exerted when the filament is increased in length $= F \times AB = F a$, if a = amplitude of vibration. The force during the stretching of the filament by a, and consequently the potential energy at the ity of a vibration $= \frac{1}{2} F a^2$, the work done in stretching ment by a.

kinetic energy of the weight of mass, m, as it passes he velocity, v, through the position of equilibrium v^2. To determine v, notice that as the extremity of lius passes from C_1 to C_2 (Fig. 2) it is moving

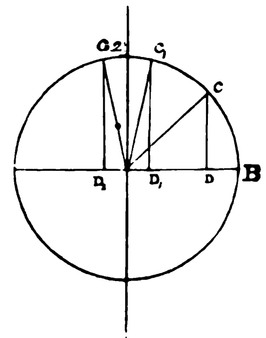

FIG. 2.

ally parallel to A B. Hence $D_1 D_2$ = length of arc therefore, velocity, v, with which the weight passes h A = velocity of the end of radius $AC = \frac{2\pi a}{T}$. The energy, $\frac{1}{2} m v^2$, may therefore be written $\frac{1}{2} m \left(\frac{2\pi a}{T}\right)^2$.

ting the kinetic energy at the middle to the potential at the extremity of a vibration, we get

$$\frac{1}{2} m \left(\frac{2\pi a}{T}\right)^2 = \frac{1}{2} F a^2. \quad \therefore T = 2\pi\sqrt{\frac{m}{F}}.$$

rning now to the electrical problem, let A B repre- e initial charge, Q, of the condenser. Then the l energy of the charge $= \frac{1}{2}\frac{Q^2}{K}$. The current round cuit will evidently be equal to the rate of decrease charge in the jar. If, therefore, the charge remain- he jar be represented by the resolved part of the A C, along the line A B, it is clear that the current instant will be represented by the rate at which D, of the resolved radius, is moving along A B. At ment when the potential of the jar is reduced to e current will be represented by the rate at which s from D_1 to D_2—*i.e.*, to the rate at which C moves to C_2, or $\frac{2\pi AB}{T}$. Hence, since A B = Q, current otential energy of charge is zero $= \frac{2\pi Q}{T}$.

kinetic energy of the current is given by one-half are of the current multiplied by the coefficient of uction, L.

efore kinetic energy $= \frac{1}{2} L \left(\frac{2\pi Q}{T}\right)^2$.

$$\therefore \frac{1}{2} L \left(\frac{2\pi Q}{T}\right)^2 = \frac{1}{2}\frac{Q^2}{K};$$

$$T = 2\pi\sqrt{LK}.$$

Hence, remembering that T represents the time of a complete electrical oscillation, we see that the quantity varies directly as the square root of the product of the capacity of the condenser into the coefficient of self-induction of the coil.

(To be continued.)

ECONOMY IN CENTRAL-STATION MANAGEMENT.

BY R. SUMMERFIELD.

As the principal reason which prevents electricity from entirely superseding gas, oil, and other illuminants is its greater cost, the chief aim of station engineers should be to produce it as cheaply as possible; and although, of course, a great deal depends on the efficiency of the plant, it is the management of the station which really determines success or failure.

Let us take the case of a fair-sized station, carefully designed and equipped with the best plant obtainable, and see in what directions economy should be exercised. The largest items in the generating bill are respectively coal, wages, water, and oil and waste. Therefore, every effort must be made to keep these items as low as possible, beginning with coal, which is the most important and in the use of which economy cannot be carried too far, as it can with wages or oil. The selection of the most economical coal for any central station is a most important matter, and will take several months to decide, as a large number of samples must be tested before the most suitable coal can be settled on. In order to make a satisfactory comparison between the different coals, the same boiler must be used for each test; the feed water should be kept at the same temperature and the steam at the full working pressure. It will then be only necessary to note the weight of coal consumed, quantity of water evaporated, temperature of escaping flue gases, and the draught in the flue, to find which sample evaporates most water per pound of coal, and also which will evaporate 100 gallons of water cheapest. Each test should last at least six hours, and the boilers must be fired with the same kind of coal as that about to be tested for not less than an hour before commencing. Each sample ought to be tested twice under ordinary working conditions and the mean result taken, and it is a good plan to take a third test, in which the boiler is forced to its utmost, in order to see what the coal will do, as some coals will not stand forcing, and this is important in an electric light station, where the load may double itself in a few minutes. In testing coal, due regard must be paid to the quantity of smoke made and the amount of ash and clinker, as in many towns smoke is prohibited, which at once causes the rejection of a good many excellent samples of coal. A coal which makes a lot of clinker should not be chosen, no matter how suitable it may be in other respects, as clinker soon spoils a set of firebars, besides the extra labour required to break it up and get it out of the furnace.

Having settled on a suitable coal, and found by experiment under what conditions it will evaporate most water, every effort should be made to keep to those conditions as nearly as possible, the chief thing being to keep the boilers clean and free from scale, as a thin layer of scale on the tubes or flues of a boiler will cause a great waste of fuel, scale having only about one-thirtieth of the heat-conducting power of metal. The best way to prevent scale is to treat the feed water before it enters the boiler by using large settling tanks and precipitating the carbonate and sulphate of lime by adding a certain proportion of carbonate of soda and burnt lime, but this is an expensive process and necessitates a large plant, so that it is seldom used for central stations. There are a great many chemical compounds sold to prevent scale, but they must be used with caution, as some of them do more harm than good, containing acids which injure the plates. The ordinary way of preventing scale forming is to blow about 1in. of water out of the boiler every six or seven hours while working, and to have it thoroughly cleaned at regular intervals; the water-level should also be kept as high as possible, as the hotter the flue-tubes are the more quickly will the scale settle on

them. Soot is a great non-conductor of heat, and it must therefore be frequently swept off the tubes and flues. The ashes from the furnaces should be screened and the large ones used again, which will save a good deal of coal, as the ashes from a boiler form at least 10 per cent. of the fuel put on the furnace; the ashes may be used for banking fires and boilers which are standing by.

The tops of boilers and all steam-pipes should be well covered with a good non-conducting material to prevent loss of fuel by radiation, as the loss from naked pipes from this cause is very considerable, it having been found from careful experiments that 1,500 more heat units are radiated per hour from a surface of one square foot of naked steam-pipe than from the same surface covered with hair felt, from which it will be seen that a great waste of fuel will be caused by having steam-pipes or boilers improperly covered. Careless stoking has a good deal to do with waste of fuel, and it will be found good policy to get the best stokers obtainable—locomotive firemen, if possible, as they have been used to making coal go as far as possible; it would also be a good plan to give a bonus for saving coal as the large railway companies do, although this would be more difficult to apportion in an electric light station than on a railway, where each fireman starts off with a known quantity of coal on his tender. Still, the men might be given a bonus for reducing of cost of coal per unit generated.

The question of wages is an important one, but it seldom receives the consideration it ought from station engineers, the general idea being to pay as small wages as possible, which is quite wrong, and the dearest system in the end. The best and most economical way is to pay the highest wages and get the best men who can be obtained for each class of work, because when a man sees that he is getting more money than he could get elsewhere for the same kind of work, he will be content to stay where he is and try to make himself worth more, and if he is a smart and intelligent man he will be able and willing to do other jobs besides his regular one, whereas lower-class men either refuse or pretend to be unable to do anything but what they were engaged to do. One really good man will do quite as much as two ordinary men, which can easily be seen by watching a lot of men at work anywhere, and as he would not be paid double the ordinary wages even when very well paid, a distinct saving will be effected by employing him. When men are badly paid they are naturally always on the look-out for a better job, and their work suffers in consequence, as they take no interest in it; and as a new man has to learn by experience the peculiarities of the machinery placed under his charge, he will generally make some expensive mistakes at first. The men should be taken on trial for a month and carefully watched during that time, and if their conduct and abilities prove satisfactory they may be taken on permanently at a good wage, with a small rise every year to a certain maximum. It will be found that where valuable machinery has to be entrusted to the care of working-men that the best plan is to employ highly-paid intelligent men instead of poorly-paid labourers, who neither understand or care anything about the plant they are in charge of. The same remarks apply in a greater degree to the engineers on watch, who should be paid adequate salaries, or they will leave as soon as they have learnt as much as they can in the station. A good engineer in charge of a shift in any large station is worth at least £200 a year, considering the responsible and unhealthy nature of the work, and yet shift engineers are as a rule paid very poorly, with the result that the ones who are any good never stay long in a station.

A great deal of water is wasted in large electric light stations which might easily be saved with a little care. Thus the blow-off pipes from the boilers, and the drains from the engines and steam-pipes, are generally connected to the drain and the water allowed to run away, whereas it should be taken to settling tanks outside the building, and then, while quite hot, it could be pumped back through a filter into the boilers. The exhaust steam from non-condensing engines should not be allowed to escape into the atmosphere, but should be used to heat the feed water by sending it through a feed-water heater, or it may be used to work an exhaust injector for feeding the boilers— economical way. In condensing engines the co steam is of course pumped back into the boilers fr hot-well, but it must pass through a filter first to of the oil which it contains. Then there is the w water caused by leaky joints in pipes or tanks, an valves or blow-off cocks, which must all be looke I have known a leaky blow-off cock to pass water rate of 250 gallons an hour, and although this wa tional, still it is surprising what a lot of water is by leaky valves, and the cost of this water comes good sum in the course of the year; and besides th loss of the water there are many indirect losses, such rotting of floors and rusting of ironwork caused b dripping about, and the danger of short-circuiting m or switch-gear.

The large quantity of oil which is used every day a small central station points to another possible so waste, and this question should therefore receive the attention of the engineer. Tests on oil in an oil machine are not of much use, as the oil is there use very different conditions to those under which it w when used to lubricate a high-speed engine, so t best way is to buy samples of oil and give each a trial on an engine under regular working condition the same engine throughout and cleaning as m possible of one oil off before testing another sample tests should last about a week, and the quantity u day to keep the engine running properly noted a the condition of the oil after use, as some oils wil being used over and over again after being filtered others can only be used once or twice. This point be well looked into, as a considerable saving can be by using the oil several times. A little fresh oil sh mixed with the filtered oil each time. It is often a matter to obtain a suitable oil for the crank cham engines whose cranks dip into an oil bath, as the as the heat of the chamber and the churning action cranks soon causes many oils to get "ropey," wh become almost useless. It will be found that it economical to use the best oils for electric light as cheap oils are not suitable for this class of wo large stations it will be found worth while to sell th oil which has been used several times, and also th waste, as a market can be found for both.

A great deal of time can be saved in an electr station by having a proper system of books, which show the date, nature, and cost of repairs to plant; of hours run each day by the engines, boilers, etc. tity of coal, water, and stores used each week; d engagement or discharge of men, with particulars o and rises; record of the crane chains used in the etc.; and when all these books are well kept, any w increase in expenditure can be at once traced, an taken to put a stop to it.

There are, of course, many small ways in which may be effected, varying with each station, but th are the items in which the largest amounts may b by careful management.

PUBLIC SUPPLY OF ELECTRICITY.

BY J. W. A. BINNER.

The supply of electricity from any town or distr be any one or combination of the following syste low-tension continuous, two, three, or five wire; (tension continuous, with sub-stations; (3) high alternating, with sub-stations or with transformers house or group of houses.

The relative advantage of these systems has alwa a moot point with engineers, and each case has to be on its own merits. Where the district to be consists of houses all grouped closely together, an an ordinary town, then the low-tension continuo decided advantage. The chief points in its favo (1) no transformation is required, so that the e during the greater part of the 24 hours is about as it is possible to get; (2) batteries can be used, whic

a great saving in the running of the station, usually dispensing with one shift per day. Its disadvantages are: (1) that the cost of the feeder mains is usually very heavy, owing to the comparatively low voltage used; (2) that the voltage of supply is fixed and cannot be varied to suit individual consumers in the way that it can be done with a transforming system; (3) there is considerable loss with the battery.

Taking high-tension continuous, with sub-stations, this system has the following advantages: (1) small line loss; (2) batteries can be used in the sub-stations. Its disadvantages are: (1) the loss in transformation and the heavy cost of transformers; (2) the voltage is practically fixed, as it would not be economical to supply a separate transformer for individual consumers. The all-day loss in the transformers is considerable, and the advantage of this system is only shown where the generating station is a moderately great distance from the district to be supplied, about a mile and a half or two miles.

With high-tension alternating, with sub-stations, the advantages are: (1) low line loss, (2) the high efficiency of alternating transformers. Its disadvantages are: (1) that storage batteries cannot be used; (2) although the transformers are more efficient than continuous-current transformers, still there remains the all-day loss in them—magnetising current and copper losses. The full advantage of this system, like the last, is only seen when the generating station is at a considerable distance from the lighting or the district to be supplied by power.

Two great disadvantages of single-phase alternating current are: (1) It practically precludes the use of motors to any great extent. It is quite true single-phase motors are at work, but when they are of a large power there is usually great trouble in starting or running them; their efficiency also is lower than that of continuous-current motors. (2) Alternating arc lamps cannot be said to be satisfactory; their efficiency is much lower than with continuous-current lamps.

Taking the question all round, there is no doubt that where the generating station is over a mile and a half from the district of supply, high-tension continuous or alternating must be adopted.

Methods of Generating Electrical Energy.

The only commercial means of producing electrical energy at the present time on a large scale is by dynamo-electric machines. These are driven either by (1) water turbines; (2) gas or oil engines; (3) steam-engines.

Water Power.—Where water power is available in large quantity and the supply is sure, a great saving is made in the generation of electricity. No fuel is required, and the attendance is reduced to a minimum. A good example of this in this country is at the Falls of Foyers, where the British Aluminium Company are using a large electrical plant for the extraction of aluminium from its ores. In this country, however, water power is not found, as a rule, in sufficient quantity to be of much practical use.

Gas and Oil Engines.—Gas-engines have been used to some extent in supply stations, such as Coatbridge and Belfast. They cannot, however, compete with high-class steam-engines owing to the high cost of gas. Along with oil-engines they are used to a great extent in private installations, where it is sometimes undesirable to have a steam-boiler about the place.

Steam-Engines.—The most general means of driving dynamos, and the one giving the highest efficiency and the most general satisfaction, is by steam-engines. The dynamos may be either direct coupled to the engines or connected to them by belts or ropes. Where ground is dear the direct coupling is the best to use, but where ground can be had cheap, it is only a question whether the extra cost of buildings is more or less than the saving effected by having slow-speed engines connected by belts or ropes to high-speed dynamos. The boilers in general use are mostly one or either of the following: (1) Lancashire or Cornish; (2) marine; (3) water-tube. Opinion is very divided upon which type of boiler should be used. Where space is scarce, the water-tube boiler is very much used, but it is being run very hard now by the marine boiler.

Regulation of the Supply.

The current from the dynamos is brought to a switch-board in the generating station, on which are fixed the measuring instruments, showing the outputs of the different machines, their E.M.F.'s, or voltages, and all the others necessary for the working of the dynamos and batteries if used. The switches and fuses are usually placed on this board also. The boards themselves are generally made up of slate or marble panels. All the regulation of the supply is done from this board.

Mains.

(1) *Low Tension.*—These may be either a bare system of copper or insulated cables. The bare copper mains are usually laid in concrete culverts, and are supported by insulators of glazed stoneware. Insulated cables are laid in iron pipes, or they may be armoured by steel tape and laid direct in the earth, or placed in wooden boxes and pitched in with bitumen. This latter plan preserves the armouring from corrosion, which sooner or later must ensue when cables are laid direct in the ground.

(2) *High Tension.*—These mains are generally laid on one or other of the cable systems mentioned in the last section, and are usually concentric cables.

The supply to consumers on a low-tension system is taken off the distributing network on to which the trunk mains feed at different points, as is roughly shown in the accompanying sketch. With high-tension the supply may be either by "banks" of transformers feeding on to a low-tension network or by having transformers scattered at different points to feed single houses or groups of houses. In high-tension continuous work the transforming sub-station system is invariably used.

The energy supplied is measured in each house or shop by means of a meter reading either direct in Board of Trade units of 1,000 volts-ampere-hours each, or by a meter having a constant by which the readings have to be multiplied to ascertain the consumption.

Street-Lighting.

For large towns and cities the best way is by arc lamps. These may be run either on a separate circuit from the generating station, or run two or four in series off the distributing mains. Where the system of supply is alternating the current is usually rectified to continuous, as a much higher efficiency can be obtained from the lamps. For side streets in cities and for small towns incandescent electric lighting is very successful. The general plan is to use lamps of very low voltage run in series, each lamp or cluster of lamps fitted with an automatic short-circuiter as a by-pass when a filament breaks.

Motive power is coming largely into use in towns where corporations or companies are supplying during the daytime at a reduced rate. Where the rebate indicator system of charging is in use, and where the motors are used pretty constant all day, the price can very often compete with steam and gas engines. It is also very advantageous where the power is required intermittently, as in a newspaper printing office.

Private Lighting.

The advantages of electricity for this purpose are many and obvious: the different methods in which the lights may be combined and fixed are innumerable, and hygienic advantages alone, such as the much purer atmosphere in the rooms of houses, make it worth while using electricity instead of gas.

WHAT ELECTROLYSED SEA-WATER HAS ACCOMPLISHED.

BY W. L. HEDENBERG.

The problem of finding an economical and efficient method of purifying and disposing of the sewage from a community would seem to be growing each year more difficult to solve.

A century or so ago, when the first settlers were pushing inland, they naturally avoided arid districts, and located

whenever possible on the banks of some stream. There were two causes which led to their so doing. The land was usually found to be more fertile in such localities, and the population had to rely in those early days almost entirely on water for transportation. As the country developed, and the population increased, towns and cities gradually sprung up where formerly settlements had been.

From the beginning all waste matter and refuse was naturally thrown into the neighbouring stream as the easiest and quickest method of disposal, and there was no apparent harm in so doing while the settlements were small and scattered. When, however, these communities became good-sized towns or small cities located within a few miles of one another, all discharging their waste into the stream and at the same time drawing their water supply from the same source, diseases and epidemics began to be prevalent.

To remedy this state of affairs and improve the public health, the proper authorities justly insisted on the sewage being at least partially sterilised. There were a number of ways in which this could be accomplished more or less satisfactorily, depending on the thoroughness of the process. Recourse was usually had to mechanical filtration, land filtration, chemical precipitation, or to a combination of these methods. Recently, however, two other processes have made their appearance. These latter consist in mixing a disinfecting liquid, obtained by passing a current of electricity through sea or salt water, with the matter to be sterilised. These two methods, one invented by Mr. Albert E. Woolf in this country, the other by M. Hermite in France, are essentially alike and differ only in their method of application.

Probably the first attempt to sterilise a polluted water supply by the Woolf process was at Brewsters, New York, in the summer of 1893. An electric plant was installed for the purpose, consisting of a 15-h.p. engine and a dynamo capable of generating a current of 700 amperes at a pressure of five volts. A vat of 1,000 gallons capacity contained the electrodes, which consisted of a platinum-zinc couple, the platinum electrode being made up of a copper core with a platinum coating ·003in. in thickness.

The disinfecting liquid, which Mr. Woolf calls electrozone, was then obtained by circulating sea-water through the tank containing the electrodes. This antiseptic was in the experiments at Brewsters allowed to flow into the sewer which emptied into a marsh from which the water supply was taken, and was also sprayed into what is known as Tonetta brook in the proportion of one part hydrochlorite to 100,000 parts of water.

The results obtained by this process from a bacteriological standpoint were exceedingly striking and attracted wide attention. The worst sample of water examined by the New York Board of Health at the time showed the presence of 22,000 bacteria per cubic centimetre before treatment and but 42 after having been mixed with electrozone in the proportion previously mentioned.

Owing to the striking results obtained at Brewsters Mr. Woolf was shortly afterwards called upon to disinfect Riker's Island, at that time the dumping ground for a large portion of New York's garbage. This tract of land, comprising some 137 acres, was fast becoming extremely offensive under the heat of a summer's sun, and numerous complaints made by citizens residing in near-by sections of the city made it imperative that some action towards remedying this public nuisance should be taken.

In June, 1894, therefore, Mr. Woolf installed an electrozone plant on a barge which was towed to Riker's Island, and which was capable of generating 4,000 gallons of disinfecting liquid per hour. By means of a 15-h.p. pump the electrozone was distributed through lines of hose to various points, where it was sprayed upon the decomposed garbage. In a comparatively short space of time this method of procedure wrought a great change. The obnoxious odours, which formerly could readily be detected at a distance of several miles under favourable atmospheric conditions, were scarcely noticeable a hundred yards distant.

The Woolf process was next tried at Danbury, Conn. The plant consisted of a 40-h.p. engine and a dynamo giving a current of 1,000 amperes at a pressure of five volts. In this case it was desired to purify the sewage before discharging it into the neighbouring river. The disinfectant was generated in a vat situated above a large tank through which the sewage flowed. The electrozone was made to flow by gravity from the upper to lower tank, a thorough mixture of the two liquids being effected by means of an agitator. As the mixture rose in the lower tank it overflowed into a line of pipe which discharged into the neighbouring water-course.

This plant, according to the opinion of the citizens of Danbury, scarcely accomplished the desired purpose, although the analytical results were exceedingly good. The objection arose owing to the fact that the heavy part of the sewage was allowed to find its way into the stream, which was considered a public nuisance by persons living along the shores. The writer has suggested elsewhere a means whereby this objectionable feature could in all probability have been remedied. However, after considerable litigation the Woolf process was ultimately abandoned at Danbury for a more expensive method of sewage purification.

The Hermite system, which has been experimented with abroad even more than that of Mr. Woolf in this country, differs from the latter, as previously stated, only in a few minor details in the production of the disinfectant and in the method of application, which can partly be accounted for in the widely different sanitary arrangements existing in Europe and in this country. For instance, M. Hermite recommends the use of his disinfecting liquid as ordinary water in all lavatories, and seeks in this way to thoroughly sterilise household wastes before they are admitted to the public sewers. In other words, a complete and separate system of piping is necessary. This method of procedure and general arrangement was probably thought necessary, owing to the fact that in most European cities the drainage systems are of the combined type, admitting both rain-water and sewage. The sterilisation of this amount of liquid, especially during a rainy period, would undoubtedly be a very costly mndertaking.

The negative electrode in the Hermite system is composed of discs of zinc, which when in operation revolve. The positive electrodes consist of glass tubes covered with a coating of platinum, one being located between each pair of zinc discs. The electrodes are usually enclosed in an iron tank connected with a perforated pipe at the bottom, through which the electrolyte, consisting of sea-water, enters. This system has been tried as a sanitary measure more or less extensively at Havre, Brest, Nice, Paris, Loriente, Monte Carlo, Worthing, Ipswich, and more recently still at Bombay, India.

Probably the experiments at Brest were on the most extensive scale, the sewage of 11,000 persons being treated. The results were apparently satisfactory, as an official report issued by Dr. Pitau and dated Feb. 21, 1894, says: "In a word, the experiments which I have made enable me to conclude that electrolysed sea-water is a perfect disinfectant and an excellent antiseptic which very rapidly destroys all microbes, even the most tenacious of life, on the condition that these microbes are brought into contact with the electrolysed sea-water."

The plant at Ipswich, in England, seems also to have given fairly good results for what it was intended, it merely being desired to arrest the decomposition of the sewage until it could be carried out to sea. On the other hand, the results obtained at Bombay could scarcely be called satisfactory.

The principal objections to both the Woolf and Hermite disinfecting processes would seem to be the fact that the deodorising fluid is unable to penetrate through the solid portions of the sewage, as was clearly proven by the use of electrozone at Danbury. The disinfectant apparently sterilises the outer surface of the heavy matter, but leaves the inner portion to decompose and breed disease germs. This defect might possibly be remedied by the use of some form of crusher or beater that would tend to disintegrate the solid portions of the sewage.

As a sterilising agent for town wastes, electrolysed sea-water has therefore been adopted but slowly, in spite of the low cost of this method, and it will be necessary to remedy the serious defect previously mentioned before it can hope to be widely made use of by large communities.—*Electricity* (New York).

SELECT COMMITTEE ON ELECTRICAL ENERGY.

Generating Stations and Supply.

Major Cardew.—In our last issue we gave a general idea of the report of this committee, but to make our notes complete we should like to make one extract from Major Cardew's evidence on May 5. After referring to the dangers from high-pressure working, Major Cardew handed in the draft regulations for the protection of employés in electric supply works as follows:

DEFINITIONS.

"In the following regulations 'generating station' means any building, chamber, or other enclosure wherein electrical energy is generated otherwise than by means of any primary electric battery or machine worked by animal power; 'sub-station' means any building, chamber, or other enclosure wherein electrical energy is regulated, transformed, converted into mechanical power, or otherwise utilised for trade purposes, and within which any employé may be required to attend, either constantly or at times.

"'High-pressure supply' means such a supply of electrical energy that the difference of electrical potential acting in the circuit may exceed 500 volts continuous or 250 volts alternating; and any machine, apparatus, instrument, or conductor of electricity, forming part of or in electrical connection with such circuit, is herein denominated a high-pressure machine, etc.

"'Metal' means any metallic body or substance or the metallic portions of any body or substance not entirely metallic, whether forming or intended to form part of any electric circuit or not. Where these regulations require any metal to be 'efficiently connected with earth,' it shall be connected with the general mass of earth in such manner as will ensure at all times an immediate and safe discharge of electrical energy.

EXPOSED METAL NOT IN ELECTRIC CIRCUIT TO BE CONNECTED TO EARTH.

"1. All metal not forming or intended to form part of an electric circuit, contained within any generating station or sub-station, or forming part of the construction thereof, and so exposed that it may be touched, shall be efficiently connected with earth, and the separate metallic bodies so connected shall also be connected to each other, except any nail, screw, or small fitting, fixed so as to be in contact with dry wood or other non-conducting substance only.

HIGH-PRESSURE CONDUCTORS, ETC., TO BE CASED IN WHERE POSSIBLE.

"2. All high-pressure conductors and apparatus contained within any generating station or sub-station shall, so far as may be consistent with the intended use thereof, be completely enclosed either in a tube of highly insulating material adequately protected from injury, or in strong metal casing efficiently connected with earth. Provided that where the conductors for any high-pressure supply are concentric, and the outer conductor is efficiently connected with earth within the generating station or sub-station, these conductors need not be enclosed, as specified above, within such station.

"3. All metal forming part of any pressure supply circuit or guarded against accidental contact within any generating station or sub-station, and not enclosed as specified in the preceding regulation, shall be so guarded by means of suitable material of highly insulating quality that persons cannot accidentally be brought into electrical connection or partial connection therewith, and it shall be, in addition, conspicuously marked as dangerous, either by bright red colouring or by a printed label. No such metal shall be fixed within 3ft. from a doorway or other access to the generating station or sub-station.

INSULATED FLOOR TO BE PROVIDED AT SWITCHBOARDS, ETC.

"4. A highly insulated platform or floor shall be provided and fixed so that it is necessary to stand upon such platform or floor in order to operate or attend to any machine or apparatus in every case where the operator or attendant may be thereby subject to any risk of contact with metal forming part of any high-pressure supply circuit. This insulated platform or floor shall be so disposed and fenced that it shall not be possible for the said operator or attendant, when standing upon it, to accidentally make a connection to earth of any part of his body.

SWITCHBOARDS.

"5. Every switchboard in any generating station or sub-station must be formed of highly insulating and incombustible material. The leads and connections thereto must be either on the front of the board, or if taken to the back of the board a passage at least 4ft. wide must be provided to enable these leads and connections to be conveniently and safely inspected and adjusted, and the only access to this passage must be through a door kept locked, the key being in charge of the chief engineer or other properly qualified person. All leads and connections between which any difference of electrical potential greater than five volts may exist, must be easily distinguishable by position, colour, or other distinctive mark. The provisions of the preceding regulation must be very carefully attended to in the case of switchboards, and any galleries, passages, or platforms used in connection therewith. Adequate means shall be provided to enable an employé to ascertain that all electrical pressure has been removed from all metal in connection with any switchboard at any time when he may be required to clean, examine, or alter any apparatus or electrical connections contained upon the switchboard.

INSTRUMENTS.

"6. All instruments used, or intended to be used, for measuring or indicating electric energy, current, or pressure within any generating station or sub-station shall be of suitable pattern and construction, and accurate in their readings within an error of 2½ per cent. at any point of their range in terms of the electrical standards, deposited at the Board of Trade standardising laboratory, and such accuracy must be constantly maintained. Care must be taken that such instruments are not fixed and connected so that their accuracy may be temporarily or permanently affected by the presence of magnets or magnetic material, electric currents, or pressure in the vicinity, or by any leakage or partial short-circuiting of current, or by any resistance in the connections and contacts. The case, cover, base, or support of any high-pressure instrument shall, if partly or entirely metallic, be either efficiently connected with earth or guarded as provided in Regulation 3.

ILLUMINATION.

"7. The light provided in any generating station or in any sub-station in which any employé is required to be constantly in attendance shall be ample in all parts, and especially where attention is required to any high-pressure machinery, apparatus, or instrument. Not more than 50 per cent. of the total artificial illumination shall be provided by means of any running machinery at the station, or, in the case of a sub-station, by means of the electric mains entering the sub-station. In the case of any sub-station which an employé is only required to visit periodically, a candle and matches, or other means of obtaining light other than from the electric supply, shall be constantly kept in a suitable receptacle at or near the entrance to the sub-station.

PRECAUTIONS IN SUB-STATIONS WHEN WORK OTHER THAN ELECTRICAL IS BEING CARRIED OUT.

"8. During the whole of the time that any work, other than any necessary manipulation of switches or attention to electrical apparatus or machinery, is carried on in any sub-station, all high-pressure conductors, machinery, and apparatus shall either be discharged of all electrical pressure or efficiently screened from the workmen.

INDIARUBBER GLOVES.

"9. At least two pairs of thick indiarubber gloves shall be provided and kept in a suitable receptacle in every generating station and sub-station used for high-pressure supply, and where the number of employés exceeds 10 there shall be kept at least one pair to five employés. These gloves shall be maintained in good condition.

INSTRUCTIONS IN CASE OF ELECTRIC SHOCK.

"10. Printed instructions detailing the precautions to be adopted in disengaging a person under electric shock from the circuit, and the best known means of restoring

animation after severe shock, shall be exhibited in a conspicuous position in every generating station and sub-station used for high-pressure supply.

"11. No employé in any generating station or sub-station shall be required to remain on any duty connected with the regulation of high-pressure supply for more than four hours consecutively, or for more than eight hours in any day; and no employé shall be allowed to take over such duty until he has been inspected by an engineer or other competent official as to his fitness to undertake such duty."

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared, and should be written on one side of the paper only. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time.

Questions.

68. Draw an indicator diagram for a defective engine and explain how the defects are shown in the diagram.—M. P.

69. What are the relative advantages and disadvantages of a steam-pump and an injector for boiler-feed purposes?—W. W. A.

Answers.

Question No. 63.—What are the relative advantages and disadvantages of carrying steam-pipes (*a*) overhead, and (*b*) beneath engine-room flooring?

Best Answer to No. 63 (*awarded* 10*s.*).—Each of these systems has a good deal to recommend it, but in my opinion the overhead arrangement is the best, except in special cases. The various advantages and disadvantages of the two systems are enumerated below:

(*a*) *Advantages.*—(1) The pipes are always in sight, and, therefore, any leak can be at once detected and repaired in time. The lagging can also be replaced when it begins to fall off. Excessive vibration will be noticed much more quickly than if the pipes were under the floor, and, therefore, the danger of the pipes bursting is lessened, as they will receive more attention. (2) The pipes are more accessible for repairs, and are in a light situation. (3) Overhead steam-pipes are nearly always above the boiler level, so that no water can drain into them from boilers which are standing by, and any water in the pipe will always tend to run back into the boilers.

(*a*) *Disadvantages.*—(1) With overhead mains any condensed water which they may contain and any water which primes over from the boilers will run into the engine cylinders, which, of course, may cause a bad breakdown, but the danger of this can be reduced to a minimum by providing each engine with a large and suitable steam separator, which must be placed below the level of the cylinders. The steam-mains should be provided with drains at several points connected through steam-traps, which should be well looked after, and fixed where they can be readily seen and got at. (2) Overhead steam-pipes generally cause a good deal of mess on the engine-room floor when part of the main is shut down, or at light loads, as the pipes cool them and contract, which opens the joints slightly and allows the condensed water to leak through, but this can be got over by hanging tins under the joints to catch the water. (3) Overhead pipes are more unsightly than those which are carried down under the floor. A lot of pipes, valves, etc., up in the roof or round the walls of a central station do not add to its neatness, and as most engineers try to have their stations as neat and clean as possible, this may be an objection to them, but this, of course, is only a matter of fancy.

(*b*) *Advantages.*—(1) The pipes being below the engines no water can drain into the cylinders when the engines are standing, and very little will be carried over even when the boilers are priming. The engine separators can therefore be done away with if the steam-pipes are provided with steam-traps and suitable drains at their lowest points. (2) A central station in which the steam-pipes are carried under the floor has a very neat and clean appearance; there is no mess caused by joints leaking, etc., and more room is left for other things.

(*b*) *Disadvantages.*—(1) The pipes will be out of sight, and the old saying, "Out of sight, out of mind," is peculiarly applicable to machinery generally and especially to non-moving plant, such as a steam-pipe, which may leak and rust unnoticed till it bursts. (2) In most cases the pipes would below the boiler level, and would, therefore, be liable to get a good deal of water in them. If a boiler were too full, the surplus water would be driven into the steam-pipe, and if part of the steam-pipe were shut down the steam in it would condense, forming a partial vacuum strong enough to draw water out of a boiler connected to it, as the water has only to run down hill after it gets out of the boiler, whereas if the steam-pipe were several feet above the top of the boiler, the weight of the water would be sufficient to overcome the pull of the vacuum. (3) Under-floor pipes are not so easily got at as overhead ones; there is no headroom as a rule, and the bends are cramped. Lamps have to be used, so that the operation of making a joint or changing a length of pipe takes longer with underground than overhead pipes. Another thing is that the engine-room will be much hotter if the heat from the pipes can find its way through the floor, as nearly all the heat from steam-pipes rises vertically.

It will, I think, be shown from the above that in ordinary central stations, where the engines and boilers are on about the same level, the overhead system of steam-pipes has more to recommend it than the under-floor system, but there may be cases in which this latter system would be the best; such, for instance, as where the boilers are at a much lower level than the engines, in which case the best system of steam distribution can be used—that is, where the steam-pipes rise all the way from the boilers to the engines, thus doing away with drains and separators. If the pipes *are* taken under the floor they should be allowed plenty of space, kept from damp, and manholes provided over all the valves so that they can be easily got at. There must be plenty of room for large expansion bends in the pipes.

So far we have only been considering steam-pipes, but there are the exhaust pipes to think of as well. These may with advantage be taken under the floor and kept below the level of the engine cylinders until they reach a common separator in which the exhaust steam can be deprived of its water, which is drained away, while the steam escapes up the chimney stack.—R. S.

Answer to No. 63 (*awarded* 5*s.*).—Although there are two sets of pipes conveying steam to and from the engine, only those connecting the engine to the boiler are usually called the steam-pipes. But the exhaust pipe may be considered as well, as it conveys low-pressure steam. Each of the two systems of arrangement has advantages and disadvantages, the value of which can only be determined in particular cases. "Steam" pipes should be arranged to convey the steam from boiler to engine as directly as possible; hence the shorter the pipe and the fewer bends (except provision for expansion) there are in it the better. When vertical engines are to be supplied, in which the steam-port is high above ground, the overhead system of steam-piping will be better than the alternative, other things being equal. If, however, the port is nearer the floor than the level of the boiler top, as in the case of horizontal engines, less piping is required to lead the steam from the main ring to the engine if the main ring is beneath the floor. As far as the connection from boiler to steam-ring is concerned, the overhead system has the better of it, as steam must always be taken from the top of the boiler, so that if the main ring is underground an extra pipe (with bend in it) is required. If the main steam-pipe is placed below the floor a trough must be prepared for it, and a cast-iron grating must be placed over it, increasing the expense of the flooring. Unless the trough be made very large the

space will be so cramped that it will be difficult to get at the pipe to cover it with heat-resisting material, or to repair a faulty joint. Special provision will have to be made for expansion devices and water separators. As it will be impossible to keep all the heat in, the grating will be warm to stand on, and a current of hot air will be rising in the engine-room at the particular time when a little fresh air is most wanted.

The advantages of the system are that the stop-valves are conveniently placed for use, and that it is a very simple matter to support the pipe on the floor. As against this are the following advantages of the overhead system: the connections from steam-ring to boiler are short; the supports to wall or roof are cheap, and easily put up; space is abundant, so that it is easy to cover the pipe with heat-resisting materials, and expansion bends and water separators have plenty of room.

The disadvantages are that the steam-pipe must be led near a strong wall, or, if the disposition of engines and boilers will not allow of this, a girder or strong roof must be provided for support. Also, the stop-valves will be in an awkward position. The handle must either be placed at the end of a long rod hanging down from the valve, or a chain must be arranged to turn the handle. In either case the driver must raise his arms above his head, which is tiring.

The arrangement of the exhaust pipe, though affected by some of the foregoing considerations, is largely governed by the position of the condenser, feed-water heater, etc. But supposing the steam goes directly to the chimney, the shortest path will be found beneath the floor. In many modern stations the arrangement is to place the "steam" ring overhead and the exhaust main beneath the floor.—J. A. SEAGER.

Answer to No. 63 (awarded 5s.).—The advantages gained by carrying steam-pipes beneath the engine-room floor are not many. A clear space is left above the engines for the working of the overhead traveller in erecting and repairing plant; condensation is reduced, the pipes being enclosed and protected from cold draughts. This enclosure also forms a protection in the event of a burst pipe, but at the same time makes it more difficult to get to the valves and cut out the faulty section, as well as hiding the pipes from view, so that a fault becomes serious before it is discovered, whereas with overhead pipes the slightest failure is seen and remedied before it has time to become a source of danger. Compared with the overhead system, the other is more costly both in first cost and upkeep—in first cost, because beyond the expense of the pipes themselves you have the forming of the chase in the engine-room floor and the checker plates to pay for, and probably more lagging will be required to prevent the checker plates from becoming unbearably hot; in upkeep, because enclosing the pipes makes the jointing and repairing awkward, and more time has to be expended on it; in the same way any future extensions will be more expensive and difficult. Many of these difficulties can be overcome by erecting the steam-pipes in a passage beneath the flooring, left open between the foundations of the engines and the engine-room wall, and wide enough to make inspection and repairs easy; this is an improvement on a narrow chase in every way, and also keeps the engine-room cool; it can be arranged for in the building of the station, and so adds nothing to the cost, but it means that artificial light must be employed when ever any repairing work is being done, and there is still the disadvantage that the pipes are hidden from view.

The great objection to putting the steam-pipes beneath the flooring, is that a large part of the main must come below the boiler level—without the engines are on a floor directly above the boilers, as in some American stations—and large quantities of water will be carried over if there is any priming in the boilers, and produce water-hammer effects, or get into the cylinders of the engines, and perhaps wreck them unless separators are fixed on the engine beds. This difference of levels prevents the condensation water from being drained back directly to the boilers, and introduces at least four more bends than are necessary on an overhead steam-main, which would have one level throughout, with, of course, a slight fall to the boilers; or, if separators are used, to the engines. These bends not only add to the expense, but also diminish the strength of the main.

The choice of system, however, must rest largely on the site and the relative positions of engine-room and boiler-house, and also on the type of engine adopted. With horizontal and low-built engines, or steam-turbines, for instance, the advantages of the overhead pipes are not so evident, and the cost of the two systems would be practically equal.—F. T. H.

Question No. 64.—What do you consider the best method of clamping commutator segments together and chucking them in a lathe for boring?

Best Answer to No. 64 (awarded 10s.).—The best way of clamping the segments together is as follows: Assemble the segments in a circle, and bind them round in two or three places with stout copper wire. Then get a wrought-iron ring, which should not be less than 2in. wide for commutators up to 5in. diameter; above that size it is advisable to have two rings, in order to prevent the segments getting a-skew. Bore the ring out smoothly inside, and at one end form a short taper. The internal diameter of the ring should, generally speaking, be about $\frac{3}{32}$in. less than the callipered size of the assembled segments, though experience soon shows about the right allowance for different sizes. If the segments are flat at the ends, the commutator should be placed with the lug end on a flat iron surface; but if formed with a bevel or with raking lugs, it should be placed on another ring first, as shown in Fig. 1, which shows the whole method, the iron

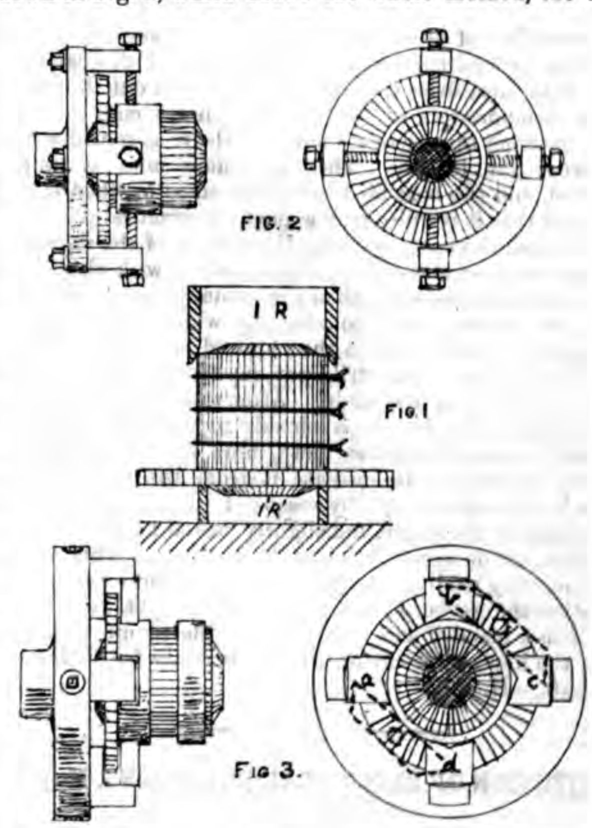

FIG. 2
FIG. 1
FIG. 3.

rings, I R I' R', being in section. The outside of the ring should be greased slightly, and then it must be knocked on, a piece of brass being interposed between the ring and the hammer to prevent damaging the edge. A number of these rings are generally to be found in an electrician's shop, and one can often be found to fit the job in hand, or will perhaps do with a slight skim taken out; if not, of course a new ring must be made. The ring having been placed on centrally, and the segments knocked as even as possible, the next thing is to chuck the commutator for boring. Commutators not exceeding 7in. or 8in. outside lugs can be fixed on the face plate of a 5in. or 6in. centre lathe in the manner shown in Fig. 2. When bored out and the end turned or recessed, as the case may be, it is advisable to just true up the outside at that end as a guide when chucking it the other way about to turn the other end. For larger sizes the method shown in Fig. 3

is applicable, and the commutator is here mounted on a large four-jaw chuck, as fitted to a 10in. or 12in. centre lathe; *a b c d* are pieces of, say, 3in. by 1in. iron, sawn square at one end and vee'd at the other. These should, if not perfectly square after sawing, be filed so that they take a fair bearing both against the jaw and the ring, and the job will then be quite firm and steady when screwed up. It is as well when the commutator is long to put two thinner pieces of iron, one across, say, *b c*, and another across *a d*, as indicated by the dotted lines, and pass a thin bolt through each, between the lugs, and through the slots usually formed in the chuck, thus clamping them against any possibility of jarring slack and letting the commutator wrench out. The above methods are, of course, chiefly useful in repair work, where no two jobs are alike. In the manufacture of commutators of regular sizes, and in quantities, it is necessary to have special tools and devices for each type.—M. C. C.

Answer to No. 64 (*awarded* 5s.).—The process usually adopted for the commutators of lighting machines is somewhat as follows: The required number of segments, which in small machines will generally be cast to the proper shape, and in larger sizes will be of hard-drawn copper cut to the requisite length and with lugs riveted and sweated on, are assembled together in a circle and a piece of rope tied loosely round them. Strips of mica of somewhat about the right size are then inserted between each segment, the right thickness being obtained in each case by placing the mica under a special measuring machine. After each segment has been insulated from its neighbour, the whole is drawn up tight by means of the rope, and a number of steel rings slightly taper are then forced on either by hydraulic pressure or driven on with a hammer. Now, with most firms it is not usual to bore out the inside of the commutators of lighting machines, seeing that the space between the segments and the sleeve is considerable, say from ¼in. to ⅜in. The superfluous mica is simply removed, and the bore filed out fairly smooth, when it will be found that it is quite true enough for practical purposes. If, of course, the space between the bottom of the segments and the cast-iron sleeve has to be filled in with ebonite or some insulating material, then the commutator is chucked from the opposite end to that to which the lugs are attached, and bored out to the required dimensions. It is then driven on a mandril, put in the lathe, the ends trued up, and the V's cut in. After this it is placed upon the sleeve, which has been already turned up, a ring of specially-prepared asbestos cloth, fibre, or micanite being inserted at each end to insulate it from the sleeve. The whole is screwed up tight by means of the screwed washer at one end of the sleeve, and slightly heated by being placed in a slow fire or upon a block of heated iron. This makes the insulating medium at the ends plastic, and when in this condition the washer is finally screwed up tight. It is again put upon a mandril and turned up to the required dimensions, the key-way is cut in, when it is ready for fitting on the shaft.—H. BELL.

INSTITUTION OF ELECTRICAL ENGINEERS, May 26.

Before the reading of Prof. Carus-Wilson's paper the **President** announced that he had received a communication from Mr. Wilde, thanking them for electing him an hon. member.

Mr. A. M. Taylor, in opening the discussion, said that there was one point in the paper which was of interest. The author said that the error involved in assuming that the acceleration was constant up to full speed did not amount to 1ft. of the distance. A paper had been read on this subject by Mr. S. H. Short, and in it he advocated a method of control giving approximately constant acceleration. Mr. Short had worked out two cases, in one of which, using his own method of control, a distance of 1,810ft. would be covered in 61½ seconds; the other, employing the ordinary control, taking 66 seconds to cover the same distance, the values for acceleration and retardation remaining the same in each case. He (Mr. Taylor) had also recently worked out a similar case where, with an ordinary control, 50½ seconds would be taken to cover 1,128ft. against 47½ seconds obtained by carrying the initial acceleration uniformly up to the point where full speed was reached. In those three seconds thus saved an additional distance of 142½ft. might be run—a gain of 142½ft. in 1,128ft., as against the 1ft. instanced by Prof. Carus-Wilson. On
high-speed railways, with frequent stops, and with a fixed
speed and time in which to get from station to station, this
of keeping the acceleration to its full initial value as
possible became very important, and he (Mr. Taylor), w
glad if Prof. Carus-Wilson could throw some further ligh
Short's device.

Mr. W. M. Mordey congratulated the author on
returned after his absence of eight years, and on the fir
his return being to read that paper. He hoped the di
would be continued in the Institution *Journal*. In Ameri
space was asked for. There was a tendency to build
motors. There was room for improvement in controlle
sorts. Figs. 10 and 11 showed how much was yet to be
making them more efficient.

Prof. R. Smith said that this paper called forth one
The method employed by the Americans in calculating th
of their motors was much better than the English method
horse-power. It seemed to him that all the calculatio
carried out on the assumption of a train resistance. Th
always an extra severe strain at the first moment. Th
was taken from one point of view—namely, that of c
certain distances in a given time. Another point was how
the work done as quickly as possible without undue strain
machinery.

Prof. Ayrton said that he also appreciated the American
of reckoning the power of the machinery by the draw-b
He didn't like the use of so many new terms. Why should "
be so universally used nowadays? Might he suggest tha
was such a word as "electromotive force"? He didn't unde
the value of "force-factor." Air resistance seemed to be
forgotten in the paper. This, he thought, ought not
Another point which had been omitted was the fact that t
had to stop. Would it not be better to take the test
stopping place to stopping place, from rest to rest,
shortest time. This, he thought, would give more
results than the author's method. He objected to th
of "T" for two different things in the paper, as it wa
leading. In the equation on p. 4 of the paper he thought
"*p*" was left out. It was a question whether uniform accel
was the best method to use. Might not a variable accel
give a better result than that obtained by the author? A
which had been brought out was that it was better from the p
economy, as well as for speed, to use series instead of shunt
On p. 18 there was an interesting result as to the perman
the air-gap, to which, he thought, their attention should hav
drawn. He would like to ask if the results given on p. 2
taken from actual tests or merely from the author's suppos
He thought the amount of coal used was very small, bein
9lb. per ton weight.

Mr. E. K. Scott said that a question at the present time w
should the motors on tramways be connected? In Fig. 7 it
be interesting to know how it would affect the bottom equat
p. 7 if roller-bearings were used?

Mr. Grove said he also did not like the use of new
neither did he like the new American formulæ. He would
ask Prof. Wilson how far his assumptions were from actual
ments. The best acceleration for a tramway was settled
amount of traffic through which it passed.

The **President** said that they had just had Prof. W
resignation as secretary at Montreal, where he had been o
use to them. They were in hopes, however, that he would co
to make his presence felt amongst them here in England as
done over the other side. He (the speaker) was greatly inte
in the subject of the paper, as the new Central London R
would run near his door, and he wanted to know how long it
take him to reach the City. Was there not a method of st
the train by reversing the current?

Prof. Perry asked if Prof. Wilson could give him figu
watt-hours per mile for any known electric railway? He ha
hard to obtain this information, but without success.

Prof. C. Wilson, in replying, said that the method spo
as to applying the brake could not be applied except by
circuiting the motor. He could not satisfy Prof. Perry, as he
data himself. In the assumptions in the paper he had endea
to take only one view of the subject, the question of get
railway train of a given weight a certain distance in a
time. Regarding the coal question, that was the actual a
used on the Baltimore railway. Prof. Smith was quite cor
assuming that he (the author) had used a constant accelera
his equation. Mr. Taylor could not agree with Prof. Sm
this subject. While Prof. Short made a quicker start, the
used was very much greater than by the ordinary met
control.

ART-METAL EXHIBITION.

In the electrical department of the exhibition of
craftsmanship now open at the Royal Aquarium, Westmi
we note especially a variety of beautifully executed cand
and electric light fittings.

Mr. J. G. Litchfield shows large gilt lanterns, suitab
staircases and halls of various designs, wall lights, and
lights. We are informed that Mr. Litchfield has for
made them a special feature in his business. Years ag
Litchfield copied some original designs by Chippendale
has since added models from the palaces of Fontainebleau

illes. Owing to the prevalent use of electric light they sprung into great demand.

ssrs. Perry and Co. exhibit examples of high-class chased gilt ormolu electric lustres (an example of which is

FIG. 1.—Eighteen-Light Chased Ormolu Poppy Pattern Electrolier.

presented in Fig. 1), wrought and mercury-gilt electric tres, chased and gilt electric ceiling fittings, hall and other terns, Italian Renaissance lampadas, electric pendants, grille

FIG. 2.—Two-Light Louis XVI. Electric Bracket, with Crystal Iris Glass and Long Ormolu Drapery Back.

erns, brackets for electric lights, floor lamps, candelabra, ctors for lighting pictures, etc. Some of these lanterns in style of Louis XI. and Louis XIV., and candelabra of the Early Renaissance, have been carefully copied after the originals by famous Italian and French masters, and represent objects which it was formerly simply impossible to acquire. A new feature introduced is a cluster of matt glass leaves, which surround the incandescent globes of some of the electroliers, thus preventing the glare of the light to be seen, and at the same time obviating the necessity of a shade. This is shown in Fig. 2.

The Tayler Smith Electric Company show their method of lighting by reflection, and reflected light as applied to a picture or looking-glass, and sundry treatments of electroliers and brackets.

Messrs. Strode and Co. have wrought-iron, brass, and copper electroliers, pendants, lanterns, and brackets, wrought-iron newel lights, floor standards, and table lamps.

Messrs. Ritchie and Co. have wrought-iron electroliers, billiard lights, screens, etc.

Messrs. Drake and Gorham have a large stand, which was not quite fitted up at the time of our visit.

The Waltham Engineering Company show armour-bright steel fittings for electric light and decorative purposes.

Messrs. Thomas Potter and Sons' exhibit consists of various examples of ecclesiastical metal work, including also electroliers and brackets in wrought iron and brass.

The loan exhibition contains armour, weapons, chalices, etc., of noted historical as well as artistic value, lent by H.M. the Queen, the Duke of Westminster, the Duke of Norfolk, and others. Especially interesting are five plaques which were only unearthed at Kew a few weeks ago. A more than usually attractive variety entertainment of 64 numbers is provided, which gives the visitor the requisite opportunity for rest during his peregrinations around the hall.

During the exhibition, which will continue until 30th inst., handicraft competitions will take place, several forges having been fitted up in the Aquarium for the purpose.

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TO CORRESPONDENTS.

 Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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AMERICA v. BRITAIN.

The statement is often made that things are done better abroad than at home, and while in many cases the statement has no justification in fact, in other cases, alas! it is too true. The English are said to be a practical nation; so they are, but in some things the exception proves the rule. Hence we may expect to find exceptions to this practical characteristic, and these exceptions are very prominent when connected with consular reports. In matters connected directly with business affairs, the Americans are far more advanced than ourselves. Our consuls may have a general order to collect such information as may assist business men, but there seems to be no idea that such information is of an urgent character. On the contrary, the American consuls understand thoroughly the value of early information, and if they cannot publish it sufficiently early in their ordinary reports, do not hesitate to make it public through the columns of the newspapers. Here is an example of such enterprise in a letter to the *Scientific American*:

"AN ELECTRIC RAILROAD FOR FREIBURG.

"The city of Freiburg, a town of 55,000 inhabitants, with most beautiful surroundings, many large villages near by, and romantic valleys into the heart of the Black Forest, is contemplating the building of an electric railroad system and a central power station for electric light and locomotive power. Competition for these new enterprises is open to the world, and as United States Consul I consider it my duty to call the attention of American manufacturers to the same, and feel that your valuable publications are the best medium for that purpose; hence send this note to you. Freiburg is a busy little city, very conservative and slow but sure in whatever it undertakes, and whatever is constructed here is built, not for a day or lifetime, but for an age. 'Rapid' transit they have here, but it is the old-fashioned omnibus. Electric light is seen nowhere but in several factories with private motors and dynamos. Hence the need of these new enterprises and the call for bids for the same, such bids to be in the hands of the Committee on Underground Structures (Tief-bau-amt) before July 1, 1898. I mail you under separate cover the circular letter, plan of the city, plans and profiles of the projected enterprises, etc., such as the above-mentioned committee sends to parties interested, and shall be glad to procure any further information for you or other Americans who may take an interest in this matter.—E. THEOPHILUS LIEFELD, United States Consul, Frieburg, Baden, Germany, April 29, 1898."

It is tolerably certain that many of the companies interested in this sort of work here do know what is going on, and consequently are in a position to see if it is worth while tendering for the work, but these are the favoured ones; and it should be no more difficult for the consular service of this country to disseminate such information than it is for the American. Then, again, people here are still too much embued with the idea that business must come without pushing for it, with the result that o

American friends have obtained almost practical control of tramway work. We admire their energy, because they are chips of the old block, and while the old block remains content to be gazed at, the chips fly in every direction with a considerable tendency towards aggressiveness. We are not at all sure that the work would come to British firms even if early and complete knowledge were given of it. Still, it could do no harm if the consuls reported early of proposed work. Municipal undertakings are generally of a character in which there is no difficulty in obtaining capital, and so those who can control a fair amount of capital are just those who are most likely to succeed in negotiations with municipalities. Our point, however, is not as to the parties that will ultimately get the business, but in the difference between our own Government and that of America in obtaining and making known commercial information. From time to time we do get information that tenders are required for coal or iron or something, and though this may convey an impression of energy on the part of the Foreign Office and the consular service, the fact is that most of those interested in the matter know of the actual request to tender as soon as the Foreign Office. What is wanted is information of work in its inception before the designs have been made, before everything is cut and dried and tenders asked for. Too often, when the specification is complete, the work is so closely defined as to be absolutely confined within a limited field. There is no flexibility. It must go into the hands of one or other of two or three firms, while, properly constructed, the work would have been open to thirty or forty firms. The specification of a particular machine is frequently only an indication of the ignorance of the writer of the specification, but it effectually limits the number of tenders. However, this is still another question. Early, complete information and a fair field and no favour, is the motto.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

OLD-TIMERS.

SIR,—With reference to Mr. Fahie's letter in your last number, it may not be generally known that the papers, etc., of three old-timers are now in the library of the Institution of Electrical Engineers—viz., Edward Davy's, presented by Mr. Fahie himself, and those of Jacob Brett and W. F. Cooke, presented by Mr. Latimer Clark.

Cooke's letters, as lately published by a committee of the Institution, stop at 1839, but why? Surely there must have been many more in the eventful years that followed. Again, why were not selections from the Cooke and Wheatstone correspondence given at the same time? Were the committee afraid of too much light?—Yours, etc.,

May 30, 1898. A STUDENT.

PHYSICAL SOCIETY.—At the meeting on Friday next, at the rooms of the Chemical Society, the following papers are promised: Exhibition of a Model illustrating Dr. Max. Meyer's New Theory of Audition, by Prof. S. P. Thompson, F.R.S.; "Attenuation of Electric Waves along a Line of Negligible Leakage," by E. H. Barton, D.Sc.; "Diffusion Convection," by A. Griffiths, B.Sc.

CITY AND GUILDS OF LONDON INSTITUTE.

MAGNETISM AND ELECTRICITY.

FIRST STAGE OR ELEMENTARY EXAMINATION.

The following are the questions set by the Examinations Department of the City and Guilds of London Institute, 1898:

Magnetism.

1. A rod of iron free from magnetism is suspended by a string so as turn in a horizontal plane and the string is twisted until the rod rests at right angles to the magnetic meridian. Explain the behaviour of the rod if a magnet is brought near to it from a distance in such a way that its axis is nearly in the line passing through the centre of the rod and perpendicular to it. (12 marks.)

2. A piece of soft iron and a piece of hard steel of the same size and shape are separately rubbed from end to end by the north pole of a strong bar magnet. How will you test their magnetic condition and what difference will you find between them? (12.)

3. You are given three equally long and equally strong magnets. How would you arrange them so as to form an astatic system? (13.)

4. A steel bar suspended by a thread lies horizontally and points indifferently in any direction, but when it is broken into halves, each half is found to point north and south when separately suspended like the whole bar. Explain the magnetic condition of the unbroken bar. (12.)

Frictional Electricity.

5. How would you show that a brass rod is capable of being electrified? Explain why on rubbing a brass rod and a glass rod the latter only ordinarily appears to be electrified by the friction. (12.)

6. Into an insulated uncharged metal jar standing on the cap of an electroscope an electrified brass ball is lowered without contact; the jar is then touched for a moment with the finger, and the ball is next allowed to touch the jar, after which it is removed. Explain the various effects produced on the gold leaves. (12.)

7. Two similar vertical insulated plates, A and B, are placed parallel to each other and about 1in. apart. Each is connected to the cap of a separate gold-leaf electroscope. State and explain the indications of the electroscope when (1) a positive charge is given to A, and afterwards (2) B is touched. (12.)

8. What is the evidence for the opinion that lightning is an electric discharge? (12.)

9. A sharp point is attached to the interior of a hollow metallic sphere. Describe and explain the action of the point (1) when the sphere is electrified, (2) when one end of a brass rod, the other end of which is held in the hand, is cautiously introduced into the sphere through a small hole so as not to touch the sphere and is brought near to the point. (13.)

Voltaic Electricity.

10. The terminal wires of an insulated battery consisting of a large number of cells touch the caps of two electroscopes. What are the effects upon the two sets of leaves, and what would be the further effects of touching one of the caps with the finger? (12.)

11. A straight horizontal wire is placed near and parallel to a compass needle and in the same horizontal plane with it. If a current is then passed through the wire, what effect is produced on the needle, and what occurs if the wire is (1) slightly raised, (2) slightly lowered? (13.)

12. A glass cell is divided into two compartments by a porous partition. One compartment contains a strong solution of copper sulphate, the other dilute sulphuric acid. A copper plate and a zinc plate, which dip into these respectively, are joined to the terminals of a galvanometer, the needle of which is deflected. State and explain how the deflection will be altered if the copper sulphate is replaced by dilute sulphuric acid.

13. Explain the meaning of the statement that the electric current flows in a circuit. By what experiments would you illustrate its accuracy? (13.)

14. Two galvanic cells are made by dipping (1) plates of

zinc and platinum into a beaker of dilute sulphuric acid, and (2) plates of zinc and copper into another beaker containing the same liquid. The plates can be connected by copper wires. Explain with diagram how the two cells may be connected in series so as to (1) strengthen, (2) weaken, the current produced by one of them. (12.)

ON THE USE OF BLAST-FURNACE GAS FOR MOTIVE POWER.*

BY ADOLPHE GREINER, DIRECTOR-GENERAL OF THE SOCIETE ANONYME JOHN COCKERILL, SERAING (BELGIUM), MEMBER OF COUNCIL.

(Concluded from page 661.)

A number of objections have been offered to the use of gas-engines driven by blast-furnace gas. The chief of these is the trouble that may arise from the dust carried by the gas. At Seraing the gas from the furnaces is no cleaner than in other places, but rather the contrary. Purple ore or blue billy to the extent of 20 per cent. is used in the ore charge, and the gas-mains are not provided with large dust catchers, as in more modern works. Thirteen and a-half tons of heavy dust is collected daily from two blast furnaces which together produce 300 tons of pig iron, and this is equivalent to 10 grm. per cubic metre. This dust, which chiefly consists of purple ore, contains about 50 per cent. of iron, and is returned to the furnace. In addition, another three tons of light dust is collected daily by cleaning out the mains and washers. This corresponds to 2·2 grm. per cubic metre.

Mr. Hiertz has analysed the dust from blast-furnace gases at Seraing, the blast furnaces consuming about 20 per cent. of pyrites residues and 80 per cent. of Bilbao ore. The results obtained are shown in Table A. These analyses show that near the furnace the dust deposited contains chiefly ferric oxide, and that, as the chimney is approached, the dust becomes richer in silica, alumina, lime, zinc, sulphuric acid, and alkalies, as might be expected.

TABLE A.

—	In the gas-pipe leading to the boilers at 20 metres from the furnace.	In the gas-pipe leading to the boilers at 60 metres from the furnace.	In the first flue in the boilers.	In the last boiler flue.	In the smoke flue at the entrance of the chimney.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Volatile matter	11·00	9·30	—	1·20	2·50
Insoluble residue (aluminium silicates)	13·00	15·40	19·00	21·80	22·00
Iron	33 85	20·45	19·15	8·05	10·10
Manganese	0·75	1·25	1·35	1·80	2·85
Lime	9·10	13·20	17·40	18 75	17·25
Magnesia	0·90	1·10	1·60	1·60	1·65
Alumina	9·50	15·20	12·30	18·55	17·80
Zinc	1·50	4·40	5·10	6·20	9·20
Sulphur anhydride	1·10	1·70	4·55	9·00	6·50
Sulphur	0·60	1 30	1·10	trace	trace
Chlorine	trace	0·30	trace	0·24	0·35
Alkalies	3·50	6·70	9·30	8·70	4·40

As regards the impalpable dust carried forward by the gas into the gas-engine, no details of its amount are available. According to Mr. Lurmann, of the Gutehoffnungshutte, there remains about 2 grm. of dust in the washed gas after all possible means of purification. At the Georg-Marienhutte, Osnabruck, an average of 2·91 grm. of dust was found in a cubic metre of washed gas. Round figures of 2 grm. and a 200-h.p. engine using four cubic metres of gas per horse-power hour would give 40 kg. or 88lb. of dust daily. Happily, nearly all this will pass out with the exhaust, as is shown by the 8-h.p. engine which ran for four months without necessitating a clean-up of the cylinder. All the dust was thrown out in the form of a translucent white smoke. It would be difficult to find gas-fired boilers which had run four months without cleaning. Besides, it is no more requisite to use thoroughly clean gas in a gas-engine than it is to use distilled water in a boiler.

The second objection attributes a destructive action to the dust, due to the acid matters, especially sulphuric acid, that it contains. Analysis, indeed, shows sulphuric and phosphoric acids, besides chlorine; but the alkalies and lime also present probably neutralise their effect. It is not necessary to use an inordinate quantity of water for washing purposes, and no corrosive action has been observed in two years. The only part that requires cleaning after a few months is the ignition appliance; but even that shows no sign of corrosion, and it can readily be replaced in a few hours. A comparison with the time taken for cleaning and repairing a boiler and its setting leaves no doubt on which side the advantage lies.

A third objection to the use of blast-furnace gas depends on the irregularity of its composition. This objection is not so serious as it appears. In the first place, the gas-engine readily accommodates itself to the variable condition of the gas, and experience has shown that when the gas ignites with difficulty under the boilers, it is not too bad to affect the regular operation of the engines. Even if the furnace is not running well, and the gas becomes non-inflammable, the same inconveniences occur with both boilers and engines. Coal has to be burnt on the boiler grates, and it would have to be used in gas producers for the engines. It has also been observed to the disadvantage of the gas-engine, which usually runs at 100 to 120 revolutions per minute, that this speed must be reduced one-half to two-thirds in order to drive such machinery as blowing engines. In reply to this, it may be stated that gas-engines of 50 h.p. run at 150 to 180 revolutions, whilst those of 200 h.p. run perfectly well at 100 revolutions, so that it is probable that one of 400 h.p. to 500 h.p. would work at 75 to 80 revolutions. As the valves of many compressors run at 50 to 60, and some even have been made at Seraing to work at 75 times per minute, it is not easy to see why they should not have a greater speed. It is a problem for the mechanical engineer to solve.

In conclusion, a summary of the advantages accruing from the use of gas may be given. Gas is, above all other means, the most suitable for transmission of power. In a factory where motive power is required at scattered points, there are many advantages in a central producer plant from which gas is led to gas-engines at the requisite places. Blast furnaces are gas-producers ready to hand, and when there are two or three together, there is not much danger of very great variations in the quality of the gas. Gas can be supplied with ease under a low pressure, and without appreciable loss by leakage or condensation, to considerable distances. The mains and pipes are simple, light, and economical. Boilers and the dangers accessory to their use may be abolished. Gas shares with electricity the advantage of directly giving light, heat and power, and this alone is sufficient to ensure its use by manufacturers and its general application in metallurgical works.

* Paper read before the Iron and Steel Institute, May 6, 1898.

GUTTAPERCHA.*

BY DR. EUGENE F. A. OBACH, F.I.C., F.C.S., M.I.E.E.

LECTURE I.

(Continued from page 147.)

In the wake of the English explorer followed a Dutch botanist, Dr. W. Burck, the assistant director of the botanical gardens at Buitenzorg, on the island of Java, who towards the end of 1883 received instructions from his Government to proceed to Sumatra and study the guttapercha-producing trees on the uplands of Padang (Padangsche Bovenlanden) along the west coast. Dr. Burck discerned 14 different species yielding guttapercha, of which, however, I will only mention two—viz., the Niato balam tembaga or Durian of Ampaloo (Halaban), which yields an excellent kind of guttapercha; and the Niato balam baringin or sundai, which produces the Getah soondie, a second-class material. The former is identical with Palaquium oblongifolium and the latter with Payena Leerii, which have both been described to you to-night. Dr. Burck's report to the Government is dated Jan. 10, 1884; it has been translated into French, and published at Saigon in the journal *Cochinchine Française* in 1885. It is a very exhaustive and valuable document, containing a vast amount of original information. Some years afterwards it was followed by another very learned publication on the Sapotaceæ of the Dutch Indies and the botanical origin of guttapercha, which has since become a standard work on the subject. The diagrams exhibited here to-night are copies of the beautiful illustrations accompanying the work. On returning from his expedition, Dr. Burck brought a number of young gutta trees with him, which were planted in the botanical gardens at Buitenzorg, and subsequently transferred to the Cultuur Tuin at Tjikeumeuh close by. He also sent dried specimens of the plants to the various European herbaria, and one of them is exhibited here to-night from Kew.

Dr. Burck only heard of M. Séligmann-Lui's expedition after his own return, but they compared notes, and on the whole agreed in their conclusions. He was also at the time ignorant of Mr. Wray's explorations in Perak.

Each of the three expeditions I have hitherto mentioned extended only over the comparatively short period of a few months, but that of M. Sérullas, which now followed, occupied almost four years—viz., from 1884 to 1887.

The plants collected in 1881 by M. Séligmann in Sumatra having failed to reach Saigon, the director of the botanical gardens there applied to the authorities at Buitenzorg for young plants of the Niato balam tembaga, discovered by Burck at Ampaloo, but instead of the particular plants asked for, "others of the better variety known as Hooker's Isonandra were supplied." This was in 1884, and M. Sérullas, who was then at Saigon, advised the Government not to accept the plants, nor others received from Singapore, as they were not of the right kind. In consequence thereof, the French Colonial Secretary, in concert with the Post and Telegraph Department, commissioned M. Sérullas to proceed to the Malay Peninsula and himself to collect the plants which he considered suitable. At that time Sumatra was reported by the Dutch Government to be unsafe on account of the internicine wars between the various Batak tribes.

During the long preliminary exploration in the Malay Peninsula M. Sérullas found a great many adult trees of the Taban merah and Taban sutra in the forests of the savage Sakais on independent territory, but, being exhausted by fever, he had to return to France almost in a dying condition. Having barely recovered, he returned to the peninsula, and from there, under great difficulties, brought all the plants he required to Singapore. It was here, after having informed the Government at Cochin-China of his success in obtaining suitable plants, and whilst he was awaiting their reply, that in April, 1887, he found in the jungles of Bukit Timah the authentic specimens of Hooker's Isonandra gutta in blossom, a discovery which he at once communicated to Saigon. The consequence of this was that the governor now rejected all the plants previously collected by M. Sérullas on the Malay Peninsula, and only consented to accept specimens of the original Isonandra gutta of the forests of Singapore. This decision, however, was subsequently withdrawn on the intercession of M. Lannessan, professor of botany at the Faculté de Médecine of Paris, who, at the time, happened to be in Malaysia, and the plants were, after all, forwarded to Saigon. There they were transplanted at the beginning of the dry season, in spite of the earnest entreaties of M. Sérullas, and as they were also neglected, they all soon perished.

In December, 1887, M. Sérullas again went to the Malay Peninsula, but instead of young trees he now took the stools of old ones with the shoots attached and transported them to Singapore. Here he carefully nursed them, and within three months had the satisfaction of seeing at least 20 shoots of vigorous growth on each stool. Sérullas received further instructions to collect seeds of the Isonandra gutta in the forests of Singapore, but he was refused the assistant for whom he asked, by the Minister, and whilst completing the collection he had a severe attack of dysentery. Again returning to France to recruit his health he had the disappointment of learning there that his mission had been suppressed, and that all the little plants which he had reared at Singapore with such infinite care and trouble had been abandoned by the French Government, which, since then, had entirely ceased to interest itself in the matter. Thus ended the fourth and, up to the present, last Government expedition in search of guttapercha trees, and we have now to see what attempts have been made to cultivate them.

EXPERIMENTAL CULTIVATION.

In May, 1847, Messrs. Wilkinson and Jewesbury, of London, received a consignment of about two dozen young guttapercha trees from Singapore, which they presented to Kew Gardens, receiving an acknowledgment from Sir Wm. Hooker.

I was unable to find out what became of these plants, but on searching the older issues of Hooker's "Popular Guide to the Gardens," I noticed that in 1849 a living guttapercha plant (*Isonandra gutta*) existed in the low double propagating-house, No. 4, and was described as having been presented by Dr. Oxley with other rarities from Singapore. In later editions of the "Guide" the plant is mentioned in plant-house No. 16, the museum stove, and the miscellaneous tropical house, and it was still in existence there in 1860, but it appears to have been considered merely as a curiosity. On the other hand, serious attempts at cultivation were made on the island of Singapore as early as 1848, when no less than seven plantations of gutta trees were established there by Oxley, Montgomerie, D'Almeida, and others, but one by one they fell into the hands of Chinamen, who, in course of time, replaced the gutta trees by other more remunerative crops. Dr. Oxley's plantation had been stocked with plants from the forest of Bukit Timah, and was therefore supplied with the best kind of tree obtainable, but it seems that some of the other plantations were supplied with a species of *Ficus* by mistake.

Out of the plantation of 4,000 trees, established by Sir José D'Almeida at Serangong, some adult specimens still survived in 1888, but were then just on the verge of extermination, and now only a few trees exist in the north of the island, and their latex is used by the Chinamen for adulterating opium.

The Botanical Gardens at Buitenzorg received a number of young *Isonandras* from Singapore in 1847, half of them being still alive two years later. In 1883 two of the remaining trees bore fruit and seeds in abundance, and in February of the following year 150 young plants, reared from these seeds, were planted in the Cultuur Tuin of Tjikeumeuh.

In 1856 the Buitenzorg Gardens also received 2,000 young specimens of the Niato balam tembaga from the west coast of Borneo, which the director, Mr. J. E. Teijsmann, distributed to three different places on the island of Java; from two they disappeared again in the course of time, but of those which were sent to Purwokarta, nearly 80 reached maturity, and although, perhaps, not very vigorous, yet ever since 1883 they have regularly produced seeds which have been found most useful for propagation.

In 1884 several kinds of *Palaquium* as well as *Payena* were planted at Tjikeumeuh, and amongst them the *Pal. oblongifolium* brought from Padang by Dr. Burck, the others consisting of *Pal. gutta*, *Pal. Treubii*, *Pal. Borneense*, and *Payena Leerii*. By the kindness of the director of these gardens, Dr. Treub, I am able to show you a photograph of the *Palaquium* sections, and I will also show you on the screen a copy of the plan of the gardens, on which I have marked those plots and added the names of the various kinds of gutta trees which are cultivated there.

In the year 1885, an experiment garden (Proef Tuin) on a larger scale was established by the Dutch Government at Tjipetir, in the Preanger Regency, at an elevation of about 1,300ft. above the sea-level, and extending over 250 acres. Here the same kind of trees as at Tjikeumeuh were planted; and I can show you the photographs of two of these plantations, taken when the trees were about five years old. The first slide shows the young *Palaquium gutta* trees, planted without shade trees, and the next the *Payena Leerii*, shaded by tall trees (*Albizzia moluccana*) planted at the same time.

In a letter, recently received from Mr. van Eeden, the director of the Colonial Museum at Haarlèm, he tells me that the *Palaquium* trees at Tjipetir bore abundant fruit in 1895—*i.e.*, 11 years after having been planted—and that they are now being cultivated on a still larger scale. I have here specimens of guttapercha obtained at Tjikeumeuh from trees about 10 years old tapped for experimental purposes.

Before leaving this subject, I will just mention that some gutta trees were also grown in the Government Gardens at Peradeniya and Henaratgoda in Ceylon, from seeds supplied from Perak by Sir Hugh Low in 1882, and yielding the material known as Getah taban puteh (probably *Dichopsis polyantha*, Benth.); there were also some young trees of the kind

* Cantor Lectures delivered before the Society of Arts.

yielding Getah sundek (*Payena Leerii*, Burck) in existence at that time; however, as no mention is made of them in the last report on these gardens, I cannot say whether they are still there now.

PROPAGATION OF GUTTA TREES.

It has variously been asserted that gutta trees cannot be reared from seeds, but I can assure you, on the high authority of Dr. Treub, that this mode of propagation is quite feasible, although the seeds do not keep their germinating power very long; and a more certain method is that technically known as "marcottage," which consists in burying a branch of the tree in the ground, allowing it to take root, and afterwards separating it from the parent plant.

According to information obtained for me from a Chinese gutta-planter, cuttings from old trees can also be used for propagation, and it is best to insert them into a cocoanut to take root there, and then transplant them. Young plants reared in this way can be bought at Penang and Batavia at 50 cents apiece. Saplings from the jungle, where obtainable, or from plantations, are also suitable for transplanting, and they can now be bought in Malacca at a very low price. Dr. Treub finds young plants reared from marcottes more vigorous than those from seeds. Grafting is declared to be impossible by Mr. Ridley, on account of the fungi and bacilli which attack the plant. M. Sérullas, as I told you, took the old stools from the forest and transferred them to a nursery.

COLLECTION OF GUTTAPERCHA FROM THE TREE.

I must now tell you how the latex is obtained from the trees. You will remember that it is contained in isolated receptacles or sacs, chiefly in the lower parts of the bark, but also in the leaves. The diagram (Fig. 1) shows a section through a small branch, *a*, and a leaf, *b* and *c*, of the *Palaquium gutta*, and you observe the numerous latex receptacles, L, in the primary and secondary bark, P B and S B, of the branch as well as in the pith, P. The sections through the leaves show you in one case, *b*, the termination of the two latex sacs, and in the other, *c*, the course of one of them within the imperfect cellular tissue or *merenchyma*.

In order to get at the latex, it is therefore necessary to cut through the bark and cause it to exude. The practice of the Malay getah-collector is invariably to fell the tree, chop off the branches, and ring the bark at distances of 12in. to 18in. all along the trunk. The milky sap soon fills the grooves cut into the bark, and with the better kinds of trees quickly coagulates; it is then scraped off with the point of a knife.

FIG. 2.

In the case of inferior trees, the latex requires a much longer time to curdle, and has to be collected in a receptacle of some sort, a cocoanut-shell or the spathe of a palm, for instance, placed under the trunk. The latex is then taken to the huts and gently boiled, either by itself or with the addition of water. The material obtained without water is called a "goolie," the other a "gutta"; but the two kinds are mostly mixed together. The goolie is more compact than the gutta, and it has a dough-like smell. For felling the trees the Malays use a small axe, called a "billiong." It has a chisel-like iron blade secured to a wooden handle by a lashing of rôtan. The branches are chopped off with the pârang or the gôlok, and these are also used for ringing the bark and scraping off the getah. A collection of these native instruments, presented to Kew Gardens by Sir Hugh Low, the Resident of Perak, and Mr. Murton, is exhibited here, and we have photographed them with some specimens of wood from gutta trees found in Perak. They will now be projected on the screen.

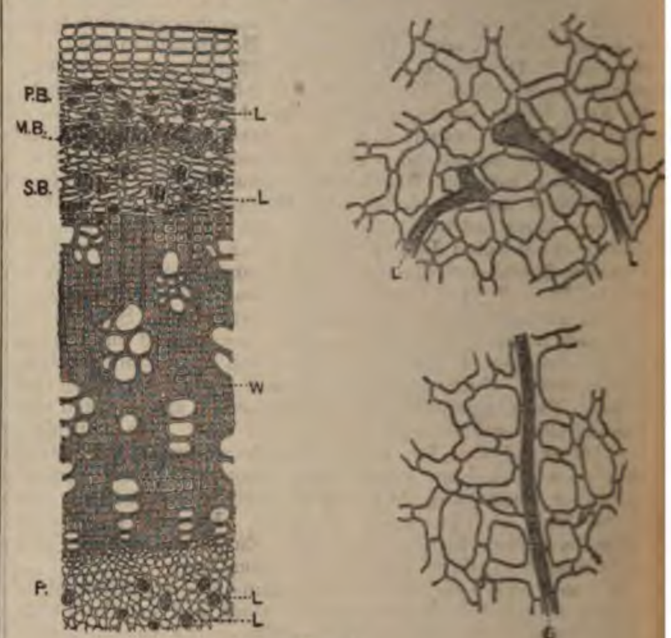


FIG. 1.

I am also able to show you on another slide the way in which the Malays use these tools for extracting the gutta from the trunk in the western parts of Sumatra. The group was arranged by Dr. Burck, who is himself in the picture (Fig. 2). Here is a piece of the trunk of a gutta tree of respectable size, and about 60 years old, which was kindly presented to me. It measures over 40in. in circumference; parts of it have been polished to show the structure of the wood. An expert whom I consulted expressed the opinion that it was probably not of much use as timber, which is contrary to the opinion expressed in some books.

As regards the quantity of solid guttapercha yielded by an adult tree, the data given are very conflicting. Older writers like Oxley and Logan give as the average 13¼lb. and 5¼lb. for Singapore and Johor respectively, but later observers quote

much smaller figures. Wray, for instance, obtained only 2lb. 5oz. of fairly clean guttapercha from a Taban merah at least 100 years old, and 2lb 11oz. from a Taban puteh. Burck obtained on an average only 11oz. from adult trees in West Sumatra, and Sérullas 13½oz. from a giant tree felled in Pehang by Dyaks. The yield evidently depends greatly upon the kind of tree, manner in which it is bled, the season, etc., the milky sap being said to run most freely directly after the rainy season is over. When the tree is wounded without first being felled, the latex flows much more tardily and sparingly and also coagulates quicker. The output is, therefore, notably smaller, this being one of the reasons why the Malays still resort to the old method of cutting the trees down before bleeding them. With caoutchouc trees it is different ; their latex is much thinner and does not easily coagulate, consequently the tapping of living trees is the usual practice. Trees yielding a special kind of guttapercha (*Balata*) likewise contain a more fluid milk-sap, and here tapping is the rule, as we shall see in our next lecture.

If we accept Mr. Wray's figure, the average yield of an adult gutta tree of good quality is about 2½lb., which, if anything, is robably too high an estimate. Taking the price of guttapercha t 3s. 6d. per pound, the value of the entire yield of a tree ould be only 8s. 9d., and it is, therefore, not very surprising at the Malay collector as well as the Chinese dealer tries ery expedient to increase the amount of the produce, the rmer by blending it with the juices of other plants, ready at nd in the forest, and the latter by recooking the materials ich he receives from the jungle, and mixing them with bark, wdust, ground sago, etc.

The guttapercha as it finally arrives on the market is usually the form of large blocks of various shapes—cylindrical rolls, uare cakes, flat bottles, etc.—which are to a certain extent aracteristic of the district whence they come, and I have ought various specimens with me to-night for your inspection. metimes the native collector shows artistic proclivities, and oulds the guttapercha into the form of birds, alligators, adrupeds, etc., specimens of which you see here. They are t at all bad productions, although by no means the best I ve seen.

In the early years the Malays went more seriously to work, d made a number of useful articles, which they brought into wn for sale, such as riding-whips. walking-sticks, pails, jugs d basins, and so forth, and Prof. Solly mentions in 1845 that batch of such sticks had then just been received at Liverpool om Singapore. I also heard from friends that in the early ties guttapercha riding-whips were not infrequently met with the Continent. I am able to show you a number of these ticles, which were sent to the Great International Exhibition 1851, and as they will probably not exist for many more ears I had them photographed, and shall show you the result the screen. Please observe the black stripes on the riding-hip and walking-stick, as well as on the basin and jug, to which have alluded before. Also please notice the shallow tray next he jug, which is the guttapercha cover of the tin box in which xley sent the flowering branch of the *Isonandra* to Sir Wm. Hooker, in 1847. The two specimens of wood shown on the hotograph are from the Taban merah (*Palaq. gutta*).

Chemical Analysis of Guttapercha.

I will now briefly consider the chemical composition of guttapercha and its analysis. The very first specimens sent to the Bengal Medical Board by Dr. Montgomerie in March, 1843, were already submitted to chemical tests by Dr. Mouat and Mr. J. G. Scott. They tried its solubility in various menstrua, such as water, alcohol, ether, naphtha, oil of turpentine, etc., and subjected it to destructive distillation. From their experiments they concluded that guttapercha was a "variety of caoutchouc," having certain remarkable properties of its own. Prof. Edward Solly, who examined the samples sent to the Society of Arts, as well as some specimens from the East India House, received by him through Dr. Royle, read a paper before he Chemical Section of the British Association at Cambridge n June 23, 1845, in which he described the behaviour of guttaercha towards various chemical agents, alkalies, acids, etc., nd on the very same day Dr. Douglas Maclagan sent a communication to the Royal Scottish Society of Arts at Edinburgh, which he likewise dealt with the chemical properties of this ubstance, and gave the result of its ultimate analysis, which e considered sufficiently conclusive to justify the opinion that is "generally the same as caoutchouc." A short time after, ent and Soubeiran found that commercial guttapercha conined two resinuous substances, one soluble and the other soluble in cold alcohol. Adriani and Arppe further examined ese resinuous components, and the latter distinguished quite number of them, some being crystalline, others amorphous. he chemical analysis of these resins showed that they conined different amounts of oxygen. Payen, in 1852, came to e conclusion that purified guttapercha contained three proxiate components—viz., a substance insoluble in cold and in iling alcohol, which he termed "pure gutta"; a crystale white resin, soluble in hot but not in cold alcohol, which he called "albane"; and lastly, an amorphous yellow resin which he named "fluavile."

Later on, Oudemans and von Baumhauer showed that Payen's pure gutta was a hydrocarbon, having the composition $C_{10}H_{16}$ like caoutchouc, and therefore isomeric with oil of turpentine, and that the resinous components might be represented by the following formulæ—viz., albane $C_{10}H_{16}O$. and fluavile $C_{20}H_{32}O$. Quite recently, Mr. Otto Oesterle subjected guttapercha to a still more searching chemical analysis in Prof. Tschirch's laboratory at Berne, and found a fourth component, which he termed "guttane," and of which he gave the composition, after repeated precipitations by alcohol from a solution in chloroform, as C 86·4 per cent., and H 12 per cent.; it is, however, a very variable substance. I myself had also repeatedly noticed the presence of this substance in guttapercha, but have not further examined it.

For albane, Mr. Oesterle finds the formula $C_{40}H_{64}O_2$, and for fluavile $(C_{10}H_{16}O)_n$—that is, he finds more oxygen in the latter than in the former, which is just the reverse of Oudemans' results. My own analyses gave the following percentage composition :

Albane.			Fluavile.	
C = 78·96	per cent.	....	C = 80·79	per cent.
H = 10·58	,,	....	H = 11 00	,,
O = 10·46	,,	....	O = 8·21	,,
100 00	,,	....	100·00	,,

which corresponds to the formulæ : albane $C_{10}H_{16}O$, agreeing with Oudemans' results ; and fluavile $C_{40}H_{64}O_3$, agreeing neither with Oudemans' nor Oesterle's determinations. The composition of the latter resin seems to vary in different kinds of guttapercha.

(*To be continued.*)

ELECTRIC ELEVATORS, WITH SPECIAL REFERENCE TO THEIR STARTING AND STOPPING.*

BY W. C. C. HAWTAYNE.

I suppose the modern elevator as we understand it owes its development to the Americans. A nation that has a weakness for 31-storey buildings certainly ought to show people how to get to the top floor in the easist way. It is just possible, however, that when things have settled down in the Far East, and China has been opened up, we may find that the Chinese knew all about elevators 3,000 years ago. The value of land in the heart of our great cities is, of course, the reason for high buildings, and with high buildings elevators are absolutely necessary. In London, Manchester, Liverpool, and all our great cities the elevator has become a necessity for the business man and the dweller in flats. In London alone there must be over 1,000 in use throughout the day, and allowing 5 h.p. as the average size of the plant required to work them, you see that there is something like 5,000 h.p. in elevator plant to be dealt with. The first electrically-driven elevator to be put to any practical use was, of course, the belt-driven machine. This consists of a winding drum, on which the lifting cable coils or uncoils, and which is rotated in either direction by straight and crossed belts. These belts run on loose pulleys when the car is at rest, and are shifted over to an intermediate tight pulley, when motion is required, by means of shifting or shipping gear operated by a rope passing through the car and controlled by the car attendant. A number of these machines can be seen in our workshops and factories, the countershaft from which they are driven in some cases taking power from the works countershaft, and in some cases from a countershaft driven direct by electric motors or other available power.

When you consider that is only about 15 years since the electric motor was really brought out, and that within a few months it was actually being used for this class of work, you will acknowledge that practical engineers saw at once how eminently suitable the electric motor was for this class of work, and that they lost no time in getting it to work. A number of these machines are still being erected, and though, of course, they differ materially in design from those first constructed, and are greatly superior both as regards safety and efficiency to the pioneer machine, yet the principle underlying them is practically the same. It was, of course, apparent that one of the first things to do was to produce a suitable starting and stopping arrangement for the motor, for all the first machines had motors that ran continuously. It was necessary to insert a resistance in the armature circuit of the motor to guard against a sudden rush of current at starting, and in order to control the cutting in and out of this resistance and to operate the main switch, an independent hand rope was provided, operated from the car or from the various landings. In some cases the armature resistance was cut out by the direct pull of the rope, in others by gravity, the hand rope releasing by means of a cam an arm,

* Paper read before the Northern Society of Electrical Engineers.

which in falling cut out the different sections, the too rapid travel of the arm being impeded by a dash-pot.

By the time we had got thus far, it was of course seen that there was a great future for the electric elevator as a passenger conveyor, but before it could be put to this use a decided advance had to be made—what would do for factory use would not do for passenger service. To begin with, the loss of a few seconds in starting and stopping would be fatal to the usefulness of an elevator in a business office, the jerky motion of starting and stopping by means of a shifting belt would not be tolerated, and the safety devices were crude in the extreme. An elevator motor must be able to work instantly with a fully-loaded car, otherwise no one will be bothered with it. In the early days of motors there were objections made to starting them under load; when they were so started it was considered necessary to transmit their power by means of a belt in order to give elasticity to the system, and one thing that had to be done by the elevator engineer was to obtain a motor with a sufficiently good starting torque, and gear the armature direct to the winding drum, providing fixed brushes, and causing it to rotate in either direction without sparking. With such a machine a single hand rope was all that was necessary to do the work originally performed by two independent ropes, and this, of course, was an advantage not to be lost sight of, as it at once relieved the car attendant of a lot of responsibility and considerably reduced the risk of a mishap.

I will now pass on to describe the modern passenger elevator as it has come under my own observation, and I think it may prove interesting if I describe at length the Otis machine, this being the one I am naturally best acquainted with. I consider two things are absolutely necessary in a well-designed elevator—the passenger's life must be safe, and the motor must be free from any chance of a burn-out or serious injury. I propose, therefore, to show you the precautions the Otis Company have taken to avoid accident. It is difficult for me to say much about this machine without laying myself open to the charge of favouritism, but I am sure those of you who have watched the progress of the elevator industry will be the first to credit them with being the pioneers of the modern electric elevator in this country, and to acknowledge that we owe much to them for the way they have developed it and pushed forward its merits, encountering by so doing not only the opposition of that class of person who pooh-poohs all things electrical, sheltering himself behind that time-honoured phrase that "electricity is still in its infancy," but also the sceptical—I use the word with all good feeling, having been a sceptic myself at one time—opposition of even the electrical engineer. This sounds rather a dreadful statement, but I myself have known one of our most prominent consulting engineers advise his clients to have a hydraulic elevator in preference to an electric, because, he said, "he could never be persuaded that all those gimcrack arrangements were going to work right." Well, let me describe the Otis machine. It consists of a motor, switch-box, and winding drum, mounted on a combination bed-plate. The motor, which is iron clad, runs as a shunt machine, but it provided with a series winding to give a greater starting torque, the series coil being cut out in the manner described further on as soon as the armature has acquired the necessary speed. The field magnets are in two pieces, the lower portion resembling a square dish, with a pole-piece sticking up in the middle, the top of the pole-piece being made concave to give clearance for the armature. The armature winding is on the Eickmeyer principle, each coil being wound separately on a former and built up on the core, so that it is a comparatively simple job to replace an armature coil at any time. In erecting the machine, the lower field coil is first dropped into position over the pole-piece, then the armature is got into position, the top field coil dropped on, and the cover which carries another similar pole-piece is then bolted down, the whole operation of building up or taking apart only occupying a few minutes. The winding drum is bolted to a geared wheel with gunmetal teeth cut mathematically to engage with a worm-wheel, which in its turn is coupled direct to the armature shaft. The worm-wheel runs in a bath of oil, and thrust bearings are provided on the drum end of the worm-shaft and the commutator end of the armature shaft to take up any end play. The coupling between the winding drum and the geared wheel is effected with loose bolts passing through flanged pieces on drum and wheel, thick rubber washers being provided between the flanges to prevent shock at starting and stopping. In some of the larger machines, a double worm-wheel is provided, driving intermeshing gears, and this, of course, does away with the necessity for providing thrust bearings.

Some makers have built machines in which the winding drum is driven by the motor through ordinary gear wheels; the worm driving, however, is obviously better, as with such gear a car cannot easily run away in case of a failure of current, and, besides, the efficiency is very much higher. The coupling between the armature shaft and worm-gear is also used as a brake pulley. The motor is provided with self-oiling bearings and fixed carbon brushes. Insulation abounds; the motor is insulated from the bed-plate, the switch-box from the motor, the shipper bar from the switch-box, and the two halves of the coupling from each other, the brake band engaging with the outer rim of that half of the coupling which is keyed to the worm-shaft. Several methods of operating the car are provided, but the most generally used is a simple hand rope which passes round a shipper sheave on the drum end of the machine; to this is bolted the shipper bar, connected to the main or "snapper" switch in the switch-box, which in this class of machine is bolted down on top of the motor. The shipper shaft also operates a reversing drum in the switch-box for changing the direction of the current in the armature circuit, and a cam, by means of which a weighted lever is set free and allowed to cut out the resistance in the armature circuit. Halfway between the shipper sheave and the switch-gear a lever is attached to the shipper bar to operate the brake band on the coupling referred to above, and the starting and stopping of the car is performed in the following way: On the car attendant pulling the hand rope, the shipper sheave is turned, carrying over the shipper bar. This first lifts the brake band by means of the lever, and turns the reversing drum; then, as the shipper bar travels further, the "snapper" switch is thrown in, and the cutting-out device for the resistance coils is set free. In order to stop the car, the hand rope is pulled in the other direction and the above order practically reversed, only the "snapper" switch breaks the circuit at once, the other motions following. The device for cutting out the armature resistance is simple and effective. The resistance coils are connected to a number of copper segments, insulated from each other by mica, and resembling a section of a commutator. The main current passes round a solenoid, the core of which is connected to a pair of brushes, which ride over the face of this "solenoid commutator," as it is called. The three top segments of the solenoid commutator are connected to three terminals of the series winding, the top segment being also connected to the negative terminal of the machine. When the weighted lever is freed to allow the brushes to rise on the solenoid commutator, the solenoid tries to hold them back; the result is that the brushes rises steadily but rapidly, cutting out all the resistance, and then the series field until the top segment is reached, when the motor is running as an ordinary shunt machine. Now, should the car be overloaded or the motor be slowed in any way, and too much current try to flow in the armature circuit, the solenoid will at once pull back the brushes and insert the resistance in the armature circuit, saving the armature from any chance of injury.

Another device is also used by the Otis Company on some of the larger machines. This is known as the "magnetic dash-pot," and is used in the place of the solenoid when a heavy current is required. It resembles a small series dynamo with a two-pole electromagnet. The armature is similar to the old-type Siemens "H" armature, except that the wire is passed through two holes instead of being wound in slots. The armature has no commutator or brushes, but is connected to the field windings by a flexible conductor. The armature works backwards and forwards through an arc of only 90deg., and is connected to an arm carrying brushes, which pass over a commutator in the same manner as with the solenoid device mentioned above. A dash-pot is provided to prevent too rapid movement of the brushes. In some machines, in addition to the ordinary brake, an auxiliary magnetic safety brake is provided. This is not in action as long as current is on the machine, but if the current is from any cause interrupted, the brake is immediately applied. It would thus be impossible for a heavily-loaded car to run away under any circumstances.

Another form of starting device has been employed by the Otis Company with good results, the machines being styled "field controlled" in opposition to the above described armature-controlled machines. The switch-box is mounted on the wall close to the motor, and is electrically connected with the motor and with a multiple contact switch in the car, operated by the attendant; the hand rope and shipper arrangement are done away with and a magnetic brake employed. The method of operation is as follows: On the car switch being moved either to the right or left, according to the direction the car is to travel in, pilot lamps in the car are brought to a dull red, at the same time current is sent to the magnetic brake and also round the coils of a heavy double solenoid magnet in the switch-box, which pulls up a rocking knife switch (which in rest short-circuits the armature of the machine) and causes it to close the main circuit; the armature resistance is then cut out by a solenoid in the manner already described, and the car attendant can vary the speed by moving the handle of the car switch, and so cutting resistance in or out of the field circuit. When the handle of the car switch is brought back to the normal position, current is of course cut off the switch magnets and the brake magnet, the final break taking place through the circuit of the pilot lamps, which momentarily show bright; a ball weight pulls open the main rocker switch taking current out of the armature and short-circuiting the armature terminals. The weighted lever held up by the brake magnet falls, bringing the brake into operation. With this type of machine, auxiliary knife switches are provided on the drum, by means of which, when the car has

reached the top or bottom of its travel, current for the direction of travel is cut off, and the car can then only go in the reverse direction.

Another type of starting device is that known as the "push button control." In one such system sets of three push buttons are placed on each landing and in the car labelled "up," "stop," and "down." The operation is very simple; on the "up" or "down" button being pressed a small current is sent through a relay, which closes a switch in the circuit of a pilot motor geared to the shipper sheave, and doing all the duties of a hand rope. As soon as this pilot motor has pulled the shipper bar over far enough, it is automatically cut out of circuit. When the car is travelling in one direction, pressing the button for the other direction is of no use till the car has been brought first to rest by means of the "stop" button. If it is not desired to have a car attendant, an automatic stop box, with stops for all floors except the top and bottom floors, is placed in the car and contact-pieces set in the shaft at each floor. Anyone may operate the car, first pressing out the contact for the floor he wishes to stop at, and then the button for motion, and leaving the car to stop when it reaches the desired floor. This is effected by the automatic stop striking the contact-piece in the shaft, which is connected electrically with the pilot motor. At the top and bottom floors contact-pieces are also placed in the shaft, and engage in the same way with a plate on the side of the car, so that anyone forgetting to press out one of the automatic stops or to use the "stop" button cannot come to grief. If a car attendant is employed, the automatic stop box is not required. When the "stop" button is pressed, or one of the floor contacts comes into operation, a relay current closes the circuit of the pilot motor, causing it to rotate till it brings the shipper bar to its normal position, when it is automatically switched off. With such an arrangement as this, it is of course necessary to provide door contacts to prevent the car being operated in the event of anyone leaving open one of the shaft doors. A switch is also provided in connection with the ordinary car safety device to cut off current instantly if the car safeties come into action. Automatic door-locks also are provided, rendering it impossible to open any door except when the car is opposite that door.

The latest system of electric control used by the Otis Company is one in which a small pilot motor is also used, but I regret I am not yet at liberty to describe it fully. It consists of push buttons in connection with a small pilot motor, actuating a series of contacts. There are two forms of this arrangement, in one of which two buttons are used—one for the up motion, the other for the down motion, and the car stops automatically at any required floor. In the second arrangement only a single push is used. No relays are required with either form. In addition to the push buttons, there are also stops in the car corresponding to the various floors. In the one-button arrangement the stop corresponding to the floor required is pressed, and then the main push is pressed, when the car commences to move towards the floor desired, no matter whether it be above or below the car at that moment. A single push button is also placed on each landing, which, when pressed, will call the car to that floor, automatically stopping it when it reaches the landing. Whenever the car is in use the pushes on the various landings are thrown out of action, so that it is impossible to interfere with anyone who may at the time be using the elevator. Automatic door contacts and locks are also used with this arrangement, which is one that is especially suitable to private houses, accidents being practically impossible, and the general arrangement being so simple that a child can use it with impunity.

I think I ought here to describe the various safety devices used on the ordinary Otis machine. In the first place, stops are of course provided on the hand rope, so that if the attendant forgets to pull his rope on reaching the top or bottom of the shaft, the car engages with one of these stops and itself moves the hand rope. A hand rope may, however, break, or a stop become shifted. To guard against this the drum shaft is carried well out at the gear-wheel end, and a solid toothed wheel, gearing with the shipper sheaves, is then keyed on; the remainder of the shaft is threaded and provided with two fixed nuts, both of which are shouldered, and an intermediate travelling nut with a double shoulder, so that as the drum turns in either direction this travelling nut runs on the thread towards one or other of the fixed nuts, and when the car has reached the top or bottom of the shaft, if the hand rope has failed, the travelling nut engages with one of the end nuts, and a train of wheels carries the shipper bar back to its normal position and shuts everything down. The ordinary Otis governor looks after the speed, and the usual safety device takes care of the passengers and car. By these, if the car acquires too great a speed, or if any rope breaks or becomes slack, wedges are driven in between the guide shoes and the guides, and the car is brought to rest. In the electric elevator, however, there is a motor and winding drum to look after as well, and so there is erected close to the winding drum the "slack cable" device, in which a small grooved pulley, free to travel on a shaft, is forced against the car ropes just after they clear the drum by a heavy weighted lever. To this lever is attached a chain, which passes over idler wheels to a toothed clutch on the drum shaft geared to the train of wheels already alluded to, and held by means of the chain just clear of a similar clutch (the teeth of which are cut in the opposite direction) fixed to the drum shaft, and revolving with the drum. Now, if while the car is descending the ropes break or become slack, the weighted lever of the "slack cable" device falls, and so lets the free toothed clutch come in contact with the revolving clutch, which grips it, and carries the shipper gear back to the normal position, shutting down everything. Safety fuses are, of course, provided, but, with all the above precautions, they are more ornamental than useful, and any elevator where the motor is protected by fuses is, in my opinion, an insufferable nuisance, and, perhaps, may become a danger, for sooner or later the exasperated lift attendant will put in a fuse that is intended to last. Modifications of the hand-rope device are also employed by the Otis Company for high-speed elevators—one being a lever device, and the other a wheel device—both of which operate ropes communicating with the shipper sheave, and work the shipping gear in the same way as the hand rope. Tension springs are provided on these ropes at the top or bottom of the shaft to ensure their always being taut.

I have only had an opportunity of seeing one of the machines made by Messrs. Waygood and Co., but I believe they now make some of similar type to the Otis. In the one in question the motor and gear are at the top of the shaft. A two-rope grip sheave is used instead of a winding drum. The car is counterbalanced, and the car ropes pass over the grip sheave direct to the counter-balance weights—an arrangement I do not care so much about as the drum wind. The grip sheave is geared through a worm-shaft coupled direct to the armature of the motor, and the coupling between worm-shaft and armature shaft is also used as the brake pulley. The motor is of the ordinary two-pole kind. The starting and stopping is affected by a hand rope working over a sheave keyed to a shaft connected with the switch-box. Midway on this shaft is a cam, which raises by means of a bar the brake band on the coupling referred to above. In the switch-box is a main switch and a reversing drum operated by the shipper shaft. At the end of this shaft is a small cam holding up a rack and pinion device. When the hand rope is pulled, depressing the cam, the rack falls by gravity, and as the pinion is turned a pair of brushes work round a "resistance commutator," cutting out the coils. I am not aware that there is any means of reinserting the resistance in case of an accident to the lift attendant, or should the hand rope break. Switches are provided at the top and bottom of the lift shaft to cut off current if the lift should overrun, but unless the brake is also applied the momentum of the car or balance weights might well cause an accident, and if the car should stick, and the hand rope should break, the motor might receive far more current than would be good for it. Perhaps in the discussion a fuller description of the machine may be given, but from what I remember of some correspondence that appeared in the *Electrical Review* a year or so ago the above description is practically correct, and I think the arrangement might be considerably improved upon.

The United Ordnance and Engineering Company, better known as Messrs. Easton, Anderson, and Goolden, have recently taken a large number of orders for electric elevators. The principal feature in their machine is the winding mechanism, by which the disadvantages of a many-grooved drum are done away with. The gear may, as in the case of all drum machines, be placed either at the top or bottom of the lift shaft, or even remote from it. It consists of a motor of either multipolar or two-pole type driving a sheave, usually provided with eight grooves, through the medium of a worm-gear. A slightly smaller sheave, having four grooves, is placed either above, below, or to the side of the winding sheave according to circumstances, and has its axle slightly skewed with respect to that of the main sheave. Usually four wire ropes are employed, and they are led from the cage, either direct or over guide pulleys, first round four grooves of the winding sheave, then round the four grooves of the smaller or cross-over sheave, and finally round the remaining four grooves of the winding sheave and away (over guide pulleys if required) to the balance weight. The advantages claimed for this arrangement are: (1) saving in the space occupied by the gearing, the length of the travel of the car not affecting the size of the winding sheaves; (2) any number of ropes may be used to suspend the cage and the balance weight without greatly affecting the size of the apparatus; (3) the ropes always lead off in the same position, and do not require space for lateral travel as when a drum is used; (4) the car and counter-balance weights being all in one, less rope is required than with the ordinary drum. A magnetic brake is used, connected, as usual, in parallel with the shunt circuit of the motor. The control of the armature resistance in the machine used to be, and I believe still is, effected by a centrifugal governor, driven off the armature shaft and cutting resistance in and out as the speed of the armature decreases or increases. I have tried this arrangement on small service elevators, but always found it troublesome. An emergency switch is generally fitted arranged to break the main circuit, and so cause the car to stop

if by any chance its motion should not be arrested at the end of its travel by the usual stop on the hand rope. As the company have the contract for the elevators at the New Brighton tower, which is in the immediate neighbourhood, I hope we may hear something more of their machine in the discussion. I should like, for instance, to know what would happen to the winding ropes and counter-balance weights if the hand rope were to break and the car be brought to a standstill through any hitch occurring.

So much has been written of late about the screw and nut machine of Mr. F. J. Sprague that, although it is a distinct type in itself, I will leave it out of consideration in this paper.

The new Central London Railway some time ago entered into a contract with the Sprague Electric Company for two experimental elevators to be placed in the shaft of their Notting Hill station, and these have been done so well that I believe the firm have now obtained the contract for all the other elevators on the line. These cars are to carry from 12,000lb. to 17,000lb. at full load at a speed of from 150ft. to 180ft. per minute. The general arrangement is on the lines of the Sprague ordinary drum-type machine, and is somewhat similar to that of the Otis Company already described. The motor is iron clad and shunt wound, having its armature coupled direct to a double worm-shaft; the two driven gear wheels do not intermesh, but are bolted to two other gears which do intermesh and turn the winding drum. The starting and stopping is effected by a pilot motor worked from a circular switch in the car; the brake is magnetic, and the car attendant can vary the speed of the car by the operation of the switch. The handle of the switch works against a spring action, so that if the attendant lets go or is

TABLE A.—SUN INSURANCE COMPANY, GLASGOW.

Rise of car, 74ft. 9in. Speed, 170ft. Volts, 220. Car designed to carry 1,000lb.

Load.	Weight.	Time in secs.	Amps.	Cost at 1d. per B.T.U.	Total.	Cost at 5d. per B.T.U.
1 man	149lb.	up 24 down 26	1·5 26·	·0022 ·0446	·04682	·2341
2 men	289lb.	up 25 down 28	4· 19·	·0061 ·0324	·0385	·1925
3 ,,	457lb.	up 26 down 28	7· 15·	·0118 ·0258	·0376	·1[illegible]
4 ,,	597lb.	up 26 down 28	10· 10·	·0157 ·0169	·0326	·1630
5 ,,	757lb.	up 26 down 27	15· 7·	·0231 ·0115	·0346	·1730
6 ,,	911lb.	up 26 down 27	19· 5·	·0302 ·0082	·0384	·19[illegible]
7 ,,	1,051lb.	up 27 down 26	25· 2·	·0413 ·0031	·0444	·2[illegible]
8 ,,	1,225lb.	up 29 down 26	29· 1·	·05 ·0015	·0515	·2575

TABLE B.—TESTS OF OTIS ELECTRIC LIFT AT 12, HILL STREET, W., NOV. 27, 1896.

No. of Test.	1	2	3	4	5	12	7	8	9	14	15	[illegible]
Direction	Up	Down	Up	Down	Up	Down	Up	Down	Up	Down	Up	Down
Load (pounds)	648	648	506	506	336	336	171	171	0	0	336	336
Travel (feet)	36·5	36·5	36·5	36·5	36·5	36·5	36·5	36 5	36·5	36·5	24·75	[illegible]
Time per trip (seconds)	28·0	22·0	25·0	21·0	22·0	23·0	22·0	22·4	22·0	24·0	16·4	[illegible]
Maximum current (amperes)	13·0	11·0	12·0	12 0	11·0	12·0	10·0	11·0	12·0	12·0	12·0	[illegible]
Average ,, ,,	11·5	3·0	8·5	4·0	6·5	6·5	4·25	7·5	2·5	9·5	6·5	[illegible]
Duration of current (seconds)	28·6	23·2	27·2	23 2	25·2	24·0	24·0	24·2	23·4	25·8	17·6	16·4
Energy per trip (watt-hours)	19 8	5·6	15·6	7·08	11·2	9·27	7·8	12·68	5 37	16·35	8·3	[illegible]
Cost per single trip, at 4d. per unit	0·079	0·0025	0·0624	0·0283	0·0448	0·037	0·0312	0 0509	0 0214	0·0655	0·0332	[illegible]
Cost per double trip	0·1015		0·0907		0·0818		0 0821		0·0869		[illegible]	
Average current from meter reading (amperes)	12·2	4·25	10 2	5·4	7·9	6 9	5 75	9·20	4·0	11·2	8·3	[illegible]
Average speed (feet per minute)	78·0	99·5	87·5	104·0	99·5	95·0	99·5	98·0	99·5	91·0	90·0	[illegible]

pushed away from his post, the handle flies back, and the circuit being thus broken the car comes to rest at once. The duty of the pilot motor is to complete the armature circuit, and, by means of a revolving arm passing over faced contact-pieces, to cut out the armature resistance. The car attendant, by moving his switch to contact No. 1, lifts the brake and gives the machine full field; on the second contact he starts the pilot motor, which cuts out the armature resistance till he considers the car has attained the right speed; he then comes back to contact 1, or else moves on to other contacts connected with a resistance in the field circuit of the driving motor. When the handle of the car switch is returned to the normal point, the revolving arm in connection with the armature resistance is returned to its normal position. The machine is provided with a slack cable device, and a switch in connection with this device opens the brake magnet circuit and applies the brake directly anything goes wrong with the ropes.

I had hoped to give a description of the Central London Railway machines, together with some figures showing their efficiency at various loads, but I understand this is to appear shortly from the pen of Mr. Sprague himself. It will, however, give you food for thought when I say that at full load the actual efficiency of the Notting Hill machines from motor terminals to lifting ropes is as high as 70 per cent., and at one-third load 50 per cent. I append results of tests made on two typical Otis machines, one of which was erected nearly four years ago in an office at Glasgow, the other about 18 months ago in a private house in London. (See Tables A and B.)

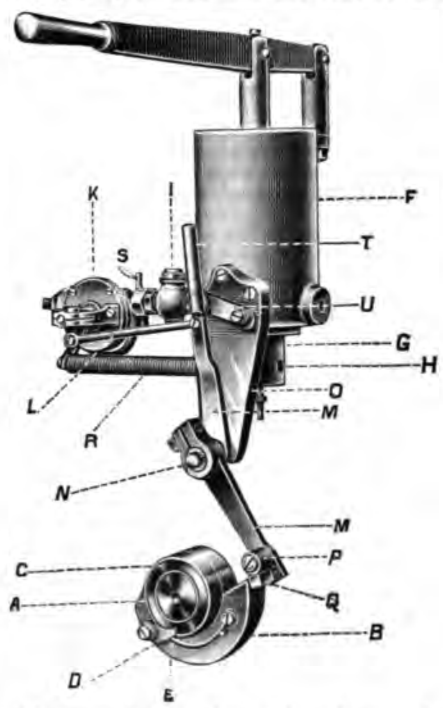
This lift was new, and would, perhaps, give better results after working for some time. It may, however, be taken as a fairly representative example of its kind. The latter tests were made by Mr. H. W. Ravenshaw, and published by him in a paper read before the Institution of Civil Engineers in March, 1897. The tests were made in my presence, and I have been given permission to reproduce them for your benefit.

In conclusion, gentlemen, I would draw your attention to the tremendous strides that are being made in the elevator business. I have seen it boldly stated, and I have no doubt it is true, that in the States more people are carried vertically in elevators than horizontally by street cars. When the electric elevator was introduced here makers of hydraulic lifts went about trying to prove how expensive they were to buy and to maintain, but most of them have since been converted, and now that they have mastered the principles of the machinery, and have seen the immense advantages to be obtained by the use of electric power, they have started into the field themselves. Some of the machines produced are very good, some are marvels of how not to do it. I was called to one a few weeks ago in London—it was a case where the lowest tender was accepted—which absolutely had not a good point about it, and on which I refused to travel. A specification had been prepared by the manufacturers duly setting forth that the machine was equal to any of the more expensive machines, and would be provided with switches and all the latest improvements, including resistance in the armature circuit to be cut out as the machine acquired speed. The consulting engineer was satisfied and the contract made. The resistance in the armature circuit turned out to be a hand arrangement, and the motor now has to run continuously, being thrown on by a wonderful friction gear; it is only brought into use on the "up" motion, and the car drops by gravity on the "down" motion, acquiring speed at such a pace that the shock of stopping nearly throws the passengers off their legs, and brings in the safety device nearly every time. You can hear the noise of the gear wheels (not worm gearing) out in the street, and the whole construction of the machine is bad. A great deal of experience and thought is required to design a first-class elevator, and I hope many of you will take the subject up. At present there is no alternate-current motor that I know of that can be used in this connection. This is an enormous drawback, for many of our largest towns are supplied, as you know, on the alternating system, and I have personal knowledge that many orders could be obtained for electric elevators in these places if the machinery was forthcoming. Perhaps during the discussion someone may be able to show us how to do it. I had hoped to give you more data with regard to loads and efficiencies, but manufacturers are still averse to letting others know too much, and so I have only been able to give you

generalities. Data that I have been promised has not yet come to hand. When it does I may find a means of communicating it to you, if the subject is of sufficient interest.

STARTER FOR GAS-ENGINES.

We illustrate herewith Edmondson and Dawson's starter, for which great advantages are claimed because of the three following features: (1) The initial impulse, being delivered on a piston already set in motion (by the compression of the charge by the pump), is cumulative in its effect. In other words, the primary inertia of the piston having already been overcome, the influence of the initial explosion upon it is much greater than it otherwise would be. (2) The initial charge being compressed by the pump, the initial explosion is proportionately more powerful than in any starter working at atmospheric pressure. Owing to these two features, the initial impulse carries the running well over the first cycle, and the piston is moving steadily when it receives the second impulse. (3) At the slow speed of starting by any self-starter the proportions of gas and air in the charge drawn into the cylinder is frequently not ignitable by the tube, hence the extreme difficulty of starting an engine by a single initial impulse. In the Edmondson-Dawson starter this difficulty is entirely removed. It injects a flame into the midst of the charge, and will therefore ignite a mixture so badly proportioned that the tube would fail to fire.



Hence, by this starter ignition is certain and successive impulses are given to the piston—the engine runs in spite of the temporary failure of the tube to fire the charge—and thus the speed is gradually but surely got up to a point at which the tube takes up the firing and the starter may be put out of gear. It will be seen therefore that this starter has the same effect as a small auxiliary engine, but with much less space, complication, and cost.

The action is explained as follows: The engine being set on the "explosion stroke" with the gas-cock turned on, and with the crank a little behind the top centre, the starting cam, B, having the square stud, Q, resting on its nose, the exhaust valve of the engine being set open, a charge of explosive mixture (gas and air) is pumped into the cylinder by the pump, F. When the cylinder is filled with explosive mixture, the exhaust valve is closed. The pumping being continued, the charge is slightly compressed till it propels the piston slowly and moves the cam, B, forward (clockwise) till it drops the roller, P, into the gap of the cam and releases the lever, M, the spring, R, rotating the plug of the ignition valve towards the right, ignites the charge in the cylinder and propels the engine. If the pumping be still continued so as to keep the connections between the pump and the cylinder full of explosive mixture, the revolution of the cam, B, by opening and closing the ignition valve and exploding the charge at the proper times, will give successive impulses to the piston, increasing its speed until the ordinary igniting apparatus takes up the firing and the engine is effectually started. The starter is then thrown out of gear by pushing the handle, T, of the lever, M, to the left, when the catch, U, falls down and holds the lever, so that the roller, P, stands free of the cam, B, and the action of the starter ceases.

DEWSBURY ELECTRICITY WORKS.

The accounts of the Dewsbury Corporation municipal electric supply station up to March 31, 1898, have just come to hand. We give below the revenue account and general balance-sheet:

REVENUE ACCOUNT.

Dr. Generation of Electricity.		£ s. d.
Coal, including cartage	£332 6 7	
Oil, waste, water, and engine-room stores	125 19 4	
Wages at generating station	362 4 7	
Repairs and Maintenance.		
Buildings	4 15 0	
Engines, boilers, etc.	68 1 8	
Other machinery	3 16 0	
Maintenance of battery	48 9 5	
Maintenance of dynamos	5 14 0	
Sundries	0 10 6	
		951 17 1
Distribution of Electricity.		
Wages—mains	15 11 0	
Wages—meter inspecting	6 18 6	
Repairs	0 10 5	
Meter repairs, etc.	20 16 4	
		43 16 3
Public Lamps.		
Attending and repairs	22 12 4	
Renewal of lamps	3 4 5	
	25 16 9	
Less amount refunded	20 0 3	
		5 16 6
Rent, rates, etc.		92 19 7
Management Expenses.		
J. B. Mitchell, manager	200 0 0	
Clerks at lighting station	75 8 6	
Stationery and printing	41 7 1	
General establishment charges	52 7 7	
Expenses of deputations	5 3 6	
Rent of telephone	10 13 5	
Proportion of town hall joint expenditure	306 5 5	
Stamps on bonds	0 10 6	
		691 16 0
Special charges—insurance		18 14 6
Diamond Jubilee illuminations		79 15 9
Balance carried to net revenue account		931 14 9
		£2,816 10 5

Cr.		£ s. d.
Sale of current to consumers		2,852 17 4
Less estimated discounts	£87 7 9	
Add leakage under-estimated, December, 1896	3 5 9	
Add library account written off	67 10 0	
	158 3 6	
Less leakage over-estimated, June, 1897	3 17 8	
		154 5 10
		2,698 11 6
Meter rents, etc., £84. 6s. 10d.; less irrecoverable, 9s. 8d.		83 17 2
Generation of electricity—lamps, £18 17s. 1d.; old iron, £1. 17s. 6d.; weighing-machine proceeds, £2. 1s. 8d.; use of room for elections £8. 8s.; incidentals, 14s.		31 18 3
Management—incidentals		2 3 6
		£2,816 10 5

BALANCE-SHEET.

Liabilities.		£ s. d.
Loan account		24,280 19 6
Sundry creditors		681 14 10
Balance due to treasurer		1,387 18 1
		26,350 12 5
To surplus—		
Sinking fund accumulated	£2,322 18 7	
Stores	73 5 10	
	2,396 4 5	
Less deficiency on net revenue account	625 3 7	
		1,771 0 9
		£28,121 13 2

Assets.	£ s. d.
Works and extensions	25,302 9 11
Sinking fund investment account	1,722 18 7
Stores in hand	73 5 10
Sundry debtors	923 1 8
Electricity supply rents owing	94 17 2
In hands of manager	5 0 0
	£28,121 13 2

PORTSMOUTH ELECTRICITY WORKS.

The electric lighting accounts of the borough of Portsmouth have just been issued, from which it appears that the amount borrowed has been £119,651, and the total expenditure up to March 31 last £112,174. 7s. 10d. We give below the revenue account, balance-sheet, and statement of electricity generated, sold, etc.:

REVENUE ACCOUNT.

Dr. Generation of Electricity.	£ s. d.	£ s. d.
Coal, or other fuel, including dues, carriage, unloading, storing, and all expense of placing the same on the works	£2,621 12 7	
Oil, waste, water, and engine-room stores	999 18 4	
Wages at generating station	969 8 11	
Repairs and maintenance as follows: Buildings	51 13 5	
Engines, boilers, dynamos, exciters, transformers, motors, etc.; other machinery, instruments, and tools, accumulators and accessories	671 7 9	
	5,314 1 0	
Less received for old material	4 10 7	
		5,309 10 5
Distribution of Electricity.		
Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same	213 7 2	
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises	599 10 4	
Cost of materials and lamps sold, as *per contra*	193 18 1	
		1,006 15 7
Public Lamps.		
Attending and repairs, including materials supplied	1,389 9 6	
Renewal of lamps	64 13 0	
		1,454 2 6
Rents, Rates, and Taxes.		
Rents payable	18 7 6	
Rates and taxes	378 14 6	
		397 2 0
Management Expenses.		
Salaries—viz.: Engineer's department	728 19 8	
Accountant and clerical staff	144 12 4	
Salary of collector	91 14 3	
Stationery and printing	44 6 5	
General establishment charges	168 6 3	
		1,177 18 11
Law and Parliamentary Charges.		
Law expenses		11 15 4
Special Charges.		
Interest on overdraft		112 9 0
Total expenditure		9,469 13 9
Amount carried to net revenue account		6,750 0 0
Balance to next account to provide for bad debts		45 9 3
		£16 265 3 0

Cr.	£ s. d.
Balance from last account, £46. 19s. 11d.; less bad debts written off, £20. 1s. 10d.	26 18 1
Sale of current at 4½d. per B.T.U., £10,857. 1s.; less allowances, £25. 4s. 9d.	10,833 16 3
Sale under contract	144 3 1
Public lighting	4,645 19 2
Rental of meters and other apparatus on consumers' premises	381 15 1
Sale and repairs of lamps, arc or incandescent	151 0 2
Sale and repairs of other apparatus	58 3 7
Rents receivable	4 0 0
Fees for testing meters, 16s. 7d.; part fees from pupils, £14. 18s. 6d.; charging accumulators, £3. 12s. 6d.	19 7 7
	£16,265 3 0

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£ s. d.
Capital account—amount received	119,651 0 0
Sundry creditors	1,378 12 4
Amount due to treasurer on revenue account	4,296 19 2
Revenue account, balance at credit thereof	45 9 3
Net revenue account, balance at credit thereof	383 12 7
	£125,755 13 4

Cr. Assets.	£ s. d.
Capital account—amount expended for works	112,174 7 10
Stores on hand at March 31, 1898: coal, £38. 16s. 10d.; oil, waste, etc., £103. 18s. 5d.; general, £298. 17s. 5d.; lamps, £80. 5s. 4d. Motors—stock, April 1, 1897, £69. 3s. 10d.; less 10 per cent. depreciation, £6. 18s. 4d.; added during year, £235. 0s. 10d.—£297. 6s. 4d.	819 4 4
Sundry debtors for current supplied to March 31, 1898	5,254 6 0
Other debtors	31 3 0
Balance in hands of treasurer on capital account	7,476 12 2
	£125,755 13 4

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		1,216,560
Quantity sold: Public lamps	389,959	
By contract	2,525	981,273
Private consumers by meter	588,789	
Quantity used on works		41,298
Quantity used for magnetising current		141,480
Total quantity accounted for		1,164,051
Quantity not accounted for		52,509
Number of public lamps		257
Total maximum supply demanded (kilowatts)		849

PHYSICAL SOCIETY.

An ordinary meeting of this society was held on May 27, Mr. Shelford Bidwell, president, in the chair.

A paper by **Messrs. Edwin Edser** and **C. P. Butler** on "**A Simple Method of Reducing Prismatic Spectra**" was read by Mr. Edser. The production of interference bands in a continuous spectrum is capable of furnishing a reference spectrum which can be employed to determine the wave-lengths corresponding to the bright lines in a spectrum of a metal or of a gas. The authors discuss various methods by which such bands can be formed. In their final experiments an air film between two plane parallel glass plates is inserted in front of the slit of the spectrometer in the path of the incident light. Owing to the interference of the direct ray with that twice internally reflected, bright bands separated by dark intervals are observed in the spectrum. These bright bands correspond to a series of different waves, whose lengths are easily determined for the whole series when two of them are known. The bands are much improved by partial silvering of the two internal surfaces of the glass. It has been found that ordinary plate glass, if well chosen, is good enough for all these experiments. In order to adjust for parallelism, a spot of light, or the filament of an incandescent lamp, is viewed through the silvered surfaces. A long train of images is generally visible; these must be brought into coincidence. If, now, a sodium flame is looked at through the film, interference bands are seen. These bands must be adjusted by pressure, to be as broad as possible. An arc lamp is used for illuminating the collimator slit. The authors exhibited the apparatus, and showed photographs of spectra scales with the appropriate wave-lengths calibrated upon them by this method. The results obtained were read from the spectrometer to 0·4 of a tenth-metre, with an ordinary pocket lens. A simple graphic method enables wave-lengths, corresponding to a great number of spectral lines, easily to be determined by inspection. The phase changes introduced by the silver do not affect the final result.

Prof. Threlfall congratulated the authors on their discovery of a method that would greatly reduce the labour of calibrating spectra, and at the same time give such accurate results.

Prof. Boys said the simplicity of the apparatus added greatly to the value of the method. It would seem to him better if the slit were somehow contrived within the film space. All want of definition due to rays falling at different angles upon the collimator object glass would thus be avoided, and only a small part of the glass plates—*i.e.*, the slit—would require to be strictly parallel planes. The limit of accuracy in the author's method depended upon the collimator, not upon the optical perfection of the silvering of the plates.

Mr. Butler pointed out that previous methods had always required experienced spectroscopists for mapping out results. In the new method, that work could easily be done by an assistant.

Mr. Edser said that by putting the two plates immediately in front of the slit only a very small part of the glass is concerned in the action. Light coming through at an angle would not reach the lens in the collimator.

Prof. Boys, vice-president, then took the chair, and **Mr. Campbell Swinton** read a paper on "**Some Further Experiments on the Circulation of the Residual Gaseous Matter in Crookes Tubes.**" In the discussion that followed the former paper on this subject at the Physical Society on March 25, 1898, Mr. Appleyard had suggested that in tracing the cause of the rotation of the exploring mill it would lead to simpler results if the vanes were made of some light conducting substance, for it was probable that mica introduced complications by retaining the charges. Prof. Boys then pointed out that the mica might be gilded. Such a tube has now been made by Mr. Wolff. With the gilded mica vanes so placed as to be outside the cathode stream the mill behaves in a manner similar to the non-conducting insulated mill. It shows a greater tendency to assume a position of stability due to electrostatic induction. This renders it somewhat troublesome in

starting, but when once under way the mill rotates always when excited. Occasionally, when starting, a few reverse revolutions are observed; these are probably due to electrostatic influence and momentum, and also possibly to eddy currents in the residual gaseous matter. But it is found in all cases that rotation in the direction that indicates a stream of residual gaseous matter from anode to cathode follows the reversal immediately after one or two oscillations. An electrometer connected to the mill through the pivot and needle point shows the vanes to be always electrified positively. The results are confirmed by a second tube with oblique vanes. The author concludes that at very high exhaustions there exists a molecular or atomic stream from anode to cathode, which carries a positive charge and travels at high velocity outside the opposite cathode stream.

Mr. J. Quick asked what was the minimum degree of exhaustion required to produce these results.

Prof. Boys said that the experiments gave some amount of probability to the truth of Mr. Campbell Swinton's hypothesis, but it did not altogether prove the mechanical theory of rotation to be correct. He was glad that the chance suggestion at the last discussion had led to such interesting experiments being continued.

Prof. Threlfall mentioned that Boettger had devised a method for gilding mica, by a chemical process, that was much to be preferred to ordinary gilding.

Mr. Campbell Swinton said it was necessary to exhaust the tubes as completely as possible—to a point where it was only just possible for any discharge at all to pass through them. If the rotation was due to electrification, there must still be some mechanical process whereby the charges get to the vanes—a stream of residual gas satisfied that condition.

The **Vice-President** proposed votes of thanks, and the meeting adjourned until 10th inst.

COMPANIES' MEETINGS AND REPORTS.

WEST AFRICAN TELEGRAPH COMPANY, LIMITED.

The thirteenth ordinary general meeting of this Company was held last Friday at Winchester House, Old Broad-street, the Marquis of Tweeddale presiding.

The **Chairman**, in moving the adoption of the report, stated that the gross revenue for the past year to Dec. 31 last amounted to £64,723, showing a decrease as compared with that of 1896 of £6,266. This was to be accounted for by a falling off in the Cape joint-purse traffic, amounting to £1,693, and to an increase on the loss on exchange of no less than £2,699. This loss, which had reached the enormous sum of £11,602, it was impossible to foresee at the time, and he could only express the hope that they might have seen the worst of it. Another reason for the decline in the gross revenue was the increase under the head of rent of cables, amounting to £1,874. This item was explained by the interruption of the cable between Bathurst and St. Vincent, which occurred simultaneously with an interruption of their communications by the East Coast, compelling them to divert their traffic on to lines not belonging to the Company, for which, of course, they had to pay rent. The total working expenses for 1897 amounted to £21,212, or an increase of £3,314. The principal items were to be found under the head of salaries and wages, travelling expenses, etc., all of which were affected by augmentation in the number of their staff, in connection with the introduction of the duplex working. They were partners in a joint-purse arrangement, by which they received a percentage of the Cape traffic carried by either route on the understanding that they maintained their cables in a state of thorough efficiency, so as to enable them to carry the whole of the East Coast traffic while that communication was interrupted. Under the head of endowment assurance fund there was an increase of £249. This was in consequence of the salaries and allowances having been brought into line with those of the associated companies, which had all now adopted the endowment assurance fund system. The expenses attending repairs and renewals of cables had amounted to £18,780, showing a decline of £1,915; but although there was this decrease, these expenses were still abnormally high. This was due to the unforeseen difficulties which they had experienced in the seas and the coast along which their cables were laid, and more especially in connection with the Congo River, which was crossed by their cable, and which had been a source of infinite trouble and expense to the Company. The French Government continued to withhold their annual subsidy of £12,000, the arrears of which now amounted to £32,415. The action of the French Government in this matter was due to a difference of opinion in respect to certain clauses of the concession. Being extremely desirous of settling the matter in dispute and of maintaining friendly relations with the French Government, they some time ago submitted a proposal to that Government for settling these differences. It was conceived in a very liberal spirit, having regard to the interests of the debenture-holders and shareholders, and they had reason to believe that it was acceptable to the Government although it had not yet received the confirmation of the Chamber. This, however, was very probably accounted for by the recent election. They proposed to renew negotiations as soon as matters settled down in connection with the new Government, and they hoped before long to come to an arrangement which would be satisfactory to all parties.

Sir Henry C. Mance seconded the resolution, which was carried unanimously.

SOUTH STAFFORDSHIRE TRAMWAYS COMPANY.

The eighth ordinary general meeting of this Company was held yesterday at Cannon-street Hotel, E.C., Mr. W. Somers L. Schuster presiding.

The **Chairman**, in his speech, said he was glad to have to present to them such a favourable report, the best they had ever had. The total expenditure for the year amounted to £29,378, the balance carried to revenue account being £4,489. In accordance with an agreement with the British Electric Traction Company, Limited, the old debentures had been paid off and a new issue of debentures amounting to £60,000 had been made. The uncertainty of the renewals for working by steam had prejudicially affected the working of the trams, especially regarding the coke contracts and advertisements.

The report was adopted.

The auditors' report concerning the electric portion of the lines was very satisfactory, no serious failures having occurred. The traffic receipts increased from 11·63d. in 1896 to 12·26 in 1897. An improvement is also shown on the Darlaston and Mellish-road section.

After some remarks by **Messrs. Dawson** and **Roff**, the meeting concluded.

HARROW ELECTRIC LIGHT COMPANY.

The second annual meeting of the Harrow Electric Light and Power Company was held at the offices adjoining the station at West-street, Harrow, last week, Mr. C. Colbeck (chairman of directors) presiding.

The annual report, which was adopted, and for which we are indebted to the *Harrow Gazette*, was as follows: "During the year 1897 the equivalent of 1,540 8 c.p. lamps have been connected to the Company's mains, making a total at the end of the year of 5,440 with 87 customers, as against 3,900 lamps, and 39 customers at the end of 1896. To provide for these and for a large number that were coming on, the directors found it necessary to practically double the station and provide further machinery and plant. The station is now capable of dealing with the equivalent of 9,000 8-c.p. lamps, including an ample reserve plant, and there is room for more steam dynamos and boilers sufficient, when occasion requires it, to bring the capacity up to 16,000 8-c.p. lamps or to 21,000 lamps if additional boiler room is provided. The shareholders will have seen that during the year the mains have been extended in various directions—viz., down Station-road to St. John's-road, and up that road and round Gayton-road, along St. Anne's-road to the laundry there; down the Roxborough-park to the Metropolitan Railway bridge at Pinner-road, along Mount-park-avenue and Mount-park-road, and down Sudbury-hill to the new convent at Sudbury-grove. It has been the policy of the directors to extend where a reasonable percentage on the outlay could be obtained, and while all the extensions are already paying, some of them are earning much more than was originally anticipated. The total cost of these extensions has been some £4,000 Consumers have freely availed themselves of the privilege afforded them of having their houses wired for them at installation rents, and out of the 87 customers 43 have had their houses wired in this way. The total consumption of current in 1897 amounted to 50,109 Board of Trade units This produced, with meter and installation rents, £1,730. 3s. 3d., and the amount would have been considerably more had the Company had the benefit of some large installations for which extensions were made, but in respect of which the benefit will not be derived until the year 1898. The directors think that the time has now come when the Company may with advantage work the station themselves, and they have accordingly given notice to terminate the present arrangement on June 30 next. The balance to credit of revenue account was £513. 12s. 1d., or, with the £29. 1s. 9d. carried forward from 1896, £542. 13s. 10d. After deducting interest on debentures, mortgages, and loans, there remains a sum of £204. 1s. 10d., and this the directors propose to expend by carrying a further £25 to depreciation of leaseholds account, £8. 11s. 1d. to further writing off the cost of the working contract, and £169. 2s. towards writing off preliminary expenses in accordance with the desire of the Board of Trade auditor, carrying forward the small balance of £1. 8s. 9d. The directors have only received £10 each on account of directors' fees, and they propose to let the remainder of the remuneration voted to them by the shareholders stand over till 1898. It has been necessary in connection with the extension of the station and the mains to obtain further capital, and shares have been issued up to £20,000, of which some £2,000 are available for subscription. All the debenture-holders have, in view of the increased value of their security, agreed to the issue of debentures originally fixed at £7,500 being increased to £10,000, and the present debenture-holders and shareholders are invited to subscribe for the additional £2,500 debentures and the shares. The directors have from the first been anxious to reduce the price of current at the earliest possible opportunity, and would have done so after midsummer last, had the average amount earned per lamp in the Christmas quarter of 1896, on which the directors' last report was based, been maintained. Calculating the earnings on the rate now shown to be the average, they think they could make a considerable reduction as soon as the equivalent of 7,500 8-c.p. lamps are installed or applied for. They do not think there will be long to wait, as since the end of 1897 24 new customers have been connected or have applied for current, with a total equivalent to some 800 8-c.p. lamps, or at the rate of 44 lamps per week, the current consumed during the Lady Day quarter recently completed being 20,382 units, as

against 12,791 in the corresponding quarter in 1897. The directors think that the reduction in the price of current will be best effected by the system known as that of the maximum and minimum charge which is being widely introduced, and which has worked so successfully in Brighton and elsewhere. The directors intend to circulate a statement among consumers pointing out the advantages of the system. Messrs. Colbeck and Bartlev Denniss retire from the Board by rotation, and being eligible offer themselves for re-election. Messrs. Jackson, Pixley, Browning, Husey, and Co., the Company's auditors, also offer themselves for re-election."

Mr. Colbeck and Mr. Bartley Denniss were re-elected directors, and Messrs. Jackson, Pixley, Browning, Husey, and Co., of 58, Coleman-street, were reappointed auditors.

REUTER'S TELEGRAM COMPANY, LIMITED.

The ordinary general meeting of the Reuter's Telegram Company, Limited, was held on the 25th ult. at the offices in Old Jewry, Admiral Sir J. C. D. Hay presiding.

The **Chairman**, in moving the adoption of the report, stated that the profits for the last year were £10,687, as against £9 708 in 1896. A sum of £5 277 has been placed to the reserve, bringing it up to £26,000, of which £13,000 was invested in their building. The war between Spain and the United States had involved heavy expense, but they had recouped themselves by increased subscriptions from newspapers.

The report was adopted.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.

The report for the half-year ended Dec. 31, 1897, states that the revenue for this period amounted to £100,300, and the working expenses to £26,166. After providing £3 200 for debenture interest and sinking fund, and £1,353 for income tax, there remains a balance of £69,580; to this is added the sum of £7,221 brought forward from June 30 last, making a total of £76,801. In commemoration of her Majesty's Jubilee, and of the twenty-fifth anniversary of the foundation of the Company, a bonus has been granted to the staff amounting to £4,139. First and second interim dividends, amounting to £39,000, have been paid, and £25,000 transferred to the reserve fund, leaving the sum of £8,662 to be carried to the next account. Negotiations for closer working with the Western and Brazilian Telegraph Company, Limited, have been in progress, and an agreement will shortly be submitted to the shareholders.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Hammersmith.—The Vestry invite tenders for the supply and erection of additional electrical plant. Tenders by June 8.

Bury St. Edmunds.—The Town Council invite tenders for the supply and erection of electrical plant. Tenders by June 13.

Bray.—The Commissioners invite tenders for the supply of the materials required at their electricity works for the ensuing year. Tenders by June 6.

Hertford.—The Corporation invite offers for a lease of their electric lighting order. Particulars may be obtained of Mr. T. J. Sworder, town clerk.

Edinburgh.—The Council invite tenders for the wiring of the police chambers (about 400 lamps). Tenders by 14th inst. For particulars see advertisement columns.

Tynemouth.—The Corporation of Tynemouth are prepared to receive tenders for steam dynamos, balancer, and booster, etc. Tenders by 20th inst. For particulars see advertisement columns.

St. Pancras.—The Vestry invite tenders for condensing plant, steam-pipes, etc., for the Regent's Park generating station, 47, Stanhope-street, N.W. Tenders by 14th inst. For particulars see advertisement columns.

Brussels.—The Provincial Government will let by public tender on the 10th inst., at 10.30 a.m., the contract for an electric installation at the Royal Library, Brussels. The estimate is 13,906·29fr., and the deposit required is 1,400fr.

Salford.—The Electric Light Committee of the county borough invite tenders for accumulators; motor-generators, balancing machinery, and boosters; switchboards; cables; alternating current transformers. Tenders by June 6.

Southampton.—The Corporation invite tenders for the supply and erection of cast-iron and wrought-steel lamp columns, arc and incandescent lamps, automatic switches, and fittings, for particulars of which refer to our advertisement columns. Tenders by 20th inst.

Madras.—The Secretary of State for India in Council announces that the time allowed for the receipt of tenders by the Chief Engineer for Irrigation, Madras, for the utilisation of water power of the Periyar Lake has been extended from Oct. 31, 1897, to July 1, 1898.

Watford.—The Council invite tenders for the erection of an electric light station adjoining the new sewage works at Watford. Specifications, etc., may be obtained from the architects, Messrs. Gordon, Lowther, and Gunton, Finsbury House, Blomfield-street, E.C. Tenders by June 8.

Bournemouth.—The Corporation invite tenders for cables, arc lamps, incandescent lamps, wiring, switchboards, fittings; steam dynamo, etc. Specification, etc., can be obtained of the borough engineer, Mr. F. W. Lacey, M.I.C.E., provided £1. 1s. has been previously deposited at his office. Tenders by June 20.

Glasgow.—The Corporation invite tenders for (1) the supply of electrical meters for a period of 12 months from date of acceptance of offer, and (2) providing and erecting condensing plant at their new generating station, Port Dundas, for particulars of which refer to our advertisement columns. Tenders by 18th inst.

Grado (Province of Orviedo, Spain).—A public adjudication of tenders will take place on June 5, at 12 p.m., for a (public) electric lighting installation. The deposit required is 2,000 pesetas. The installation to comprise 65 incandescent lamps of 16 c.p., two of 10 c.p., and two arc lamps of 1,500 c.p. The contract will be for 30 years.

Cape Colony.—The Town Council of East London, Cape Colony, is prepared to receive tenders for the erection of buildings and the supply of electric lighting machinery, electric tramcars, plant, rails, etc., and for their maintenance for six months from completion. Full particulars will be found in our advertisement columns. Tenders by June 28.

Belfast.—The Harbour Commissioners invite tenders for the supply of three belt-driven, continuous-current, series-wound dynamos, capable of giving 15 amperes, 2,850 volts, at a speed of not exceeding 800 revolutions per minute for 18 hours' continuous running, without undue heating. Specifications, etc., may be obtained from the harbour engineer, Mr. G. F. L. Giles. Tenders by June 6.

London, S.W.—The London County Council invite tenders for supply of engines, dynamos, accumulators, switchboards, the feeders, distributors, and service mains, and all accessories, to be fixed complete in buildings at the Crossness outfall works, near Erith, Kent. Specifications, etc., may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W., upon payment of £1, to be returned to bona fide tenderers. Tenders by June 21.

Kingston-on-Thames.—The Committee of the Kingston-on-Thames Workmen's Club and Institute invite tenders for the fitting-up of an installation for electric light at their club premises, Fairfield-road, Kingston-on-Thames. Specifications, etc., can be obtained at the office of the Consulting Engineer, Electric Light Works, Down Hall-road, Kingston, between 10 a.m. and 5 p.m., on deposit of £1, which will be returned on receipt of a bona fide tender. Tenders by June 6.

London, S.E.—The Electric Lighting Committee of the Vestry of St. Mary, Newington, invite tenders for the supply and erection of engines, generators, and public lighting plant for the Vestry's electric lighting station in Penrose-street, Walworth. Specifications, etc., can be obtained at the offices of the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of a fee of £5. 5s., which sum will be returned on the receipt of a bona fide tender. Tenders by June 6.

Taunton.—The Corporation invite tenders for the supply and erection of (Section A) certain engines and alternator, exchange of existing alternators, and exchange of transformers; (B) rectifiers and alterations and additions to high-tension switchboard. Specifications, etc., to be obtained at the Municipal Buildings, Taunton, or at the offices of the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of a fee of £3. 3s., which sum will be returned on receipt of a bona fide tender. Tenders by June 6.

London, S.W.—The London County Council invite tenders for providing and fixing cables, wires conductors, casing, pendants, brackets, watertight and other fittings, columns, lanterns, lamps, switches and switchboards, distributing boards, fuses, cut-outs, etc., which may be necessary for the lighting by electricity of the Crossness pumping station and works near Erith, Kent. Specifications, etc., may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W., upon payment of £1, which will be returned to bona fide tenderers. Tenders by June 21.

Coventry.—The Electric Lighting Committee invite tenders for the electric mains, switchboards, arc lamps, posts, and apparatus: (Section A) high-tension feeders on a solid system, and low-tension armoured distributors, laid and jointed complete (indiarubber-covered cables will not be considered); (B) supply and erection of switch-gear, etc., in sub-stations; (C) public arc lighting (about 40 alternating arc lamps, posts, transformers, etc.); the whole bound up in one specification. Tenderers are at liberty to tender for the whole or for either section separately. Specification, etc., may be obtained from Mr. Gilbert S. Ram, city electrical engineer, Coventry. Tenders by June 7.

Victoria (Australia).—Tenders are invited by the Council of the city of Hawthorn for the supply and erection, or for the supply only, of: (Section A) buildings only; (B) boilers, water-heater, pumps; (C) engines, dynamos, switchboard, mains, sub-mains, transformers, meters, arc lamps, insulators, testing instruments; (D) supply of poles and their erection; running of the plant for three years. Specifications and forms of tender can be obtained at the office of the Agent-General for Victoria, Lieut.-General Sir Andrew Clarke, G.C.C.M., Victoria Office, 15, Victoria-street, Westminster, London, S.W., on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Tender for Electric Lighting," and addressed to the Mayor of Hawthorn, Victoria, Australia, on June 24, at 5 p.m.

RESULTS OF TENDERS.

st.—The Harbour Commissioners have accepted the tender I. Allen, Son, and Co., Queen's Engineering Works, Bed- or the supply and erection in the electric light station, rn Basin, Belfast, of three compound, two-crank, self- ting, single-valve, quick-revolution vertical engines, each of developing 70 h.p., with a steam pressure of 130lb. per inch.

BUSINESS NOTES.

ern and Brazilian Submarine Telegraph Company.— ffic receipts for the past week were £3,077.

a.—The members of the Electric Lighting Committee paid of inspection to Dewsbury and Bradford on Friday last.

don.—The additional loan of £10,700 for electricity works ons has been sanctioned by the Local Government Board.

e.—The Town Council have resolved to retain Prof. J. son's services for preparing a scheme of electric lighting we.

ridge Wells.—We understand that the year's electric accounts will show a surplus up to March 31 of close 2,400.

t.—The Local Government Board electric lighting pro- order relating to Ossett was confirmed last week in the of Commons.

.—At the last meeting of the Town Council the Mayor, an Marvin, J.P., promised that the question of the electric ould not be lost sight of.

lebone.—The Board of Trade have issued a provisional npowering the Vestry to supply electricity for public and purposes in their district.

.—The Town Council have adopted the electric lighting of Mr. J. Foster, and have decided to apply to the Local nent Board for £10,000 for the purpose.

ondsey.—The Board of Trade have issued a provisional the Vestry empowering them to supply electricity for all and private purposes throughout the whole area of their

leen.—At a meeting of the Gas Committee of the Town on the 27th ult., the resignation was intimated of Mr. n, the electrical engineer, who has accepted an appoint- London under the Poplar Board of Works.

of Engines and Boiler.—We beg to draw attention to a Messrs. W. A. Massey and Co., shipowners, Hull, of adapted for electric lighting installations, for particulars we refer readers to our advertisement columns.

m.—A Local Government Board enquiry has been held by eneral H. Darley Crozier, R.E., into the Town Council's ion for sanction to borrow £30,000 for purposes of electric , and £6,670 for purposes of a refuse destructor.

head.—The Parliamentary and By-Laws Committee is to ds with a view of affording members of the Corporation tunity of gaining fuller knowledge on the subject of the of tramways by the overhead electric system and to the system which is in force there.

Copper Company, Limited.—The directors have declared m dividend of 3s. per share on the cumulative preference nary shares, free of income tax, payable on July 1. The books will be closed on June 4, the dividends being to shareholders registered on that date.

pool.—The Local Government Board enquiry referred to st issue was held on the 31st ult. The inspector was Mr. Willcocks, M.I.C.E., and the application was for the g of £40.000 for purposes of electric lighting. The Lighting Committee is recommending an advance of £100 gineer's salary.

pool.—At the usual meeting of the Lighting Committee it ded to extend the electric mains at a cost of £691. Pre- to the satisfactory commencement of a service of electric , the Health Committee of the City Council have deter- nally to recommend the widening of Vernon-street to the f 30ft. from Dale-street right along to Tithebarn-street.

Wiring—We are informed that the order for the complete d wiring of the St. Anne's Hotel, St. Annes-on-the-Sea, given to the National Electric Free Wiring Company, Faraday House, Charing Cross-road, who have also the orders for the wiring of Jones's Hotel, Suffolk-street, d the residence of Mr. Ernest Franklin, 50, Porchester- W.

ey Hill.—The work of getting out the foundations of the tation for generating electricity for working the local s has been begun in the past week. The station will be rge one, as it is intended to supply power for working not present tramline when converted for working by elec- ut also the lines the British Electric Traction Company contemplation in the district.

tch.—The erection of the station in connection with the ighting scheme has been commenced. It will consist of h stone dressings, with a frontage of 88ft., and the first om and gas plant will go back 35ft. from the road. The ill consist of boiler-room, offices, storeroom, and engine- The work is being carried out by Mr. T. Yeomans, and all expedition is being made.

Kidderminster.—The starting of the electric tramway last week created enormous excitement both at Kidderminster and Stourport. The motorcars were at all times crowded with passengers. The electric lighting report has been adopted. An expert is to be called in, and application will be made for extension of the order. The Council express themselves as extremely satisfied with their bargain with the British Electric Traction Company.

Conway.—The Mayor of Conway and several members of the Cowlyd Water Board, with Mr. Marks, Llandudno, as professional adviser, on the 26th ult., visited the Board's property at the Turbine, near Cowlyd Lake, to report as to utilising the water power for purposes of generating electricity. The Mayor states that the result of the inspection quite warrants the action of the Board, and that the property is likely to lead to important developments.

New Premises.—We are informed by Messrs. Geo. Trollope and Sons that, in consequence of her Majesty's Commissioners of Works having acquired and pulled down 15, Parliament-street, Westminster, which has been occupied by their firm since 1777, they have opened new offices at 14, Mount-street, Grosvenor-square, and at 5, Victoria-street, Westminster. The new offices will be in direct telephonic communication with Messrs. Trollope's other offices.

Southall.—At the last meeting of the District Council a letter was read from Sir Richard Nicholson stating that an application had been considered by the Middlesex County Council for an order for the purpose of constructing a light railway in the Council's district, and further stating that the company proposed to use electric power. If the District Council had any objections to make to the scheme, would they communicate them to the Middlesex County Council?

Portsmouth.—An agreement has been arrived at between the Corporation and the tramway company, by which the Bill now before Parliament will go forward as an unopposed measure, and in the course of a few weeks become law. Thereupon the Corporation will give 12 months' notice to acquire the entire undertaking, the price to be settled by arbitration, and preparations will forthwith be commenced for taking over the system and converting it into electric traction.

Wigan.—On the minutes of the Gas and Electric Lighting Committee being presented at the last meeting of the Town Council, it was said that the action of the Council with reference to the proposal to adopt the electric light was not creditable to the Council or useful to the town. Unless active steps were taken, a syndicate might be formed and apply for the powers which the Corporation already possessed. After a discussion of some length, a committee was appointed to deal with the question.

Bath.—At a meeting of the Electric Light Committee on the 27th ult., Mr. R. Hammond reported that the contractors were arranging for the new engines to be fixed next week, and it was anticipated that the first set of the new plant would be in position in July. The new mains had been tested, and were up to the full Board of Trade standard. Letters were read from tradesmen complaining of the new electric light posts as obstructing entrances to their premises, and in one instance it was decided to place the light on a wall bracket if practicable.

Manchester.—The special committee of the Corporation appointed to consider the proposed municipalisation and the general working of the tramway system of Manchester, is still discussing with the authorities of the out-townships as to the terms upon which the tramway lines in their districts are to be worked at the expiration of the present lease, in 1901, of the same held by the Manchester Carriage and Tramways Company, Limited. The committee, after investigating the working of the tramways in the leading cities of the Continent and of America, has unanimously recommended the adoption of the electric overhead wire system.

Appointment Vacant.—The Town Council of Aberdeen invite applications for the appointment of electrical engineer in connection with the electric lighting department. Applicants must have a thorough mechanical training and experience in station work. The salary will be £225 per annum, and the person appointed will be required to take the charge of the electric lighting department under the engineer of the Corporation gasworks, act as executive engineer at the station, and devote his whole time to the duties of the appointment. Applications, accompanied by testimonials, and stating age and past and present employment, to be lodged with the town clerk by 17th inst.

Hampstead.—At the last meeting of the Vestry, Mr. A. P. Johnson, the clerk, reported that the profits on the Vestry's electric lighting undertaking for the past year had exceeded all expectations. The revenue for the year amounted to £8,081. 0s. 9d. They had paid £2,980. 8s. 3d. interest on capital, and they had also repaid £1,187. 12s. 10d. instalments of capital, leaving the net profit £3,905. 3s. 4d. Sir Henry Harben, the chairman, pointed out that, if the Vestry were a trading corporation, and had not to repay the capital by instalments, the profits for the year to rank as dividends would exceed £5,000. The total amount of capital expended up to the present is £100,167.

Derry.—On Monday afternoon Dr. R. H. Todd appeared before a meeting of the Corporation to further explain the offer made by him on behalf of the New General Traction Company, Limited, which proposes to acquire the electric plant locally, establish a private lighting system, for distributing motive power and supplying light at fixed prices, continue the public lighting, and inaugurate an electric tramway service in the city. After discussion it was resolved to appoint a committee with instructions to ascertain the price for the electric lighting plant, based on the actual cost, which Dr. Todd's clients would be prepared to give.

The committee were also instructed to consider this offer in its relation to the report on private lighting recently drawn up.

Catalogue.—We have received an illustrated catalogue of the Dermatine Company, Limited containing a short account of the discovery and manufacture of indiarubber and guttapercha, and a description of the special characteristics and qualities of Dermatine, which is claimed to be superior to either wherever flexibility without elasticity is required. Dermatine consists of a combination of gums and chemicals treated specially, and vulcanised much in the same way as indiarubber. As the oxidation of the sulphur at the surface of Dermatine articles is said to be to a great extent neutralised it would last longer, especially in tropical or polar regions. Its uses are similar to indiarubber—viz., as a non-conducting material, for packing, for motor tyres, buffers, brake-blocks, hose, etc.

Poplar.—At the last meeting of the District Board of Works the Electric Lighting Committee submitted the names of the following candidates for the position of electrical engineer: Messrs. W. R. Wright, A. Blackman, H. Coles, and J. A. Jeckell, and recommended that the Board do proceed to the appointment from the list submitted of a resident electrical engineer on the terms of the report of the committee approved by the Board on the 10th ult., and at the salary named in the application of the gentleman elected. Mr. Clarkson moved the adoption of the recommendation, and in doing so said the committee had before them the names of 33 gentleman willing to occupy the position. That number was reduced to 12, who were interviewed by the committee, and the committee were unanimous in coming to the conclusion that the four candidates were the best to recommend for selection to the post. After a long discussion Mr. Alfred Blackman was appointed at a salary of £300.

Accidents.—On Whit Monday, while one of the electric cars was making a journey with a full freight of passengers down the line of electric railway from the Alexandra Palace to the entrance near Wood Green railway station, the brake refused to act, and consequently the vehicle ran down the track at a great speed. Two gentlemen, who were sitting near the front of the runaway, jumped off, and sustained serious injury. Meanwhile the car collided with the car which was coming up, completely smashing one of the brake bars, and a number of large glass windows and an electric lamp. Fortunately, with the exception of a boy who had occupied the back seat of the runaway car, no one was injured.—On Tuesday night as an electric car, carrying about half a dozen inside passengers, was running along North-street towards Briggate, Leeds, the guard wire snapped. A crowd soon gathered, when a second car came along, and several men and women received a slight electric shock, but no one was seriously hurt.

Hull.—At the last meeting of the Corporation Electric Lighting Committee it was stated that considerable delay had taken place in the completion of the Sculcoates-lane station, but it would probably be finished early in July. The chairman, deputy-chairman, and the electrical engineer were appointed to attend the annual convention of the Municipal Electrical Association, to be held in London this month. It was resolved to extend certain mains. The Electrical Engineer reported, with reference to the subway proposed to be erected by the Gas Committee under the Queen's Dock basin, that, owing to the distance from the line of main feeders, he did not consider it advantageous to that committee to co-operate with the Gas Committee in that work. It might possibly, in the future, be a convenience for that committee to lay cables through the subway, but, in that case, doubtless the cost could be met by paying an annual charge or rental to the Gas Committee. The report was ordered to be entered on the minutes.

Bridlington.—Pending the laying of a new cable by the British Insulated Wire Company, Limited, of Prescot, the ordinary gas lamps are being used on the Prince's-parade. When the installation for the electric light was first put in the cable was laid in earthenware pipes, and it was stated that the cable was not only defective but rotten through water getting into the pipes. That was one of the reasons why it was decided to abandon the arc lamps on Beaconsfield and to augment the number on the parade. In addition, a new cable is being laid for lighting at the north gate steps. The copper wires which transmit the current are securely wrapped in paper, the whole being enclosed in a leaden pipe about 1in. in diameter, and this is laid in the ground, after being hermetically sealed, like an ordinary gas-pipe. As air and water are alike excluded, a cable so laid should last many years. Mr. W. Simm is the electrician in charge of the new installation. A length of 520 yards will be laid in the first instance, and afterwards another of about 320 yards.

Edison and Swan United Electric Light Company, Limited.—The "Ediswan" exhibit at the soirée of the Royal Institution on Friday last comprised that firm's latest improvements for 1898 as follows: (1) Patent dry cap lamp, for use in damp places or for outside lighting. The cap is attached by means of a brass disc, and is fastened to the glass bulb by specially prepared cement, which is thoroughly damp-proof. (2) Patent casing cut-out. Each casing cut-out is provided with four brass thimbles, adapted to the connecting cables, and these are held in position by the form of the porcelain case, without screws, and are easily removable. Provision is made for holding reserve fuses. (3) Patent direct-contact high-voltage lamp and holder. The holder is wired without being taken to pieces. The wires pass direct to the spring contact, pieces which enter cavities in the lamp socket. There is no possibility of short-circuiting, and the work of wiring is greatly facilitated. (4) The patent anti-shock switch for high voltage, an improved "tumler" pattern, with patent enamel liner. (5) The patent anti-shock holder for high voltage, an improved "S" holder, with patent enamel liner.

Birmingham.—Messrs. Dick, Kerr, and Co., of Glasgow, have submitted to the Corporation a scheme for tram service upon roads in the city along which there is at present no such accommodation. They undertake to adopt either the underground electric conduit or the cable system of traction, as may be found suitable to the various routes; they stipulate that the term of concession must be for 21 years, and agree that if the Corporation purchase the business of the Birmingham Electric Lighting Company, as is proposed, they will become customers for their electric power. In lieu of rent a profit-sharing arrangement is suggested, contingent upon paying 5 per cent. interest upon the capital of any company that may be formed, and the laying aside of a sufficient annual sum to provide for a sinking fund for the whole of the capital. Finally, at the expiration of the term of concession the whole of the lines within the city would revert to the Corporation without payment. The firm are satisfied as to the financial success of the undertaking.

Dudley.—The *Herald* says: "The Kidderminster Town Council have taken a step of very considerable interest to Dudley. We do not, of course, suggest to off-hand and straightaway follow Kidderminster's lead, but at the same time it is at least worth a passing thought. Kidderminster obtained an electric lighting order in 1891, but never acted upon it. They now have unanimously decided to sell that order to the British Electric Traction Company on a basis which includes powers of repurchase by the Corporation at stated periods of time and on specified terms. The company have agreed to repay the Corporation all the expenses incurred in obtaining the order. Kidderminster, this week, has seen its electric railway start, and altogether we are afraid Dudley is rather behind its neighbours. Electric lighting has been discussed in Dudley for the best part of 20 years, and we are no nearer to it than we ever were, whilst the public are asking how long it is to be before a decisive step is taken with regard to electric tramways. We all know that it is a very big business, and one that must not be rushed, but delay is tiresome, and apt to breed dissatisfaction. Perhaps at the next Council meeting we shall have a definite pronouncement on the subject."

Dundee—At the last meeting of the Gas and Finance Committees of Dundee Town Council it was reported that the revenue account had closed with a deficit of £314 17s., but that in the electric lighting department there had been a surplus of £1,328. 4s. 3d. The expenditure of the electricity department was estimated at £5,284. 6s. 7d., but it actually amounted to £4,941. 9s. 6d., being £342. 17s. 2d. below the estimate. The income was calculated at £6 000, and amounted to £6 269. 13s. 8d., an increase of £269. 13s. 8d.. and an excess over actual expenditure of £1,328. 4s. 3d. For the current year the revenue, including a balance of £946. 17s. 8d., is put down at £7,553. 17s. 8d., and the expenditure at £7,039 6s. 7d, bringing out an estimated surplus of £514. 11s. 1d. In view of the satisfactory nature of the electricity accounts, it was decided that the charge for amounts up to 20 units should be reduced from 7s 6d. to 6s. 8d, and that the supply above 20 units should be charged for at the rate of 4d., being ½d. under last year's price. With the object of encouraging parties to utilise electric energy for motive power, it was agreed that the energy should be supplied at the rate of 2½d. per unit, on the understanding that separate meters were used.

Walthamstow.—Colonel W. Langton Coke, M.I.C.E., Local Government Board inspector, held an enquiry last week into an application of the District Council for sanction to borrow £5,200 for about two acres of land as a site for an electric lighting station and a stoneyard. There appears to be no objection to the scheme for electric lighting, but several witnesses objected to the paying of what they called an exorbitant sum for the land. Mr. E. J. Cowen, clerk to the Council, said it was most desirable that they should have a central site. This land, bordering on the railway, was the most suitable, and was of more value for the purposes proposed than for any other purpose. It would enable them to have a siding, and as the Council were now doing their own work and requiring large quantities of material there would be a great saving in cartage. Mr. Enright, the electrical engineer, spoke strongly in favour of the site, and said the saving on the cartage of coal would alone pay the interest on the money. The whole district could be lighted from this station at the lowest possible cost, and he incidentally mentioned that they would have the district better lighted and at a less cost than it was with gas at the present price. After closing the enquiry the inspector viewed the site.

Shoreditch.—The chairman of the Shoreditch Lighting Committee (Mr. H. E. Kershaw) has written to the *Daily Chronicle*, giving his version of the position of the electric lighting in that district. It has been asserted that the committee have raised by loans a sum of £80,000; the chairman stated that the loan account, including the bankers' overdraft of £16,000, does not exceed £64,123. The committee now propose to raise in the open market a loan of £15,000, to which objection is taken on the ground that it will increase the loan account, but as the new loan is intended to be applied to the reduction of the bankers' overdraft, the chairman contends that it does not affect the financial status of the Vestry. Complaint is made that last year's operations resulted in a loss of £474. To this the chairman replies that during the three previous years the total deficit had amounted to £3,474, but that out of the profit made during the first nine months of the new system £3,000 of that deficit had been paid off, and he contends that it is reasonable to expect that at the expiration of the next quarter the whole of the deficit will be extinguished. Objections have also been made against the estimated items of depreciation and of the dust destructor account, but as these accounts will not be made up until after the

f the year's working, the chairman cannot authentically his position, seeing that the preliminary report just issued vith a 12 months' estimated expenditure, and only a nine s' realised income.

ord.—In the *London Gazette* of May 31 the Corporation give of their intention to make a lease of their tramways to the ester Carriage and Tramways Company for a term, as s certain of the tramways, dating from May 1, 1898, and ıg on April 27, 1901, and of certain other tramways from , 1898, until April 27, 1901. The first-named tramways ınder two schedules, the first schedule comprising the Bury oad line and the lines from Pendleton to Albert Bridge, d-road to Regent-road, Oldfield-road along Regent-road to lowes-street, Lower Broughton-road to Cliff-road, and certain lines. The second schedule deals with several single and nes. The annual rental payable in respect of the entirety e tramways is £8,852. 2s. The third schedule comprises a line from Broad-street, passing along Cross-lane, across -road and along Trafford-road to the boundary of the h, including junctions with existing lines at Broad-street, -road, Goodier's-lane, and the line near Tatton-street, and e line from Windsor Bridge along Windsor, and connected last-mentioned line in Cross-lane. The annual rent payable se lines is a sum equivalent to £7. 10s. sterling per centum num upon the sum of £7,000, or such less sum as shall nt the cost incurred by the Corporation in constructing ramways. A number of covenants and conditions are d to the lease, one of which stipulates that the tramways be used in connection with those of the city of Manchester, ough of Eccles, and the urban districts of Swinton and rd. The draft lease is deposited at the office of the town f Salford, and is open for inspection.

echapel.—At the last meeting of the District Board, the committee appointed to visit electric lighting stations t up a report which stated that they had visited Brighton, itch, St. Pancras, and Ealing to ascertain the best method ing the district with electricity, had inspected the various s, and interviewed the engineers in charge of the works. mmittee were most favourably impressed with the result of isit to Brighton, and the principle and operation of the were very fully explained by Mr. A. Wright, engineer to rporation. The impression left upon the committee was e great object aimed at at these works was to supply con- at the smallest rate of charge consistent with the provision intenance of a thoroughly efficient and up-to-date plan, and mercial success appeared to have been assured by attracting ers by the reasonableness of the terms of supply. The se by the Board of additional land in George-yard next to tructor premises of the Board presented, in the opinion of mittee, the most favourable opportunity to work a special tion to supply the district with electric light, but the tee considered it advisable in the first instance for ard to be advised upon that point by a competent ty. They had ascertained that Mr. Wright, engi- o the Brighton Corporation, was, by reason of his ment with the Corporation, free to advise upon matters ted with engineering plans in other districts, and from the ble impression entertained by the committee of the value vice of Mr. Wright would be to the Board, they recom- l that the Board should obtain a report from him upon the bility of the land named for electrical purposes, and upon bable demands of the district for an electrical supply, with tions as to the best method of supplying electricity in the , with an approximate estimate of the capital necessary to sted, and the returns likely to arise from the adoption of gestions to be made in the report. The cost of the investi- and report by Mr. Wright would be 100 guineas, and the tee recommended that Mr. Wright be instructed to report se terms. After discussion the report was unanimously d.

llesbrough.—At a meeting of the Streets Committee of the ation on the 27th ult. the question of the laying of the tramlines in the town by the Imperial Tramway Company ain discussed. It was pointed out that the rails, contrary ification, were laid below the level of the paving, much to nger of vehicular traffic. It was decided to oppose the g of the system until the tramway company have carried eir work according to specifications. The *North-Eastern Gazette* says: "Local enterprise has given Tees-side an able name in the world of industry. In a week or two we pect again to see public attention fastened upon it with liest interest, and possibly with no small amount of admira- d envy. The fame which is in store for it is not, however, occasion due to local genius or spirit of adventure. It will outcome and reward of the daring and ambitious enterprise Imperial Tramways Company. The district stretching from Ormesby to Norton, and passing through the towns of sbrough, Thornaby, and Stockton, has been selected and l as the site for a great experiment in electrical locomotion. the scheme has the promise of brilliant success. The work structing the permanent way and of supplying all the ry equipment has been performed with almost electric- pidity, and, so far as can yet be judged, with astonishing cy. The scheme, begun in midwinter, will, to all appear- be in full operation in midsummer. Elsewhere changes e old to the new tramway systems, especially when under- by the municipal corporations, have been disappointingly , and have exposed the communities to serious as well as ged inconvenience. Here on Tees-side the transformation has been made quickly, quietly, and with the minimum of disturbance. Undoubtedly, the tramway company have given the Streets and Buildings Committee of the local municipalities many surprising lessons, and have opened the eyes of the ratepayers to the speed with which streetmaking and causewaying can be carried on under vigorous and intelligent direction. . . . The trial run made the other evening was to all appearances a signal success, and justifies the hope that before many days the system will be in full and successful operation. Certainly, the opening of the line is being anticipated with the liveliest interest, not merely on Tees-side, but throughout the country generally, and especially in those towns where the possibilities of electric tramway service are being anxiously discussed. It may be assumed, therefore, that the opening ceremony will be more than a local function, and that it will attract the presence, as well as the notice, of prominent men of science and high municipal dignitaries." A successful trial trip was made on Monday evening, a car being driven from Norton to North Ormesby by Mr. Clifton Robinson, managing director of the company, without a hitch. The trial was watched by great crowds of people. On Tuesday evening two more of the cars were run down from Norton to the central depôt at Bridge road, Stockton. Mr. Robinson had an interview with the Middlesbrough Streets Committee on Tuesday regarding the complaint as to the projection of the scoriæ bricks above the tramlines. He undertook to see that in no place were the scoriæ bricks more than their ⅛in. bevel above the level of the rails; that the tramways remain so for three months to give the material time to settle; and if at the end of that time the paving is not level with the rails, Mr. Robinson will undertake to make it so.

PROVISIONAL PATENTS, 1898.

MAY 23.

11570. **Improvements in or connected with electrolytic cells.** George Bell and George William Bell, 15, Water-street, Liverpool.

11579. **Improvements in electric signalling on railways.** Joseph William Wadkin and Denzel John Jarvis, 53, Elliscombe-road, Charlton, London.

11604. **Improvements in and connected with the electro-metallurgic production of iron, steel, and their alloys with chromium, tungsten, nickel, manganese, and the like.** Ernest Stassano, 4, Corporation-street, Manchester. (Complete specification.)

11609. **An improvement in electrical fuses and cut-outs chiefly applicable to the bridge fuse.** Arthur Wellington Sowry and Herbert Edwin Munslow, 2, Hafer-road, Clapham Junction, London.

11610. **An automatic electrical temperature indicator.** Albert Henry Wood and David Martineau Haylings, 109, Victoria-street, London.

11627. **Improvements in electric cables.** Willoughby Statham Smith, 24, Southampton-buildings, Chancery-lane, London.

11640. **Improvements in accumulators or secondary batteries and apparatus for their manufacture.** Franz Heimel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

11678. **Improved apparatus for use in the electro-deposition of metals.** William Dunn and William James Twining, 11, Burlington-chambers, New-street, Birmingham.

MAY 24.

11723. **Improvements in and relating to the making and breaking of electric circuits.** John Alexander Steven and Claud Hamilton, 96, Buchanan-street, Glasgow.

11731. **Improvements in the globes of electric incandescent and similar lamps.** English Industrials, Limited, and George Edward Heyl-Dia, 55, Market-street, Manchester.

11732. **Improved means for measuring current or voltage in electric lamps.** English Industrials, Limited, and George Edward Heyl-Dia, 55, Market-street, Manchester.

11757. **An improvements in jointing or junction boxes for connecting distributing and the protection of electric wires.** Thomas McEwan, 36, Dick-place, Grange, Edinburgh.

11783. **Improvements in and relating to conductors for electric railways.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (William Augustus Putnam, Willard, jun., United States.) (Complete specification.)

MAY 25.

11858. **Improvements in the manufacture of elements or plates for secondary batteries or electric accumulators.** Frank King, 47, Lincoln's-inn-fields, London.

11860. **An improved means for making and breaking electric circuits.** Adolf Wilhelm Sauerbrey, 15, Tooks-court, Chancery-lane, London. (Complete specification.)

11906. **Improvements in or relating to fuseboards.** Albert Vandam and Thomas Herbert Marsh, 322, High Holborn, London. (Complete specification.)

11917. **Improvements in means for silvering or plating the glass bulbs of incandescent electric lamps or the like.** Ferdinand Fanta, 1, Queen Victoria-street, London.

11924. **Improvements in electric lamps.** William Peto, 65, Chancery-lane, London.

11922. Improvements in electric lamps. Alan Archibald Campbell Swinton, 18, Southampton-buildings, Chancery-lane, London.

11926. Improved circuit connections for continuous-current shunt machines. Adolf Sengel, 53, Chancery-lane, London.

11936. Improvements in electric arc lamps. Ralph Gaynor, 34, New Ash-street, New Benwell, Newcastle-on-Tyne.

MAY 26.

11989. Improvements in and relating to telegraphic transmitting and recording or receiving apparatus. John Clayton Mewburn, 55, Chancery-lane, London. (Bernhardt Hoffmann, France.)

12011. Improvements in electric gas igniters. Fritz Deimel, Jacques Lehmann, and Alfred Sylten, 4, South-street, Finsbury, London.

12013. Improvements in printing telegraphs. Leo Kamm, 4, South-street, Finsbury, London.

12016. Improvements in systems of electrical control. Henry Harrington Leigh, 22, Southampton-buildings, Chancery-lane, London. (Frank Julian Sprague, United States.)

12029. Manufacture of active material for accumulator batteries. Henri Tobler and Jacob Heinrich Graeber, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MAY 27.

12049. Improvements in electrical resistance coils. Samuel Wells Cuttriss, the Elmwood Electrical Works, Camp-road, Leeds.

12092. Improvements in electric bells for cycles. Alwin Rufus Gould, 6, Bank-street, Manchester.

12106. A new or improved electrical appliance for curative or remedial purposes. Henry Krauss, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

MAY 28.

12172. Improvements in electric arc lamps. Kasimir Panian and Michel Bernhard, 77, Chancery-lane, London.

12175. A new or improved composition for the manufacture of carbon pencils for arc lamps, incandescent filaments, and the like. Charles Schnabel, 40, High Holborn, London.

12190. An improved chemical composition intended for the manufacture of mantles or blocks for use in electric arc lamps. Paul Mersch, 45, Southampton-buildings, Chancery-lane, London.

12191. Improvements in reflectors chiefly designed for incandescent electric lamps. Curt Bartenstein, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1897.

10719. Primary batteries. Rowbotham.

11009. Manufacture of incandescent electric lamps. Barras and Gover.

11045. Apparatus for supplying or measuring a current of electricity. Watson and Humphreys.

11149. Methods of and means for controlling electric motors. Belfield. (Westinghouse Electric and Manufacturing Company.)

12088. Apparatus for controlling electric motors. Siemens Bros. and Co., Limited, and Stopher.

12211. Electric propulsion of road vehicles. Nave. (Date applied for under International Convention, Nov. 17, 1896.)

12675. Galvanic batteries. Krayn and Koenig.

14659. Counting and recording of the number of messages transmitted over telephonic or other signalling circuits. Sinclair and Gray.

15047. Electric accumulators or storage batteries. Heinemann.

15560. Electrical bell pushes. Mercier.

15870. Electrical propulsion of carriages and other vehicles, boats, and the like. Muller and Tudor.

16255. Apparatus for administering mist or vapour and electric baths for internal purification, and for ventilating, heating, and cooling purposes. Junge. (Renstrom.)

16728. Device to be used for electrical heating purposes. Edmunds.

18701. Electric arc lamp for projection and other purposes. Davenport.

20145. Accumulator plates. Lehmann and Mann.

1898.

192. Support for electric lamps. Bromhead. (White.)

3395. Reflector holders for incandescent electric lamps. Mütz.

5469. System of electric traction and apparatus therefor. Boult. (Anney.)

6831. Electric miners' lamps. Wood.

7016. Telephone transmitters. Payne.

8341. Electric alarm apparatus. Wigand.

TRAFFIC RECEIPTS.

Liverpool Overhead Railway.—The traffic receipts for the week ended May 22 were £1,416, as compared with £1,386 in same week of 1897, being an increase of £30.

Birmingham Tramways.—The traffic receipts for the week ending May 21 were £3,597. 15s. 3d., as compared with £3,745. 5s. 6d. for same week in 1897 being an increase of £147. 10s. 3d.

Dover Tramways.—The traffic receipts for the week ending May 28 were £147. 1s. 2d. The total receipts for the year 1898 are £2,357. 0s. 3d. The mileage open at present is 3 miles.

Bristol Tramways.—The traffic returns for the week ending May 27 were £2,653. 5s. 4d., compared with £2,473. 2s. 6d. for same period of last year, being an increase of £180. 2s. 10d.

South Staffordshire Tramways.—The traffic returns for the week ending May 27 were £601. 7s. 3d., as compared with £615. 10s. 6d. in same week of 1897. The aggregate receipts for the year are £12,445 18s. 0d., as against £12,548. 15s. 1d. in the same period of the previous year.

City and South London Railway.—The returns for the week ended May 29 were £1,012, compared with £929 for same week of 1897, being an increase of £83. The total receipts for the half-year amount to £22,678, compared with £22,390 for the same period last year, being an increase of £288.

Dublin S.D. Tramways.—The traffic receipts for the week ending May 27 were £577. 2s. 1d., as compared with £681. 15s. 10d. in the corresponding week in the previous year, being a decrease of £104. 13s. 9d. The number of passengers carried was 89,005 in 1898 and 98,010 in 1897. The aggregate returns up to date are £9,498. 3s. 2d., as compared with £10,049. 11s. 7d. last year, being a decrease of £551. 8s. 5d. The mileage open is the same as last year—viz., 8 miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	10-10½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	15½-16
——— 6 p.c. Cm. Pf., 30,001-40,000 (iss. at £2. 10s. pm., all pd.)	4	7-8
Brush Company, Ordinary	2	1½-2
——— Non. Cum., 6 per cent. Pref.	2	2¼-2½
——— 4½ per cent. Debenture Stock	100	110-114
——— 4½ per cent. 2nd Debenture Stock	100	[illegible]
Callender's Cable Company, Debentures	100	[illegible]
——— Ordinary	5	9½-10½
Central London Railway, Ordinary	10	10-10½
———	6	6-6½
——— Pref. Half-Shares	1	[illegible]
——— " "	5	[illegible]
Charing Cross and Strand	5	[illegible]
——— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	[illegible]
——— 4½ per cent. Debentures	100	115-117
City of London, Ordinary	10	24½-25½
——— Prov. Cert. 90,001-100,000	5	16½-17½
——— 6 per cent. Cumulative Pref.	10	16½-17½
——— 5 per cent. Debenture Stock	100	129-134
City and South London Railway, Consolidated Ordinary	100	69-71
——— 4 per cent. Debenture Stock	100	126-128
——— 5 per cent. Pref. Shares	10	15-16
——— " " " '96	10	13½-14½
County of London and Brush Provincial Co., Ordinary	10	13-14
——— " " "	4	6½-7½
——— 6 per cent. Cum. Pref.	10	15-16
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	7-7½
——— 5 per cent. Debentures	—	[illegible]
Crystal Palace District, Ordinary 5 per cent. Stock	100	[illegible]
——— Preference 5 per cent. Stock	100	143-148
Edison and Swan United Ordinary	3	2¼-2¾
——— 5 per cent. Debentures	5	4-5
——— 4 per cent. Deb. Stock, Red.	100	[illegible]
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	3	[illegible]
Electric Construction, Limited	2	[illegible]
——— 7 per cent. Cumulative Pref.	2	[illegible]
——— 4 per cent. Perp. 1st Mort. Deb.	100	[illegible]
Elmore's Copper Depositing	1	[illegible]
Elmore's Wire Company	2	[illegible]
W. T. Henley's Telegraph Works, Ordinary	10	21½-22½
——— 7 per cent. Preference	10	[illegible]
——— 4½ per cent. Debentures	100	[illegible]
House-to-House Company, Ordinary	5	9-10
——— 7 per cent. Preference	5	11-12
India Rubber and Gutta Percha Works	10	[illegible]
——— 4½ per cent. Debentures	100	[illegible]
Kensington and Knightsbridge Ordinary	5	15-16
——— 6 per cent. Pref.	5	[illegible]
London Electric Supply, Ordinary	5	3½-4
Metropolitan Electric Supply, Limited, Ordinary	10	16-17
——— 4½ per cent. First Mortgage Debenture Stock	100	[illegible]
National Telephone, Ordinary	5	[illegible]
——— 6 per cent. Cum. First Pref.	10	[illegible]
——— 6 per cent. Cum. Second Pref.	10	[illegible]
——— 5 per cent. Non. Cum. Third Pref.	5	[illegible]
——— 3½ per cent. Deb. Stock, Red.	100	[illegible]
Notting Hill Company	10	[illegible]
Oriental, Limited, £1 shares	1	[illegible]
——— £5 Shares	5	[illegible]
——— £4½ shares	4	[illegible]
Oriental Telephone and Electric Company	1½	[illegible]
Royal Electrical Company of Montreal	—	[illegible]
——— 4½ per cent. First Shares Mortgage Debentures	100	[illegible]
South London Electric Supply, Ordinary	2	[illegible]
St. James's and Pall Mall, Limited, Ordinary	5	16-17
——— 7 per cent. Pref.	5	10-11
——— 4 per cent. Deb. Stock, Red.	100	107-110
Telegraph Construction and Maintenance	12	34-37
——— 5 per cent. Bonds	100	[illegible]
Waterloo and City Railway, Ordinary	100	[illegible]
Westminster Electric Supply, Ordinary	5	16-17
Yorkshire House-to-House	5	[illegible]

NOTES.

Royal Institution.—The Friday evening discourse this week (June 10, at nine o'clock) will be given by the Right Hon. Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S., M.R.I., on "Some Experiments with the Telephone."

The Institution of Junior Engineers.—A special meeting of the above institution will be held to-day at 8.30 p.m., at the Westminster Palace Hotel, to welcome Sir T. Salter Pyne, C.S.I., as an honorary member of the institution.

Three-Phase Plants. — The electrical installation supplied to the Angelo and Driefontein mines in South Africa is a three-phase plant, including engines of 450 h.p., and was manufactured by Messrs. Brown, Boveri, and Co., Switzerland.

Submarine Telegraph Literature.—We understand that the Queen has been pleased to accept a copy of Mr. Charles Bright's recent work on "Submarine Telegraphs," and also of his brochure entitled "Science and Engineering during the Victoria Era."

Institution Conversazione. — We would again remind our readers that the conversazione of the Institution of Electrical Engineers will be held at the Natural History Museum, South Kensington, on Thursday next, June 16, from 9 p.m. to midnight. A large gathering is expected.

London Chamber of Commerce.—The Electrical Section of this Chamber of Commerce held a meeting on Wednesday last to further consider the action of the Board of Trade in granting provisional orders under the Electrical Lighting Acts to local authorities in districts where companies are already giving a supply under provisional orders.

Telegraphs in the Soudan.—The telegraph lines from Suakim to Kassala and Berber are rapidly approaching completion. Bimbashi Manifold has left for the front, *viâ* Cairo, after completing his work at the Suakim end. Of the line to Kassala 130 miles have been laid, and of that to Berber 30. Both lines are expected to be finished in three months.

Long-Distance Telephone.—During the past week the telephone exchanges of Manchester and Brussels have been put in direct communication with each other for the purpose of an experiment. Land and sea wires had to be utilised, the wires running from Brussels through Courtrai and Lille to Calais, where they were connected with the London-Paris telephone cable under the Straits of Dover. It appears that the experiments were very successful, the conversation being distinctly heard.

Indiarubber.—The latest American rumour is to the effect that a Chicago chemist has succeeded in producing indiarubber from corn oil. The indiarubber so produced is at least quite equal in all respects to the genuine article, and in some cases has superior properties. We regret to notice, however, that the process is still in the experimental stage, but this does not prevent the reporter who announces the fact from enlarging on the various uses which the so-called indiarubber has in common with the real article.

A Book in the Press.—Mr. Richard Kerr's short popular account of wireless telegraphy, as given in lectures delivered by him in the principal cities of England, Scotland, and elsewhere, is shortly to be issued by Messrs. Seeley in book form. It will explain in simple language the methods devised by Mr. Preece, Signor Marconi, Dr. Oliver Lodge, and others who have worked on this new method of signalling. The little book will be illustrated with diagrams drawn by the writer, and portraits. Mr. Preece contributes a preface.

The Norwegian Customs Tariff.—The Board of Trade have received through the Foreign Office a dispatch from her Majesty's consul-general at Christiania stating that the whole of the amendments in the tariff of Norway came into force on the 1st inst. The most important alteration is the imposition of a duty on machinery. Thus motors for steam, water, wind, gas, petroleum, benzine, and electricity, dynamos, and parts of the same will pay from 5 to 10 per cent., depending on their details and the materials used in their construction.

Royal Meteorological Society.—At the ordinary meeting of the above society, to be held at the Royal Astronomical Society's rooms in Burlington House on Wednesday, the 15th inst., at 4.30 p.m., the following papers will be read: "Frequency of Non-Instrumental Meteorological Phenomena in London with Different Winds from 1763 to 1897," by R. C. Mossman, F.R.S.E., F.R.Met.Soc.; "Progress of the Exploration of the Air by means of Kites at Blue Hill Observatory, Mass., U.S.A.," by A. Lawrence Rotch, M.A., F.R.Met.Soc.

A Powerful Light.—An important alteration is to be carried out in connection with the revolving light at Cape Gris Nez, the red and white flashes of which are such conspicuous objects at the south-eastern towns on the English coast. A new lighthouse is to be erected, much higher than the present one, so that the light will be seen at a distance of 48 miles. It is to be an electric light having a white flash every second, and the candle-power of the ray, it is stated, will be no less than three millions. It is computed that the light will pierce the fog for a distance of 16 miles, but the fog in question is not specified.

A Tramcar Seat.—A most ingenious novelty in "garden seats" has been adopted on one of the tramcars running from Vauxhall to Norwood. It is a new form of seat, with a back that may be shifted from one side to the other, according to the direction in which the car is running. Instead of the reversible rail, with a pendant board intended as some safeguard against pickpockets, there is a broad sheet of iron so ingeniously contrived that it fits down as a cover to the seat when it rains, or may be raised on either side to form the back. It thus protects the seat when unoccupied, forms a comfortable support to passengers riding in either direction, and must render the art of the light-fingered brigade very difficult.

Prize Competition.—Our American contemporary *Electricity* is offering two prizes to be competed for by students of the various universities in the United States in which electrical engineering courses are held. The students are asked to submit theses on electrical matters likely to be of value in advancing practice or theory of electrical engineering. The subject-matter contained is to be original, and it is also a *sine quâ non* that it shall not have been published before, but whenever comparative information is given the credit must be given to other experimenters. All the theses must be sent to the editors by Aug. 1. The student who is adjudged by the editorial staff to have contributed the most useful thesis will receive a prize of £5 and a year's subscription to the journal, while the next man will receive £3.

Magnetic Survey of India.—The Government of India is favourably considering a proposal to have a complete magnetic survey made throughout India. Our contemporary *Indian Engineering*, in a leader on the subject, has no fault to find with the fact that the survey is to be made, but considers that the gentleman selected to take charge of the survey is not sufficiently acquainted with

the work he will have in hand. We must confess that in our opinion the chief element in a successful magnetic survey is nowadays to be looked for from the careful worker rather than from a man versed in original research. With good, reliable instruments, and a habit acquired from other physical researches of accurately noting down observations taken, there is no great difficulty in the work. Still, we see no reason why additional assistance for the survey should not be obtained from our observatory at Kew.

Cantor Lectures on Guttapercha.—We understand from the *Journal* of the Society of Arts that a few extra copies of the appendices to Dr. Obach's Cantor lectures on "Guttapercha" have been printed. These consist of some additional tables, etc., which were not printed in the *Journal*. A copy will be sent on application to any member of the society who desires to bind it up with his volume for the current year. In connection with these articles in may be of interest to our readers to learn that the collection of the various botanical and other specimens, diagrams, etc., used to illustrate the lectures at the Society of Arts were exhibited at the soirée of the Royal Society on Wednesday last, June 8, and will also be shown at the Royal Institution on Friday, June 10, after Lord Rayleigh's discourse, "Some Experiments with the Telephone." A few experiments demonstrating some of the properties of guttapercha will be shown on this occasion.

The Iron and Steel Institute.—As previously announced in our columns, the autumn meeting of this institute is to take place at Stockholm on Aug. 26 and 27. For the convenience of members a special steamer will leave Newcastle on Aug. 17, and proceed by way of the Baltic Canal, Kiel, and Wisby to Stockholm, where she will remain as a floating hotel until Aug. 28. The return journey will be by way of Copenhagen, Gothenburg, and Christiania. The cruise is to occupy 19 days. An alternate route is by the "St. Sunniva," a steamship of 1,000 tons, which will leave Leith on Aug. 20 for Stockholm, by way of Christiania. This cruise will occupy 24 days. The Orient Steam Navigation Company, Limited, have also rearranged the itinerary of their pleasure cruise to the Baltic so as to bring their steamship "Lusitania" to Stockholm on Thursday, Aug. 25, and to keep her there until Sunday, Aug. 28, and the Great Eastern Railway Company has promised to afford special facilities to members travelling by the Continental route.

Early Trolley Roads.—A Mr. H. Haskins, writing to our New York namesake, gives the following details of a double-trolley road which was in operation in 1886, connecting the village of Montreux, Chillon, and Villeneuve, at the head of Lake Geneva, in Switzerland. The two conductors used were hollow brass or copper tubes, open at the bottom. In these tubes were metallic plungers 8in. to 10in. long, with wire brushes at each end of them, to make good contact with the tubes. The wires were fastened to the centre of these plungers. They were flexible cords twisted into a rope, and as the car ran, it dragged the plunger after it. The power came from a dynamo, up the mountain side, moved by a waterwheel; and the boy up there, who acted as chief engineer of his power station, was telephoned from time to time for more or less current. Altogether this little road was a curious affair. Where it wound through the narrow, crooked streets—too narrow for sidewalks and poles—the trolley tubes were supported by handsome iron brackets projecting from the building fronts.

Enclosed Arc Lamps.—As far as one can judge while within the exhibition now open at New York, says the *Electrical World*, the open arc lamp is a thing of the past, enclosed lamps for both direct and alternating current constant-potential work and pressures up to 250 volts, as well as for series circuits, giving brilliant evidence of their success in every direction. The control of these lamps is, as a rule, effected by a series magnet with an armature having a large range of motion with a limited variation of current, controlling a clutch which lifts the carbon. This arrangement lowers the carbon gradually as the arc lengthens and the current weakens, until the desired limit of the armature motion is reached, at which point the clutch is arranged to let go, dropping the carbons together momentarily and pulling them apart immediately thereafter. This action gives a "wink" to enclosed arc lamps at intervals of about half an hour, the burning of the carbons being, of course, much slower than in open arcs. Some of the latest designs of regulators are designed to avoid this winking.

Home-Made Electricity.—A paragraph is going through the Press stating that a syndicate is being formed to acquire certain inventions for generating electricity by air. "The discovery, if reports are to be relied upon, is one of the most important and far-reaching of the century. With a small apparatus, weighing only a few pounds, and without the aid of gas, or steam power, or dynamo, sufficient current can be generated for lighting any ordinary dwelling-house. Experiments conducted over a period of some months are said to show that very striking results can be obtained by this method, and that the current developed remains quite constant. By means of this invention, it is expected that the supply of electric current will be brought within the reach of all without the necessity for taking it from corporation or company mains, and at a trifling cost as compared with the present charges for current." We will believe it when we see it, but the paragraph has, we fancy, a primary battery for its foundation. Primary batteries are not promising even in theory, and in practice do not as a rule approach even by 50 per cent. to the theoretical figures.

Change of the Zinc Sulphate in the Clark Cell.—Mr. Wilhelm Jaeger (*Ann. Phys. Chem.*, 1897) says that at 30deg. the ordinary crystals of zinc sulphate, $ZnSO_4 + 7H_2O$, change into crystals of the composition $ZnSO_4 + 6H_2O$. There is a break in the solubility curve at this point, the solubility of the new salt being greater than that of the original compound. In keeping with this, the E.M.F. of the Clark cell shows a change at 39deg. on heating, and it is possible to cool the cell down again in such a way as to prevent a return of the zinc sulphate to the ordinary condition, abnormal values for the E.M.F. being thus obtained at ordinary temperatures. Two curves are thus obtained for the E.M.F. of the Clark cell. For the normal cell containing $ZnSO_4 + 7H_2O$

$$E_t = 1{\cdot}400_5 - 0{\cdot}00152\,(t - 39) - 0{\cdot}000007\,(t - 39)^2.$$

For the abnormal cell containing $ZnSO_4 + 6H_2O$

$$E_t = 1{\cdot}400_5 - 0{\cdot}00102\,(t - 39) - 0{\cdot}000004\,(t - 39)^2.$$

In using the Clark cell, care should, therefore, be taken not to raise the temperature above 40deg., and to make certain that the zinc sulphate is present in its normal state.—*Jour. Chem. Soc.*

Electric History.—The record of the first electric line runs back far enough to enable several rival claims for priority to be made. The last of these we find in a letter from Mr. W. W. Hubbell in the *Scientific American*. This gentleman is now 77 years old, and hence we leave the first person in the quotation. Mr. Hubbell says: "A few days since I was examining several of your papers of 1850, containing a description of my solar magnetic engine, which was a continuous rotary motion derived from the alternating action of horseshoe magnets. I then gave it to the world,

through your paper, the Franklin Institute *Journal*, and *London Mechanics' Magazine*. Now I ride in the cars here, propelled by its power. I had it running in Philadelphia in 1850, and now the world knows not whence it came. Such is the fate of science and invention when not accompanied by the grasping greed of gain. My prediction that it would become an engine of power to the world has been verified, and that is my satisfaction. I was far ahead of the electric age in 1850 when I made it." We do not quite understand the reason for the term "solar magnetic engine" by the above pioneer, and certainly there is no solar action about the modern electric motor.

Firing Submarine Mines.—The possibility of firing submarine mines by the Marconi method has been questioned by naval experts, and we ourselves have doubts whether the people who propose to ignite mines in this way would care to risk their lives on a boat in a mine field with only the protection afforded by a Marconi resonator. It is another matter, however, to construct a submarine mine which is specially adapted for being exploded in this way. Experiments in this direction have been carried out at the electrical exhibition now being held in New York City, where small quantities of explosives are ignited under water as an attractive feature for visitors. In this case the idea is that the mine will be fired by the defenders of the fort by the Marconi apparatus, instead of using electric conducting wires as at present. In the experiment in question only one mine was used, and the difficulty of discriminating—or, rather, of selecting—one particular point to receive the signals is even more apparent than in the space telegraphy. From what we can see, if suitable mines were provided, the whole mine field would be exploded at the same time in order to blow up the enemy's warship which was in contact with one mine only.

Electric Welding Extraordinary.—The exhibits at the New York Electrical Exhibition include a large number of novelties, but we note from the American journals that in certain cases the features of the exhibit are more novel than practical. As an instance of this we would refer to an electrical welding outfit in which a storage battery is used to supply the necessary current. We gather from a description of this outfit that two volts only are employed in welding, and that these are obtained from an accumulator which is under normal conditions supposed to give 50 amperes. During the time the weld is being made the current used commences at about 800 amperes, and then drops to 400. The effect of such high discharges on the accumulator plates will be most disastrous, and we can hardly imagine that the company supplying the cell is pleased with the conditions under which it is used. In the old days, when accumulators were first introduced into this country, it was a common practice to roughly ascertain the condition of the cells by seeing if they would make a certain sized copper wire red hot. It was quickly found out that this rough-and-ready test caused a number of the troubles which the users of accumulators at that date experienced.

The Telephone Enquiry.—At the Parliamentary Committee on Tuesday last, Mr. J. C. Lamb, comptroller of telegraphs, gave further evidence to the effect that Sir James Ferguson's agreement, the draft of which was signed in August, 1892, was only finally approved in March, 1896. The causes of the delay were chiefly of a financial character. In reply to various members of the committee, Mr. Lamb said that since the trunk wires had been taken over by the Government 24,526 miles of wire had been erected and 4,647 more were now in the course of construction. In addition it was intended to construct several thousand miles more. He did not think that population or size need necessarily be considered when establishing an exchange. The main consideration must be the number of allied businesses in the neighbourhood. The Paris telephone area was very much smaller than London. Further questioned as to the rates charged by the Government and the company, Mr. Lamb said the Government had fixed one tariff for the whole country while the company had different rates in different towns. In reply to further question, Mr. Lamb said he thought the public interest would be best served if the whole telephone system were in the hands of one body. He personally thought the whole system should be in the hands of the Post Office.

Electric Coal-Winning Machines.—The London correspondent of the *Glasgow Herald* gives the following data, the results got from some of the mines in the United States where electric coal-cutters are used. In one of the large mines where the electrical equipment is very extensive, first cost ran about £23. 10s. per horse-power of engines, the operating stores and repairs costing about £5 per horse-power per annum. This works out to 1½d. per ton of coal produced or delivered at the bank, while the total outfit represented an investment paying 25 per cent. For coal-cutting in this particular mine there are 11 500-volt breast machines able to make a cut 69in. deep, 36in. wide, and 4in. high. Their weight is 2,800lb., and the power of the motor about 12 h.p. These will make the cut above in 4½ minutes, and allowing for changing position, etc., will do 30 cuts, or mine 60 tons of coal per shift, or 120 tons per day for each machine. The production per man works out to six tons per day when he uses the machine, but when using the pick the output is only four tons. It follows that where the machine is used the production for a given amount of manual labour is 33 per cent. more, so that it is easy to understand that under the new conditions wages could be higher, with greater profit also for capital. Moreover, less pit room is required with the machine, and the cost of blasting and loading up machine-cut coal has worked out to be only one-half the rate for hand-pick work, while the cost of undercutting by machine is one-eighth that in the case of manual work. Again, the work is so much better done that there is an increase of about 3 per cent. in the yield of lumps. The cost of traction in the mine with electricity is nearly 30 per cent. less than with mules, while for electric fan ventilation the fuel required is less than half that used for furnace ventilation.

Electrical Engineering in Italy.—The use of electricity in Italy, both for lighting purposes and as a motive power, is constantly extending, and there is consequently an ever-increasing demand for all kinds of electrical appliances connected with this development. Some of these are now made in Italy, but by far the greater part come from Switzerland and Germany. Our British electrical engineering firms do not seem to be making any effort to secure a share of this business in Italy. In 1899 the centenary of Volta's discovery of the electric pile is to be celebrated in Como, his native town, by an international exhibition of electrical appliances, which will no doubt be most important and interesting. Our Consul at Milan, in his report on the trade of Lombardy for last year, says further that although electric traction has not yet been applied to all the tramway lines of the city, still the first year's working under the new arrangement has resulted in a net profit for the municipality of £38,000, as compared with about £14,000 under the old system. In the course of the next few months, the Edison Company, which works the electric tramways for account of the municipality, will bring into Milan a force of nearly 10,000 h.p. obtained from the River Adda at Paderno. Six turbines, each of

2,160 h.p., with a seventh as a reserve in case of accidents, will be employed for developing the water power and conveying it to the dynamos, which will be seven in number, and the electric current will be carried from Paderno to Milan, a distance of 20 miles, across country by means of overhead wires. These turbines are said to be the most powerful hitherto in use in Europe. It is estimated that the loss of power in transit will not exceed 9 per cent. Of the nearly 13,000 h.p. to be thus developed, 2,000 are already disposed of in the town of Menza. The remainder will be brought to Milan, and any surplus that may remain, after providing for the public and private lighting of the city and the working of the tramways, will be let for industrial purposes.

Motor Protection.—Mr. H. H. Cutler rectlyen delivered a lecture before the Chicago Electrical Association on "Motor Regulation and Protection." In introducing the subject, Mr. Cutler spoke of the practically unlimited field now opening up for the electric motor in shop transmission, in which field it now has a sure foothold. The regulation and protection of these motors had given rise to what might almost be called a separate branch of electrical engineering. The regulation of an electric motor is always accomplished by reducing the voltage across some part or parts of the windings, according to the nature of the motor and the work to be done. A compound-wound motor with provision on the rheostat for cutting out the series windings and cutting resistance into the shunt field was spoken of as one of the neatest methods. A regulating rheostat of this kind with automatic underload release on all of the various speeds was shown. He also described in detail an elevator controller which relieved the strain on the field insulation when reversing. He advocated, for protection, the enclosed fuse, because it gave the kind of protection that the motor really wanted—namely, protection against overheating, whereas the circuit breaker took no account of the heat being generated in a circuit, but opened whenever the current exceeded a certain amount. Since heat is the thing to be prevented, protective devices operated by heat should be used. The objections made as to the unreliability of the open-air fuse did not hold against the enclosed fuse, which always has a definite surrounding medium. He exhibited a new form of circuit breaker of his design which had the magnet coil in shunt with a low resistance. This resistance had a high temperature coefficient, and would rise in resistance with an excess of current so as to increase the voltage across the magnet coil and cause it to trip the catch. The value of this form of breaker in motor work lies in the fact that it will permit an overload for a short time, but will never let it remain longer than the safety heating limit of the circuit permits. The latter idea is a good one, and we agree with our New York namesake in praising it.

Electric Traction in America.—The engineer and manager of a trolley line in the States does not have a bed of roses. It seems, from the *Street Railway Review*, that it is no uncommon thing for him to find a long length of the trolley wire stolen when the cars want to start in the morning. One correspondent suggests that there are two ways to assist detection of theft of trolley or feeder wires when the power station is shut down at night. The simplest plan would be, if a source of alternating current is available, to open all main switches at the switchboard and throw the alternating high-tension circuit from the local lighting company on to the 'bus bars, keeping all feeder switches closed. The effect of this would be to give a very severe shock to anyone attempting to cut the wire, and after it became known that the trolley wire at night was charged with one or two thousand volts, we think there would be few attempts made to cut wires. By attaching to the 'bus bars at the switchboard, all feeders, as well as the main line, would be in circuit. It would, of course, be necessary to insert in series with the line sufficient resistance to prevent a heavy flow of current. Another method would be to run a small pressure wire from the terminus of the circuit back to the power-house, then, having opened the main switches, set in a magnetic device similar to an annunciator, in connection with several cells of gravity battery. In this plan a circuit would be made from the 'bus bars and through all the feeders to the line returning through the small pressure wires spoken of at first, and so long as the circuit was complete the armature of the annunciator would be held against its magnet, but on breaking the circuit at any point the armature would be released, and a bell-ringing circuit thrown in, thus giving a visible and audible notice of a break in the line. An indicator could be arranged for use there in the power-house, or at any other point in the city at the option of the superintendent. These seem to us to be preventives, but we wonder where the police spend their nights if such bulky stuff as trolley wire can be freely taken away.

Como Exhibition, 1899.—An international exhibition of electricity will be held at Como from May 15 to Oct. 15, 1899, in honour of Volta on the occasion of the centenary of the electric pile. Volta was born at Como in the year 1745. The exhibition will review the history of a century in the vast field of electricity, and a congress of electricians ready to present the most recent progress of the science and electric applications will be its principal feature. By uniting with this an exposition of the silk industry, a branch of trade much developed in Como, it is desired to diffuse the knowledge of the application of electric energy to an important series of machine tools. The exhibits will comprise: Volta's discovery, illustrated by his apparatus — Bibliography — Manuscripts — Autographs — Portraits—Medals—Personal objects—The story of electricity during a century—Documents, publications, manuscripts, designs—Plans of machines and electric installations, and transports of electric energy—The teaching of electricity: models, apparatus, and instruments for didactic use—Apparatus for measuring, controlling, and distributing electric currents—Meteorological electricity—Batteries and accumulators—Steam boilers and engines: water, gas, petroleum, and wind motors—Transmissions and accessories for installations for the production of the electric current—Dynamos—Alternating-current dynamos—Transformers—Electric motors, and their application to machine tools—Electric conduits, aerial, subterraneous, under-water, with their accessories—Apparatus for isolation and safety—Means and rules for preventing personal injury—Electric light: incandescent and arc lamps; complementary apparatus—Lamps with portable accumulators—Lamp fittings, reflectors—Apparatus for projection—Lighthouses—Application of electricity to tractive power, and propellers—Electricity in telegraphy and telephony—Signals by means of electricity—Oscillators and sounders—Radiography—Electro-metallurgy—Electricity in chemical and extractive industries—Thermal applications—Galvanoplastics—Electric applications in mining and military operations—Therapeutic electricity—Various applications. We are informed that applications of intention to exhibit should reach the committee by Oct. 31.

British Association.—The autumn meeting of the British Association will this year be held in Bristol. A large gathering is expected, and the local committee is sparing no exertion in getting the guests well received and provided for. It is hoped that a large number of Canadian

members will be present. The reception-room and offices of the local treasurer and secretaries, during the meeting, will be at the Victoria Rooms; the offices of the presidents, the general secretaries, and the council will be in the building lately occupied by the Salisbury Club, where also a room will be set apart for representatives of the Press. The sections will meet as follows: A—Mathematical and Physical Science. In the Lecture Theatre, Bristol Museum. The president of this section is Prof. W. E. Ayrton, F.R.S. B—Chemistry. At the University College. The president of this section is Prof. F. R. Japp, F.R.S. C—Geology. In the Hannah More Hall. The president of this section is Mr. W. H. Huddleston, F.R.S., F.G.S. D—Zoology. In Victoria Chapel Schoolroom. The president of this section is Prof. W. F. R. Weldon, F.R.S., F.L.S. E—Geography. In the Music-room of the Blind Asylum. The president of this section is Colonel Church, F.R.S. F—Economic Science and Statistics. At the Merchant Venturers' Technical College. The president of this section is Dr. J. Bonar. G—Mechanical Science. At the Merchant Venturers' Technical College. The president of this section is Sir John Wolfe Barry, K.C.B., F.R.S. H—Anthropology. At the Park-place Schoolroom. The president of this section is Mr. E. W. Brabrook, C.B., F.S.A. K—Botany. At the Fine Arts Academy. The president of this section is Prof. T. O. Bower, F.R.S., F.L.S. The Museum Committee of the Corporation, the Charity Trustees, the Society of Merchant Venturers, the authorities of University College, and those of Clifton College have all kindly granted the use of buildings under their control. A number of the owners of manufacturing and engineering works have offered to open them for inspection during the week of the meeting. The evening entertainments usual at British Association meetings are being arranged for, and the programme will probably be as follows: Wednesday, Sept. 7, at 8 p.m.—Address in the Colston Hall by the president, Sir William Crookes, F.R.S. Thursday, Sept. 8.—Conversazione at Clifton College, by invitation of the chairman of the council (the Lord Bishop of Hereford), the head master, and Mrs. Glazebrook. Friday, Sept. 9.—Evening discourse in Colston Hall by Prof. W. J. Sollas, F.R.S. Saturday, Sept. 10.—Public banquet at the Colston Hall, arranged by the president and members of the Chamber of Commerce, and lecture to the working-classes by Prof. E. B. Poulton, F.R.S. Monday, Sept. 12.—Evening discourse at Colston Hall by Mr. Herbert Jackson. Tuesday, Sept. 13.—Conversazione at Colston Hall, given by the local committee. Banquet given by the Master and Society of Merchant Venturers. An important international conference on terrestrial magnetism will take place during the meeting, delegates to which are expected from France, Germany, Italy, Russia, Austria, Canada, and the United States. Amongst the excursions we note the following as of engineering interest: on Saturday, Sept. 10, excursions to Avonmouth Dock and the Severn Tunnel pumping station; on Thursday, Sept. 15, excursions to the sources of the Bristol water supply and also to the Great Western Railway Works, Swindon. There are many others of more general interest, and it is hoped that the Admiralty would send some of the big ships of the navy to Kingroad, so that members would have an opportunity of inspecting them. We are indebted to the *Bristol Times and Mirror* for much of the above details of the arrangements made by the local committee.

Dynamo Design.—The following editorial notes from the *Electrical World* of New York are most interesting, as giving a critical survey of the present practice in dynamo design in the States. The notes are as running comments on the machines now on exhibition in New York: "In the design of direct-current dynamos there is evident a still increasing partiality for the multipolar as opposed to the bipolar type, the multipolar machines being made in sizes as small as ½ h.p. at low speeds. These machines are all of the circular type—that is, having external circular yokes and internally projecting poles. In the construction of fields the rage for steel seems to have subsided, cast iron being quite largely used for the yokes, with cores—or at least pole-tips—of wrought-iron plates or laminations about ⅛in. to ¼in. in thickness. The practice of casting these into yokes is about equally in favour with that of bolting the parts together with machined joints. The yokes are noticeably thinner and wider than was the practice hitherto, being now as a rule sufficiently wide to cover completely the windings of the fields, so that on looking at the machine from one side the field spools are invisible. The purpose of this is probably mechanical protection simply, the same principle being carried still further by some makers in what is called the 'apron type field,' this designating a yoke which is flanged at either edge inwardly toward the shaft, thereby still further enclosing and protecting the coils. Generator fields are universally compound wound, edgewise tape winding, particularly for series coils, beginning to be used. Coming to the air-gap, a notable feature is the increase of the magnetic density at this point, the use of pole-shoes to increase the area of the gap in order to reduce the reluctance having been quite largely abandoned. On the contrary, many makers now bevel the poles of the field-magnet cores, thereby reducing the active area of the gap below that of the cross-section of iron in the field. This, with the area lost by reason of the crowding of the lines of force into tufts over the teeth of the armature, obviously increases the density greatly above that in the iron of the fields. The purpose of this is to reduce the distortion under load, the lines being so crowded at the pole faces that the distorting effect of the armature currents cannot crowd them much more into either horn. This is obviously done at the expense of an increased loss of energy in the field exciting coils, but the demand for a machine that will run sparklessly without rocking of the brushes from no load to 25 or 50 per cent. overload necessitates some such sacrifice. Coming to the armatures, the smooth body type has practically vanished from the design of the present day. The notches are deep, about one-half the width of the teeth, and, as a rule, with parallel sides, the teeth being narrower at their bases that at their tips. The edges of the laminæ are finished after assembling to remove burrs and irregularities in the slot walls. Binding wire is still quite largely used, but other methods of resisting the centrifugal force are coming into practice, one popular one being the insertion of long strips of wood the whole length of the slot, entering notches just beneath the tip of the teeth binding them firmly in place. Some makers use an overhanging tooth with but a very slight gap between the overhanging tips of adjacent teeth, making practically a tunnel winding, thus eliminating the tufting of the lines of force across the air-gap and the consequent necessity of laminating the poles, as well as the need of any binding devices, at the expense of greater difficulty in armature winding. In armature insulation the use of mica and its products has fallen off, owing undoubtedly to the expense of such materials and the production of cheaper insulating materials, such as oiled paper, pressboard, sheet fibre, etc., with sufficiently high breakdown strength for the voltages common in direct-current constant-potential work. Straight out end connections or barrel windings are apparently growing in favour, being now used as much as the older spiral type."

for central stations and tramway works on behalf of this company, as well as in supervising their electric lighting department. In 1891 he was engaged by the firm of Messrs. Bramwell and Harris, engineers, of 5, Great George-street, as assistant engineer, and in 1893 was appointed by them as resident engineer on the Derby Corporation works. At the beginning of the year 1897 Mr. Stewart was appointed by the Derby Corporation sole engineer of the electricity department, and in this position he is carrying out several large extensions at the Corporation's electricity works, including the addition of a 600-kw. steam alternator. Mr. Stewart is an A.M.I.C.E., and member of the council of the Municipal Electrical Association, and an A.M.I.E.E.

Rider, J. H., was born at Bristol in 1864, and studied electricity and magnetism at Bristol Trade and Mining Schools from 1880 to 1883. For two successive years he headed the list of students. He was apprenticed to Messrs. Paterson and Cooper, of London, in 1883, and remained with them four years, carrying out lighting contracts in England and abroad. In 1887 he was appointed electrical engineer to Messrs. Blakey, Emmott, and Co., Limited, Halifax, where he designed dynamos and superintended the manufacture of electrical plant generally for six years. Mr. Rider was appointed borough electrical engineer of Bolton in 1893, and prepared plans and specifications and designed the whole of the electric undertaking, the works being opened in 1894. He reported on a general electric traction scheme for the borough in 1896. Mr. Rider was next appointed borough electrical engineer of Plymouth in 1896, and is now carrying out the construction of works for electric lighting and traction from his own plans and designs. The completion of this work is expected at the end of 1898. Mr. Rider is a member of the Institution of Electrical Engineers, associate member Institution of Civil Engineers, member Northern Society Electrical Engineers, and member of council of Municipal Electrical Association. The Municipal Electrical Association was formed on his initiative in 1896 at a meeting in London called to consider the new Board of Trade regulations. He has contributed papers to the Northern Society of Electrical Engineers and to the Municipal Electrical Association conventions of 1896 and 1898.

Wilmshurst, T. P., A.I.E.E., in 1885 entered the shops and office of the late Sir Charles Bright, mining and consulting engineer. In 1887 he was appointed to a post on the staff of the Taunton Electric Light Company. While in the employ of this company he had a large experience of pioneering work in various towns in the West. In 1889 he was appointed chief assistant to the Exeter Electric Light Company, then being formed, and in the following year he was made chief engineer. In 1893 he left Exeter on receiving the post of borough electrical engineer to Halifax. He was here called upon to design a complete scheme of electric lighting on the high-tension alternating system, which was successfully carried into operation. At the present time he is engaged in laying down an electric tramway system in Halifax, the power to be supplied from the existing electricity works.

Wordingham, Charles Henry, was born in 1866, and educated at King's College School and at King's College, London, in the department of applied sciences, where he took up complete three years' course of engineering. While there he obtained the Clothworkers' exhibition for science, and numerous other prizes and certificates, and on leaving was elected associate of the college (A.K.C.) and was presented with a special certificate of honour. On leaving college he was articled to Dr. John Hopkinson, F.R.S., for two years; had charge of his laboratory, and carried out a large amount of original research under his direction, also assisting him generally in his consulting work. On completion of articles with Dr. Hopkinson he went to the United Telephone Company for rather more than a year, being engaged chiefly in the erection of telephone exhanges. In 1889 he joined the London Electric Supply Corporaton as third engineer at their Grosvenor generating station. On the removal of the works to Deptford, he was appointed to take charge of the standardising department, the whole of the testing plant for which he designed. Subsequently Mr. Wordingham had charge of the distributing stations in addition to the standardising department. In 1892 he left the London Electric Supply Corporation to return to Dr. J. Hopkinson as his assistant, and was engaged in supervising on his behalf the carrying out of the contracts for the erection of the central stations at Manchester and Whitehaven. In December, 1893, he proceeded temporarily to Manchester to organise the staff and working arrangements of the station, and in March, 1894, at the invitation of the Manchester Corporation, accepted the permanent position of chief engineer of the electric works, since which time he has managed the entire undertaking. In July, 1894, when Dr. Hopkinson's agreement with the Corporation terminated, Mr. Wordingham became ...ulting engineer in addition to his other duties; and addi... ...al plant to the extent of 3,000 h.p. has already been laid ... under his direction, while that for another 5,000 h.p. is now ... added. The area of supply also has been increased eight-... He is at present engaged in preparing a scheme for the ...ution of electrical energy for light, power, and traction in a ... having an area of about 85 square miles, comprising the ... the city of Manchester and the districts of three adjacent ...thorities. He was elected student in 1884 and associate ... of 1892 of the Institution of Civil Engineers; student in ...ciate in 1887, and a member in 1894 of the Institution ...al Engineers, and is now a member of council of this ...; member in 1894 of the Institution of Mechanical ...; member in 1894 of the Northern Society of Electrical ..., and for four years member of council of this society; ...ember and was one of the founders of the Municipal Electrical Association, and was president of this association last year; is a life Fellow of the Imperial Institute. He is the author of various papers, including two presented to the Institution of Civil Engineers, one on "Telephonic Switching," the other on "Meters for Recording the Consumption of Electrical Energy." Both received Miller prizes, and were printed in full in the *Proceedings* of the institution, and the second has been republished in book form in America.

At the meeting on Wednesday, after the usual formal business, the presidential address was delivered by Mr. A. H. GIBBINGS, as follows:

Presidential Address.

BY A. H. GIBBINGS.

In presenting to you my presidential address, I find the first and most fitting opportunity in which to express my grateful appreciation of the honour I have received at your hands in being elected your president, and the great pleasure it has afforded me to accept the office. I must also heartily congratulate you not only on the fact that the association is now entering upon the third year of its existence, but also on the exceptionally rapid growth of membership, and the important and useful work which has already been carried out under its auspices. We have reason to believe that the influence of this association is daily becoming more powerful in the various municipal electricity undertakings throughout the United Kingdom, and we are sure that since our inauguration, greater good fellowship and ready co-operation exist among municipal electrical engineers. We have therefore every reason to congratulate ourselves on our present position and to be more than hopeful as regards the future. It will perhaps be of interest, if for a few moments, we look back upon the work which the association has undertaken since the first annual convention was held in this room two years ago. The papers which were read on that occasion were significant of the necessity of such an association as ours, and if we may judge from subsequent developments of many matters which were then discussed, that convention has indeed borne good fruit. I may mention the present very extensive adoption of electricity supply at 220 volts compared with the few places in which it had been adopted two years ago. Then there is the general coming into use of electric traction for tramcars, and the supply of electricity for both lighting and power from one central station. Nor must I omit to mention the control of electrical apparatus and wiring on the consumers' premises, which it has been suggested should be in the hands of municipal authorities. Here I may say incidentally that at this convention something approaching an uniform and complete set of wiring rules and regulations will be submitted to the members for approval and adoption.

All this has been largely the work of the council of the association, who have held 17 council meetings since June, 1896, the members travelling considerable distance to attend them. Many other important subjects have had their consideration, and have ripened into practical results. There are, for instance, the model clauses in connection with plant specifications, which are the direct outcome of conferences between the representatives of plant manufacturers and the council. They have also succeeded in securing important reform in keeping the statistical records of all the municipal electricity works, and the proper tabulation of the annual accounts and figures in such a form that a better and more reliable comparison of one undertaking with another is now possible. Other equally important matters are still in progress, and a list of some of them is given in the hon. secretary's report, at the end of the last published *Proceedings*.

It will be seen that the work of the association which I have just briefly summarised, has reference more particularly to the general or non-engineering side of municipal electricity supply. But other subjects concerned with engineering details, with management, and with questions of policy have also been dealt with, and also been productive of equally good results. I conclude, and I think with reason, that the reading and publication of papers together with the discussions thereon, have an educational effect which is beneficial and stimulating, and the importance of

which cannot be over-rated. When we look around and see the exceptionally rapid progress which electricity supply has made within the last two years, and the greater interest which municipalities are taking in matters which should rightly and properly be under their own control, such as the municipalisation of telephones and tramways, I cannot help thinking, and some pardonable pride mingles with the thought, that the awakening of this spirit has been due in no small degree to the splendid meetings of this association. It is eminently worthy of observation that these meetings have been well supported by the chairmen and councillors of the electricity committees of the various municipalities. I wish here and now to express the hope that these gentlemen who represent the political and public sides of municipal government, and who are peculiarly acquainted with those aspects of municipal electricity supply which do not as a rule come within the immediate province of the electrical engineer, will continue to give us their valuable and valued support, and will introduce as many more members of their committees to these meetings as they are able. I feel this to be a very strong and essential feature of this association. I shall not now indulge further in belauding ourselves and our work, but turn at once to those topics on which I wish to say a few words.

The first matter with which I shall deal is the character and functions of electricity committees. In some places we still find in existence a gas and electricity committee, an anomaly however in the matter of combinations which is rapidly becoming obsolete. In most places the electricity committee is separate and distinct, its functions being simply to deal with each and every matter appertaining to the department. Lord Provost Richmond, of Glasgow, was the first to call attention to the multifarious duties which attached to this one committee, and to show how inadvisable it was for one committee to attempt to deal as a whole with every phase of electricity supply, and how impossible it was that they should do so with any great success. The remarks of the Lord Provost were followed up by an able exposition by Mr. Arthur Wright in a contribution to the technical press. The technical press however, valuable and far-reaching as it is, does not often meet the eye of municipal councillors, and I should like, therefore, to call attention to this important and pressing subject through the medium of the association. I propose to point out briefly some of the reasons which make it almost essential that electricity committees should be reconstituted in order to be effective in the highest degree. It may be urged, and not without some show of reason, that there exists a precedent for our methods, in the municipal ownership and supply of gas, and that those arrangements which in the case of gas have proved entirely satisfactory and sufficient ought to work equally well in regard to electricity. But the supply of electricity is not to be compared with that of gas, as if they were in all respects the same. Electricity is more complicated and varied in its methods of generation and distribution; it is more subtle in its nature; its applications are more diversified, wider in their scope, and of greater importance. The details of all these phases of electricity supply are far removed from simplicity, and require special and careful consideration in nearly every development of the undertaking. In addition to these highly-differentiating features, the growth of the business has been very much more rapid than was the growth of gas supply, and this is likely to continue. We have also at present not a few collateral matters which it would be the province of the committee to deal with. Some of these are electric tramways and other motive power, street-lighting, methods of charging for current, commercial problems, assessments and other financial questions, and, by no means least important, the extension of existing electricity works with an eye to a greater future development than was dreamt of five years ago.

At the present time one committee, with possibly a small works sub-committee, attends as best they can to all these matters. If any special subject arises (and it often does arise) the practice is to nominate a few members to consider it and report thereon to the general committee, after which they exist as a special constitution no longer. As a matter of experience, it has been found that such temporary expedients do not usually work well. The electrical engineer has to deal with constantly changing sub-committees, with the inevitable consequence that the decisions are unduly delayed and progress is slow. The position is scarcely improved when the entire committee considers every subject. In that case the machine is often too big for its work. Frequent meetings may mean many absentees, and there is endless repetition in the discussions as a matter of course. I think the satisfactory solution lies in the formation of a number of permanently-appointed sub-committees, each entrusted with some well-defined section of the affairs of the department. I cannot do better than give the divisions already suggested by Mr. Wright. They are (1) a sub-committee on production, having charge of the works and sub-stations; (2) a sub-committee on distribution, having charge of the mains, feeders, connections, and meters; and (3) a sub-committee on finance, having to do with all data, estimates, loans, and accounts. Such an apportionment of work would lighten the labours of the General Purposes Electricity Committee, greatly help the electrical engineer, and probably facilitate business all round. Having thus indicated the lines upon which it appears to me it would be advisable to remodel and reform, I will not proceed further into detail. The subject seemed to me to be peculiarly appropriate in addressing this association. We have managed fairly well perhaps in the past, but the watchword of electrical science is "advance," and we must adapt ourselves to the vast developments which are going on at a rapid pace, if we are to get the public to more thoroughly appreciate the infinite applications and the immense importance of this new force in the service of man.

Another subject, not indeed wholly new, but which as yet has had only partial consideration, is that of the commercial or public side of municipal electricity supply. I think I shall be right in assuming as a broad proposition that the object of all municipalisation is to act in the interests of the ratepayers and to give them the best value for their money. Whether this should take the form of applying large profits to the reduction of the rates, or of working at the very minimum of profit, just paying expenses as a matter of fact, and retailing the article to the public at cost price, is largely a matter of opinion, and of which we shall hear more during the course of the present convention.

My own opinion is as regards the supply of electricity that at present there is only one wise course for us to pursue. We are bound to act in the interests of our clients rather than to subserve the interest of the public generally. Only in that way shall we enlarge the constituency of our customers and thus be moving in the direction of a cheaper supply. In a certain city which owns the gasworks it has long been the practice to supply all the gas for the public lighting of the streets without making any charge whatever upon the rates. The whole cost has, in fact, been treated as if it were part and parcel of the costs of production for private consumption, thereby, of course, raising the price per 1,000 cubic feet charged to private consumers. Street-lighting is undoubtedly a public necessity and a general boon, but the gas consumer alone in this instance is mulcted in the expense. I do not know that any great injustice arises, however, for the gas consumers are almost co-extensive with the ratepayers. But I should certainly deprecate any attempt at present to supply electricity for street-lighting purposes on the same basis. It would practically mean burdening a comparatively few—that is, the consumers of electricity—for the advantage of all. The entire cost of the public lighting, including the capital cost of erecting lamp-pillars, represents no inconsiderable sum of money, and the burden would simply be intolerable. In addition to this it would not be, as I have already stated, a sound commercial policy.

I am tempted here to refer to one or two other matters in which I have always taken a great interest, bearing upon this question of a sound commercial policy. Is it incumbent on a municipal electrical supply undertaking, or is it desirable that they should restrict themselves to being the mere purveyors of electrical energy? Is it their bus-

s, and is it to their advantage to go beyond this, so far least as to ensure, to the best of their ability, that the isumer gets what he ultimately pays for—that is, ht and power as nearly perfect as possible? My answer the first of these questions is in the negative; to the ond, in the affirmative. I am convinced of the expency, from all points of view, of the policy of undertaking supply of lamps, and of selling or letting out motors on e, by the municipal electricity supply. I am well aware t this may be characterised as the paternal regime, but end, or ends, in my opinion, will in this matter tify the means. Consider how the consumer looks these things. The fact of the voltage and the meter ng correct is of small consequence to him if his ips are bad and his motor inefficient and troublee. He, of course, attributes everything wrong to dquarters, and thinks the supply must needs be the gin of mischief in all cases. And so, as matters now id, a great deal of odium and much trouble fall the electrical engineer for faults which really arise of defective apparatus not under his control. I do wish to advocate here a wholesale proprietor- of electrical apparatus by the municipality. The nt to which the business should be carried must be rmined by experience, and perhaps also by local umstances in some degree. But it is certainly pos- and probably advisable for more to be done in this ction than at present. With regard to the financial ect, these methods appear to me thoroughly sound both the municipality and the consumer. The municipality the money to buy such apparatus as electric motors arc lamps at the time the demand arises, which in ct is of course creating a demand, because a consumer hire and pay good interest upon the capital outlay, n he might neither be able nor inclined to purchase right. The disinclination to purchase electrical aratus for himself arises principally from his ignorance mistrust. His difficulty and hesitation are overcome n the electricity department itself provides these and es a certain amount of responsibility. He feels confident t he will get what is best suited for his purposes, and t he is guaranteed against all risks. It is obvious also t by thus creating and fostering a demand, trade is ulated and increased for the contractor and manuurer.

have specifically mentioned the supply of lamps and tors, but I should like it to be clearly understood that re are many other developments on which, in my nion, it would be well worth while for electricity supply lertakings to enter, as a matter of practical policy. ere seems to be no inherent reason why a hard-and-fast should be drawn by municipalities at the mere genera- and distribution of electrical energy. But whatever w we may take in regard to this question of extended iness, there is one phase of the matter which we cannot rd to lose sight of. It is perhaps the most pertinent of which we need to remind ourselves in relation to it. efer to what is done by supply companies and what they even yet prepared to do. Up to the present time it has n the practice to grant a provisional order either to a nicipality or an independent company, which order carries h it the practical monopoly of the business for a certain , and it certainly is not the tendency with these comies to limit or circumscribe their business in any way. w it is very significant to observe what is the attitude the public to these concerns. I think I might go so far o say that in many towns and districts the ratepayers ild show their preference, if a reliable ballot could be en, that the supply of electricity should be in the hands an independent company. Whilst this is, of course, no ument whatever against the desirability on general unds of the undertaking being in the hands of a local hority, it is clearly enough an indication that the public sider that their requirements are likely to be better served the company. Why should this be so? The municipality ght to be able to do far and away better for the city or ough, not only in the long run, taking the future into ount, but also in the immediate present. Let municiities be wise and read the signs of the times, and, above all, them be scrupulously particular to avoid conducting their business in any way and every way which savours of the methods of monopolists. You will probably be aware that at the recent sitting of the Joint Committee of both Houses of Parliament on the clauses relating to electrical generating stations, the first attempt has been made to obtain sanction for admitting competing companies into the areas supplied by local authorities. This is a serious menace. Local authorities, be it remembered, have not the same privileges in the management and prosecution of their business as a company would have. The former are at present handicapped by parliamentary restrictions; the latter would be practically free or subject only to the conditions which impose themselves on any wisely-conducted business enterprise. It is high time that extended powers were conferred on municipal authorities in order that they may not be cramped in this new undertaking, and especially if competition is to come, in order that they may compete at least on an equal footing with the companies. It will then be incumbent on them so to use these enlarged powers in the interests of the public that no question of admitting rivalry within their borders shall arise, and progress be no longer hampered by statutory regulations which are more stringent than necessary.

The third and final point to which I wish to make reference is the important subject of "standardisation." I am glad we are to have a paper entirely devoted to this subject from the able pen of Mr. Wordingham, in view of which I shall only travel very lightly over the surface of the question. The standardisation or uniformity of plant, apparatus, sizes, and dimensions of mains and dielectrics, speeds, periodicities, voltage of supply, etc., has now become an absolute necessity in some cases, and a matter of desirability in nearly all. It is a subject eminently worthy of the careful consideration of the association, for while there can be no doubt that consulting engineers, electrical engineers, plant manufacturers, contractors, and others are unanimous as to the value of standards in the abstract, they are by no means of one opinion as to what the respective standards should be. Let us take a brief view of the position. In the first place, each manufacturer has his own particular type and sizes of plant and apparatus; each consulting engineer has his own ideas of speeds, periodicities, and systems of supply; and each borough electrical engineer has probably more "fads" than all the rest together, and little wonder when it is remembered that he has in many cases to conduct operations with plant put down with very little regard to the adaptability of one portion to another. There are, of course, some good points in most of the many varied designs and excellent reasons for each of the many varieties of method, and what is wanted therefore is that the very best of these should be taken and formed into what can be recognised as standards or bases. In the United States there is much less variety of plant, apparatus, and methods than in this country, and the reason is clear. There the business of electric supply and manufacture has been in the hands of two or three great and influential companies, who have recognised the immense value of making as far as possible an uniform class of article. The consulting engineers having in many cases arisen from the employ of these firms, they have followed the same ideas, and the result is apparent in the confidence and progress which everywhere obtains. We have in this country at least one prominent instance which I may mention by way of illustration. I refer to the ordinary bayonet lampholder. The original high price of incandescent lamps has been a very small matter compared with the advantage of a standard form of holder, which is the outcome of the lampmaking monopoly. There are many makers of engines, dynamos, motors, cables, arc lamps, etc., who have standardised their own particular article of manufacture and its details of construction, and with the best possible result. There are others who are for ever varying their types and patterns, and who never keep spare and numbered parts. They are generally most indignant if specifications are not sufficiently wide to admit any or all of their vagaries.

It is not, perhaps, in regard to such details of special manufacture that we can accomplish much. Indirectly, they would be affected, but the object of the association

should be, I think, to standardise the conditions rather than actual details of the various matters already mentioned. It will be a work of equal and inestimable importance, and of unquestionable advantage to all parties concerned.

I have now come to the close of my remarks upon the three special features of electricity supply, which I have ventured to suggest might with advantage have the consideration of the association. The question now arises as to what is the best method of considering such matters, with the object of achieving the best practical results. The answer seems to be that, where several distinct and yet allied interests are involved, the most suitable initial step is that of a representative conference. When once such a conference has agreed upon a definite course of action, the object desired is rendered comparatively easy of attainment. Therefore I suggest our co-operation, wherever possible, with kindred and longer-established institutions and societies, to deal exhaustively with the details of these matters, and to lead us to those wise and workable conclusions which are only reached by thorough deliberation and open discussion.

In conclusion, I think that this association has arrived at a stage in its existence when its usefulness has been demonstrated beyond all question. Like other societies and individuals who set themselves an earnest task, or create an honourable sphere of work, the labour grows on our hands. If it were necessary I might here read a little homily on rising to the occasion, putting our shoulders to the wheel, and in other hyperbolic language inculcate the duties of energetic application and devoted effort, but these are virtues which scarcely need fostering among the members of this association. I thank you sincerely for the attention with which you have heard me.

Mr. C. H. Wordingham said they had listened with great interest to the president's address. He was sure all would agree in giving him a vote of thanks, and would ask him to allow it to appear in the *Transactions* of the association.

The following paper was then taken as read:

Management of Electrical Undertakings by Local Authorities.

BY COUNCILLOR HESFORD, EX-CHAIRMAN OF THE SOUTHPORT ELECTRICITY COMMITTEE.

It calls for no great demand upon our credulity to-day to assume that electrical undertakings can be efficiently administered and profitably managed by local authorities. We have evidence of this sufficient to convince the most sceptical, even Government departments. Yet, with such evidence plainly before us, the anomaly remains that of the total number of provisional orders annually obtained, many drift into and dwell for years in the regions of the doldrums. Here pessimistic majorities love to dwell until leavened by the optimists, when the good ship soon finds its way into the trade winds. Having arrived in such active sphere, committees generally exhibit a desire to understand something of the work they are called upon to do. Nay, their zeal is generally worthy of emulation by every manufacturing committee of corporations. Some are even as zealous as the boy who took the bellows to pieces to see from whence the wind arose. "It is a new thing," is a common remark; and who does not like to see and hear of something new?

Having taken their decision to establish a station, alas! difficulties face them at all points. Shall an engineer be at once engaged to design and subsequently work the station, or is it better to call in the advice of some consulting engineer to advise and plan? To approach the makers of machinery at this point, as private individuals do in building factories and works, is rank corporate heresy. On such a momentous question members seek advice from those of their friends who have already gone through the mill. But here diversity of opinions is the bewildering fruit of their efforts. Every committee know what they want. It is a station and system of distribution that shall be second to none. It must be planned for utility and convenience, and meet the unknown wants of futurity. Its machinery should be designed to adapt itself with precision and success to all the varying requirements, work at a cost that shall top the record, and be obtained from the lowest tenderer. These are the ideals, and the question is how to get them. Friends tell us privately that consulting engineers are divided into schools, and that somehow or other their district will be found to be well suited to the particular system that the engineer called in generally advises. The advantages of such system are explained and made manifest, whilst the disadvantages of others are clearly portrayed.

Having read or remembered something of the battle of the gauges fought by railway engineers in the first half of this century, and its termination by the evidence of convenience, members of committees subside into despair of being able to give a clear-reasoned decision on any system. In this condition the influence of persuasive oratory generally prevails and soon seals their capture. An engineer is engaged and a suitable system declared. Should the committee continue in the jelly-fish condition produced by abundant and earnest advice of opposite polarity, they will be spared the distractions of listening to the arguments of Lancashire *versus* water-tube boilers, or high-speed *versus* slow-speed engines—one advantage of being in a plastic condition of mind. The station being now completed, committees for a time at least are rid of their perplexities and difficulties. This is for a short time only. Errors in design and equipment soon make themselves apparent. Our buildings are too narrow or too short, is a frequent cry. But that much-belauded day plant is the dilemma of most committees. Having been at work a year or two it leaks out gradually that the small unit specially advised for economical day-load work is too small, and of insufficient power in some cases to energise the transformers alone. We are advised to sell them, but to whom? If the Asiatics could be induced to take them as readily as they take modern rifles, what a relief to the corporations and benefit to the buyers it would be. The advice frequently given to sell this or scrap that—often advisable and perfectly sound from a business point of view—must or ought to bring to every committee the concomitant duty of making a reserve fund out of which the unpaid sinking fund on such plant can be met.

But the primary and foremost duty of committees having stations under their control ought to be the production of electrical energy at the lowest possible cost. None need be at loss for a standard whereby to measure such costs. With the excellent and up-to-date tables in *Lightning*, the failings of every station becomes apparent. Certainly few, if any, can excel in every item of costs in the group into which they, as measured by output, fall. All can, however, try to stand well by comparison where skill and forethought in design and equipment, as well as management, make themselves felt. The policy of willingness to lay cables to supply proposing or likely customers, has hitherto been attended with general success. Of the day when it will become the poor man's light, we all anxiously await the dawn. Whenever the cost of distribution can be cheapened considerably, that day will have arrived. Everyone connected with electricity committees remarks on this at present very costly process.

Street-Lighting.—Electricians all advise, and wisely no doubt, the lighting of our streets with electricity. What a smug satisfied look would pass over the face of every corporate electrical engineer if he could obtain it. The nice 3,000-hour load factor would delight him. How is this desirable change to be brought about? The prize is worth every effort. But all here know that corporate gas committees are tough, thick-skinned gentlemen. The one lever that would be rapid and successful in gently lifting them from their commanding position is the one of less cost. Bring that about by whatever means you like, and the object of our desire is attained.

Charging.—No paper on management would be complete without reference to the prices charged. In this matter corporations stand well in comparison with private companies. By a large and constantly-increasing number the Wright system of charging is finding favour. Personally, I am strongly in favour of retaining the maximum price intact, setting the time limit of such price to suit the circumstances of each locality. For all energy consumed beyond the time of maximum price I would drop it to the lowest possible charge consistent with covering all charges. A reserve fund I deem a necessity. In a word, my policy would be one of charging the lowest price the system will bear, rather than the one that generally obtains in the gas world of charging the maximum that the public will quietly consent to pay.

In conclusion, as an earnest member of committee, let me add that it will be the opening of a grand day for the popularity of electric lighting when a greater portion of the capital energy and resource now expended by electricians on various schemes for improving steam-engines and boilers shall be spent on the cheapening and perfecting of the means of distributing energy for lighting purposes. An average of from £8 to £10 per connection is a very heavy capital charge to carry. The interest and sinking fund on this amount is equal to one-third the annual cost of light in cottage houses. Nor as a member of a corporation can I ignore the fact that the calamities that we were almost passionately pressed to anticipate and guard against by the expenditure of capital on duplicates have not generally shown themselves in practice. Accepting the Press as my authority, the major portion of failures in lighting have occurred in consequence of weakness or defects in the distributing plant. Our boilers, steam-pipes, and engines have not failed so often

as the underground portions of our systems. It is on this portion of the plant that members of committees entertain a fear that is fruitful of halting and indecision.

DISCUSSION.

Mr. Faraday Proctor (Bristol), in opening the discussion, said it was a fact worthy of notice that this was the first meeting at which a paper had been read by a member of the Municipal Association. It was a subject of great interest to everyone who had the cause of electrical undertakings at heart. The paper had touched on all the most important points of the question. The greatest difficulty was with the jelly-like committee referred to. With reference to starting an electric station, he should say that it was better to engage an engineer who would design and afterwards work the station instead of calling in a consulting engineer. He thought that Councillor Hesford was rather hard on station engineers. No doubt they had their little weaknesses, but so also had consulting engineers. With regard to day-load plant, how should it be got rid of?

Mr. C. H. Wordingham (Manchester) said that a system might be introduced by which, when a station got large enough to do without its day-load plant, it might pass it on to another station which was just starting.

Mr. Faraday Proctor, continuing, said he should like to hear from other engineers how stations should be managed. It seemed to him that in the daytime engineers had charge only of internal work at the station, but at night they were held responsible for what happened outside. That was a rather curious arrangement. As to the question of accounts, and whether they should be kept by the engineer or not, he should say not. An accountant ought to be kept who should take charge of all these, but under the supervision of the engineer. New plant, he thought, ought to be charged to capital account, while repairs, etc., should go down to revenue.

Mr. J. T. Skinner (Hull) said a remark had fallen from the gentleman who had just spoken with reference to keeping the accounts. He thought that any accounts connected with a municipal body should be done by the treasurer of the council. At Hull they were done by the Corporation treasurer and secretary. He felt it a great honour to speak before such a highly technical audience.

Mr. Faraday Proctor said his idea in bringing the question of accounts forward was to know whether the engineer should be troubled with them, in addition to his ordinary work. He thought that ought to be the work of a separate officer.

Mr. A. Bromley Holmes (Liverpool) said he thought a consulting engineer should be called in to design the station, but once that was accomplished it should be turned over to the engineer who was to take charge permanently.

Bailie Maclay (Glasgow) said that electrical distribution was a much more delicate system than gas, and required more attention. He did not think that the electrical engineer's duties should be mixed up with rates, accounts, etc. In Glasgow they had a separate and independent secretary for this, and he had nothing at all to do with the city treasurer. They had a separate committee from the Gas Committee for electricity. It used to be part of the Gas Committee, but they were now separate except that the accounts were done together. The committee had once the power of appointing the inspectors, but on complaints reaching them the power was handed over to the engineer. This was, of course, what should always have been, as the engineer would know better than the committee on this matter.

Mr. R. C. Jackson (Newcastle-on-Tyne) said he would like to remark on the way municipal accounts were done, and would ask if it were not possible to get them more into line with the Board of Trade requirements. With regard to the question of staff, on the Continent there was, as a rule, the chief engineer, one engineer for the purely mechanical working of the station, one engineer for the electrical portion, and one for the outside work. That seemed to produce good results.

Dr. Panton (Bolton) asked how the cost of provisional orders should be met? He himself thought it should come out of the capital. If deducted from the first year's revenue account, people thought the station wasn't paying. He thought the engineer employed in the working of the station should also take part in the construction of it.

Mr. Minshall asked, with regard to the charging of overdue plant, did it come out of the capital?

Mr. Webb (Stockport) said the point raised was one of the greatest importance to municipal undertakings. With regard to the jelly-like condition of the committee, they were, he thought, to a great extent in the hands of the engineer. The committee might consist of shrewd men on ordinary questions, but they probably did not know much about electrical matters. With regard to the little weaknesses of engineers, these little weaknesses were apt to be costly. Some engineers always recommended the high-current alternating and others the direct-current plant. They should guard against this as much as possible, and recommend the plant which was really required. As to the taking of day-load plant from one station to another, that was not as easy as it seemed, as different stations had different standards.

Mr. C. H. Wordingham said that the paper dealt with the question of committees, and it would have been better to have had a supplementary paper dealing with the internal management of stations. As to the question whether they should engage an engineer to design and carry on the station, or have an engineer to design it and another to carry it on, he thought that the latter was the better plan. Regarding the last paragraph in the paper on the question of duplicating plant, the network should not be duplicated, as that would involve too great an expense. The chief cause of breakdowns not being noticed was that they always had the duplicate plant ready, and when the other broke down this was switched in and nothing was noticeable to ordinary consumers. Instead of duplicate mains, these might be connected so as to leave the current several alternative ways to go. In large electric stations it was quite impossible for the engineer to attend to the accounts as well as his other duties. That post should be entirely separate from the electrical. The accounts should be attended to by an accountant who had charge of the accounts proper, apart from anything else. It would not do to lose sight of the fact that an electrical undertaking was a commercial affair. He should like to ask why Continental stations so divided up the work? He did not think that arrangement would work very well, as there would be constant bickerings and disagreements.

Mr. Horace L. P. Boot (Tunbridge Wells) said that one speaker had said that engineers advised high or low tension plant as a regular thing. That was a state of affairs which had now died out. It would simplify matters very much if they had a good system of standardisation. In a paper read by him at a former meeting on street-lighting, the figures given then, when worked out, showed that electricity was cheaper than gas for street-lighting. But they could not get the public to understand that if they got 10 or 12 times more light, they had to pay about 10 or 12 times the price. He could not understand the great differences in the sinking funds of various installations.

Mr. R. Hammond said that Mr. Boot seemed to be under a misapprehension as regarded the reserve fund. All that was provided for in the provisional order. He would find there that it might not at any time be more than one-tenth of the capital invested. It might also be used for new plant, etc., at any time it might be required. It seems a pity that in the first paper in the meeting there should be a condemnation of English stations. The works were found to be badly designed, and many were too short or too narrow, and required greatly altering. As it was a rule of the association that they must represent somewhere, he represented Newport. At Newport they had not found any of these errors, and in two years their light supply had never failed. With reference to the commercial side of electricity, he thought it should be kept entirely separate from the electric side.

Mr. A. H. Gibbings (president) said he was sure Mr. Hammond need not be afraid of the stations being built wrongly in future.

Councillor Hesford, in replying, said he would start with Mr. Hammond. The bad work mentioned was not so serious as he appeared to think. The errors were not very great, but he had seen many stations which had wanted widening or lengthening. With regard to the reserve fund, he agreed with Mr. Hammond, the point he wanted to show being that it should be used as the plant became obsolete, for the purchase of new. He was sorry to hear that he was hard on the station engineers. He was glad to know that the practice was dead among them. But if it was dead, the tradition was not; traditions had a habit of living a long while. Financial matters should be under the control of a financial committee, but it was right that the electrical engineer should have some say in the matter. He would rather have direct taxation to pay for the station. With regard to the provisional order, it should be charged to capital. He did not wish to cast any reflections on committees; one could not expect them to know much about electricity. There was a great deal of human nature about committees.

The next paper was by Mr. J. R. Blaikie, and was, in his absence, taken as read.

Switchboard Apparatus.

BY J. R. BLAIKIE, CHIEF ASSISTANT ELECTRICAL ENGINEER, BRISTOL.

The control and measurement of electric energy is one of the most fascinating details of this branch of engineering. The switchboard, with its glittering array of polished metal and graduated dials, has always an attraction for the lay mind, while its intricacy or beautiful simplicity is a source of wonder or poetic appreciation to those better acquainted with such devices. Almost every station has some noticeable peculiarity with regard to its switch-gear, and there are few stations that have not lived to see radical changes brought about in this portion of the original scheme. The result at the present time is that it is almost impossible to classify the types now in use. This striking nonconformity, although intensely interesting, is not particularly happy, since it appears to show either ignorance or vanity on the part of the designers. One must admit that the spirit of commercial industry is to suppress varieties in favour of a standard. It would be ridiculous to suppose that the mere straining after novelties has been the whole cause of the present multifarious assortment. Switchboards have been conscientiously designed and constructed to suit individual cases, simply because there was no general standard that might be adopted. After certain results and experiments, modifications and improvements have been gradually introduced. But this form of private research work is too frequently misguided and uneconomical. The experimenter cannot, as a rule, afford to test a portion of his work to destruction; so long as it answers his immediate purpose, he is satisfied. A certain elegance of variety and some treasures

of ingenuity must be sacrificed to further the march of scientific progress. One must be content to labour in a vast organisation, and strive towards a higher ordeal than a more or less original switchboard. It is hard for a young enthusiast to surrender an opportunity for displaying a capacity for design in a field of such unlimited possibilities. It is far easier for him to imagine that there are peculiar necessities and requirements in the case under consideration, but seeing that there are life risks, and that the very heart of the undertaking lies in the switchboard, surely it should be the outcome of the strongest possible combination of experience, and beyond the reach of individual fancy.

Before dealing with the disposition of the component parts of the switch-gear, it might be well to enquire into the duties and characteristics of the details. The necessity for ever breaking a circuit while carrying much energy is not universally granted. For example, Prof. Forbes in his paper on "The Electrical Transmission of Power from Niagara Falls," Nov. 9, 1893, says: "I hold that it is a piece of culpable ignorance, ruinous to the machinery, if anyone should ever on a large power circuit with alternating current suddenly break the circuit while current is passing. The practice is quite unnecessary, and has given rise to a large proportion of the breakdowns of alternating-current machinery." Nevertheless there are switches at Niagara (see *Cassier's Magazine*, p. 291, Niagara number, capable of breaking 5,000 h.p. without damage to themselves, etc. Prof. Fleming agrees with Prof. Forbes, but he asks what happens if the circuit opens itself, and what is to be done about fuses? Unfortunately, Prof. Forbes omits these points in his reply. In practice, of course, one never opens a circuit conveying much energy, unless some unforeseen circumstance throws the whole or a portion of the machinery out of the usual control. Could not such emergencies be met by inserting a moderate amount of resistance or impedance in the circuit, increasing either by degrees if necessary? The same might apply to cut-outs when they are under the observation of an attendant. In the author's opinion main switches should work through steps in this manner, making it impossible to make or break with large currents. Assuming, as is customary, however, that a sudden break is necessary, or that the switch is in such a form that a sudden break could be made by a mistake, or accident, on the part of the attendant, while transmitting a large amount of energy, the essential characteristics of the design appear to be as follows: (1) that there shall be no danger to the operator, either by electric shock or from particles of molten metal flying free—this latter to apply to adjacent apparatus as well; (2) that there shall be no maintained arc; (3) that the contacts shall not be burned or injured in such a manner as to prevent the efficient working of the switch on closing again; (4) that the contacts and current-carrying portions of the switch shall always be in such condition that no heating will occur while carrying the maximum current for an indefinite period.

With reference to the first condition, there are several well-known satisfactory examples. The plug form having a large insulating handle and shield, the breaks being in earthenware pots, gives a pretty certain immunity from danger. A sufficiently long handle or mechanism actuated by cords can be considered safe. Another method is to mount a plate-glass screen between the operator and the breaking contacts, but this does not protect the other apparatus. To secure a certainty of break many contrivances have been devised. The simplest means is a sufficiently long air-gap in the circuit. For the sake of eliciting the opinions of the gentlemen assembled, some breaks (total length) for various conditions are suggested, assuming that the breaks are made with considerable and uniform rapidity.

Amperes.	100 to 500 volts alternating or continuous.	500 to 1,000 volts continuous.	2,000 volts alternating.
5	¾"	4"	4"
25	1"	6"	6"
50	1½"	8"	10"
75	1¾"	10"	12"
100	2"	12"	13"
150	3"	12½"	14"
200	4"	13"	15"
300	5"	14"	16"
400	6"	15"	18"
500	7"	16"	20"

(When these breaks are in the tubes, and so protected from air currents, it might be well to add, say, 50 per cent., to the length of the gap, and the same if the breaks are in a vertical direction). The air-gap may be in one line, but in order to save space and ensure a rapid break, it is more frequent to have several breaks made simultaneously in a circuit. It is not safe, however, to draw out two or more arcs close together in air without a substantial fireproof insulator between, as a slight current of air will blow them together and thus defeat the action of the switch. The plug switch becomes rather too c[illegible]brous in large sizes, since the sockets must be very deep or [illegible]lugs must be spaced out considerably. One very happy [illegible]n is the use of an electromagnet in the main circuit to

blow out the arc when it is formed. Another effectiv
perhaps, rather complicated means, is the applica
shutter, or clapper, which flies through the path of th
blows it out with the air currents set up. Some oth
cause the circuit to be broken under water, or an
oil, but to the author this appears to be a last ext
there are obvious objections to the use of a li
satisfy the third condition, "that the contacts shal
burnt, etc.," is a comparatively simple matter. Th
breaking is a primary consideration, though it may
so forcibly in the case of the alternating currents. T
springs, or the multiplicity of simultaneous breaks,
itself at once. A liberal weight of metal, or the
of a good heat-conducting fireproof insulator, red
temperature of the arcing points somewhat. As
precaution, the blades are usually made of wedge a
plugs are tapered, so that they may clear themselves
less on returning by shearing off the small globules
left on the contact faces. It is therefore desirable
mechanism should be able to withstand such strain
proportioned that sufficient force can be applied. An
of overcoming this difficulty is to provide auxiliary
which break just after the main contacts, and so carry
These contacts may be merely butting surfaces, whic
much the worse for being burnt, or provided with easi
able faces, or some material having a high melting or
ing point, such as carbon. The degree in which th
switches on the market meet this requirement is readi

The current-carrying capacity of the contacts i
greatest importance, since a defective contact deter
a sort of compound interest law. Taper plugs ar
jaws almost invariably share this responsibility. V
reflects that trouble from this source may loosen t
contact from the board, by destroying an eboni
melt the solder from a sweating thimble and allov
to fall, or even render the handle of the switcl
or unsafe, there is enough material for serious thou
addition to this there is not a very far remote chanc
Possibly there may have been few accidents up to th
time from this cause, owing to the newness of the app
from the fact that many switches are not working u
full capacity. Certainly in point of design this is o
weakest features. In some instances the spring, in
and copper, without any means of adjustment for w
that can be relied upon. In the case of four plugs rig
to a handle there are instances where they are suppo
tight home into four fixed conical sockets. There a
relics of the dark ages, when current was allowed to pas
the hinge or pivot of a switch. Of course, there are c
the laminated type, built up of hard-drawn or hammere
which are admirably suited to their purpose. As a
conclusion, under this heading, it appears that it i
tageous to have few, preferably only one breaking co
circuit, which can easily be arranged by means of fle
nections. This arrangement gives the operator an op
of feeling the condition of the spring contact while fo
switch home. It has occurred to the author, with ref
this subject, that there might be a useful application c
known invention, of a paint which changes colour on h

The merits and risks of automatic apparatus ope
wide question. Where springs are employed they sho
be strained through a small part of their range, and
secured from all possible chances of getting heated, e
current passing through them, or by conduction or
from other sources. There should also be some prov
retaining the spring, or parts of it, should it happen t
A single speck of rust on a steel spring will sometim
it to break, but the reliability of such springs as are
watches and rifle locks may be urged in favour of
when thoughtfully applied. Weights released by trig
catches are frequently used with success, but the ine
sometimes be a drawback. Special attention should
to hinges, etc., in such apparatus, since a slight def
alter the adjustment or foul the whole mechani
switch work it is quite common to have brass wo
brass both of the same composition; this is sure to
bind in time. When it comes to talking of an a
appliance that does not work, adjectives fail. Anoth
sometimes neglected is the provision of suitable b
arrangements for taking up the mechanical shock
Unfortunately, nearly all insulating materials are mec
weak, so they should never be subjected to rough us
most cases these switches are set by hand, and can t
have strong reliable contacts. Where they have to be
at a distance by means of a small current, the contac
serious trouble. An accumulation of small impulses
used or the much-abused mercury-cups have to do duty.
are details in mercury-cups, however, which make
difference. The cups should be of iron, nickel-plat
copper forks should also be nickel-plated, and be sh
cause as little splashing as possible. For large curre
high voltages a multiplicity of breaks should be empl

those depending on the expansion of a metal due to heat. The electromagnetic are not available for alternating currents generally speaking, and except for the purpose of recording instruments, where some power has to be expended in overcoming the friction of the pen on the paper, they do not possess many advantages. The Weston instrument, however, from its dead-beat action and extreme accuracy is again a favourite. As a voltmeter it can be fitted with a luminous scale, and it is usually provided with a movable index in the shape of a disc, which eclipses a circular aperture in the pointer. This form of index is very easily seen from a distance. Electrostatic voltmeters are useless for recording, and some forms are liable to stick owing to the very small forces which actuate the pointer. They can, however, be used for alternating and continuous currents, and they consume a minimum of energy. They are most commonly employed for high-tension work. Some engineers object to a dangerous potential across an instrument, especially as it has to be observed closely and frequently tapped to ensure a correct reading. A small sparking gap has to be introduced to protect the instrument, and with concentric mains a momentary rise of potential is common and causes the fuses to blow. The familiar "Cardew" is a most useful instrument, being applicable for continuous and alternating currents, and is very dead-beat in action. It gets out of adjustment rather too easily, however, and is an awkward shape to accommodate on a switchboard. The horizontal pattern is much steadier than the vertical, owing to the steadier rate of cooling. The consumption of energy is rather heavy. In spite of its many defects, it is very popular; probably its wide open scale and sensitiveness compare very favourably with rival instruments. Recording voltmeters are developing, and may now render faithful accounts of electrical pressure; but from some points of view they are still imperfect instruments, since they may sometimes ignore the willingness of the spirit, whilst testifying to the weakness of the flesh. Where these instruments are used the temptation to tamper with them should be removed, and the interpretation of the charts humane.

Rheostats, Multiple Switches, and Field Switches.—Rheostats are often suggestive of the skeleton in the cupboard. They are unsightly and the connections are frequently clumsy, even though they may be sound. The choice of resistance material is a matter of great interest. Some alloys possessing excellent qualifications under laboratory tests have been found to have become rotten and brittle after a few years' use, or they may suffer mechanical injury during construction either from bending, etc., or heat applied for soldering. Radiating surface should constitute one of the principal features of the design, ventilation being not an unmixed blessing, as the more air you get through the rheostat, the more dirt and dust is deposited. Compactness is desirable where it can be obtained without sacrificing other advantages. The displacement due to the expansion of the metal while hot must be provided for, and in forms other than the spiral this is rather an awkward matter. Spirals of wire are unsatisfactory, since they are liable to shake altogether and interlock if accidentally displaced. They accumulate a lot of dirt, are inconvenient to clean, and also involve comparatively confused connections to the multiple switch. Where a rheostat is only in the field circuit of an exciter, and consequently small, it may be wound on a block of slate having a sliding connection along one edge. The slate absorbs a good deal of the heat, which can then radiate from the larger surface. It is objectionable to have the contact on the actual wire, as the wear and any slight sparking might in time cause the wire to break. A great advantage, however, can be claimed from the fact that such an arrangement may be fitted on the board always in sight and kept thoroughly clean. An improvement on this form and suitable for larger work is effected by having special contact-pieces fitted, and in the use of several small wires in parallel, whereby a large radiating surface is gained. Tubular resistances would be better still, introducing at the same time additional mechanical advantages. With reference to multiple switches, besides ample current-carrying capacity, there must be exceptional provision for wear, as this may be very heavy. Circular switches or linear motion derived from a screw are most usual, but as there is a chance of the operator forgetting for the moment which way to turn the handle, it is preferable, in the author's opinion, to have a lever working through a quadrant in a vertical plane at right angles to the board, the connections being so arranged that the rising of the handle raises the voltage of the machine. It is sometimes necessary to make fine adjustments and occasionally large alterations rapidly, so that a good regulating switch should have two handles, one having a number of intermediate steps between any two steps of the other. Field switches should always be so arranged that they short-circuit the windings at the instant of cutting off the current. The author is acquainted with two designs—one by Messrs. Siemens, the other by the Electric Construction Company—which are well suited for this duty.

Synchronising Apparatus.—In alternating-current stations this apparatus is of first importance, and should be the object of the designer's special care and foresight. The possibility of a

mistake on the part of the operator should be tho
investigated. The risk of breakdown in any part
apparatus having been reduced to a minimum, provisio
be made for replacing any defective detail within a m
two, with no possible chance of reversing a connection,
should be a simple method of throwing a spare set into
There have been three or more methods suggested for
nising. First, two lamps, or one lamp and a voltm
series, off the secondaries of two transformers in se
primaries being one on each of the pair of leads req
be synchronised. Second, a similar arrangement, h
telephone or buzzer to indicate the flow of current
the secondaries. Third, goldleaf electroscope which
used direct on 2,000-volt mains. The first method is
always employed, and it has the advantage of bein
seen by the driver, enabling him to adjust the sp
his engine. This information can also be obtained by
the station with alternating-current arc lamps. Wh
armature is at the correct speed, the coil-holders appea
stationary, or revolve very slowly forward and bac
as the speed is too high or too low. It might be
worth while to switch on a lamp in broad daylight
synchronising, for this purpose. Where alternate-
arc lighting is adopted, a goldleaf synchroniser could b
It is more secure from breakdown for having no trans
It is very dead-beat, but at present it has not been de
as a switchboard instrument, and requires modificat
preserve the extremely high insulation necessary. Wi
the subject of synchronising, it is instructive to notice
English stations an artificial load on the incoming m
is considered unnecessary, although usually employed
Continent. In one English station it has been found
tageous to parallel machines through an impedance co
then short-circuit the coil in two steps. As an extra pre
the paralleling of all machines up to 400 kw. capacity i
through a 20-ampere fuse, and this fuse is not blown mo
once a month. (It may be mentioned that the armatu
of the coreless type.)

Having discussed the details, the general arrangeme
construction of the board may be criticised. Slate or
are usual as a base; but all holes should be bushe
ebonite, and ebonite plates fixed under all instrume
high-tension work. There is a skeleton form, however,
of a lattice work of wood or angle iron on which the
instruments are mounted. This form is highly efficien
many points of view, but in appearance it is untidy,
occupies a good deal of room. A recent development c
of a number of cells, made by vertical slate partitions fitt
slate shelves, which are built into the wall. In this ar
ment there is, of course, no back, the connections being
from the front, and carried up through the vertical series o
The commonest form of board is constructed of slate al
panels, having the instruments on the front and all conne
at the back. It is the back of such boards that should b
closely watched. It is often necessary to change an instr
or connect a new machine or feeder, and with high-te
current at all points, such work is frequently attended
great personal risk. Accumulations of dirt and dust hav
to be removed periodically. Such boards, if designed in a sta
panel form to permit extensions, should also have a sta
system of back connections suitably protected, and in n
should miscellaneous cable and wire connections be allowe
double-pole boards the opposite poles should be far apart,
horizontally or vertically. For the arrangement of om
bars and varieties of combinations, some reasonable limit
be fixed. Breakdown terrors are usually more prominent
minds of high-tension engineers; they may stimulate
careful design, but there is also a tendency to run t
in a progression of combinations. It may be reasona
have a means of dividing the main omnibus bars, and p
have a spare set, often called "hospital bars," for the p
of connecting any particular circuit or any particular mac

With reference to the relative position of the apparatus,
is a decided preference for the complete set belonging t
generator, or one feeder being in a vertical line, well m
It is also advisable to have the lines as close as possible in
that the effect of any adjustment can be watched in the
lines. This principle is so important that where some
of the apparatus are necessarily large, it might be worth
adding auxiliary gearing to permit of concentration.
of course, essential that the handles of all the contr
gear should be within easy reach, and that the indic
of all instruments should be accurately readable f
convenient position. A necessity or temptation to le
stretch over any portion of the board should never
It seems almost absurd to mention such an obvious p
yet it is common enough to find a clock which has
wound periodically mounted on the top of a switch
There are boards protected on the front, but this
encourages carelessness, and is often at the expense of
at the back. By all means guard against every conce
accident, but under the roof of a central station a board

e assured from wilful misuse or grossly ignorant handling. main switch, fuses, or other safety device, and ammeter are mong the first requisites of a panel, then perhaps there may e plug connections, synchronising connections, field switch, nd rheostat switch. Voltmeters are usually common to the hole board, and here a suggestion may be borrowed from an merican practice—in that of mounting a voltmeter on a winging bracket from the end of the board. It can then be noved to show to the best advantage at that part of the board here an adjustment is being effected. Field switches may be dvantageously mounted on the machine. By this arrangement here is a saving of conductors, and the man who lets down the rushes may be more confident that the machine is not excited t the time. For continuous-current machines the rheostat nd multiple regulating switch might also be mounted on the nachine, or on the wall close by, thereby saving long conuctors. Since the electrical pressure regulation is shared etween adjustments of excitation and speed, both may be ttingly performed by one man, preferably the driver or ynamo attendant, whose attention can thus be directly called the brushes at every alteration. Further, it can be urged hat fire risks are minimised by distributing the rheostats and tuating them away from the wood platform or other such work connection with the switchboard. In the case of alternatingurrent machinery, the rheostat switches at least must be on e board or close at hand. But there are some alleviations to mpensate for the fire risks involved. Alternating current ually means high tension, and the heat generated is of use in eping the board at a slightly higher temperature than the rrounding atmosphere. There are occasions, when there is a g, or perhaps in the event of a mishap with steam connections, at this higher temperature may save condensation and further nsequent troubles.

One of the most pressing considerations in connection with e switchboard as a whole is the efficient protection from dust d accumulations of dirt, especially at the back. Not only ould elaborate precautions be taken, but an easy and safe eans of inspection and cleaning should be a prominent feature the design. From an æsthetic point of view a little license n be granted if all details are well designed. Wood mouldgs and panelling add greatly to the general appearance. me engineers severely cut down anything that is inflammable. his, like everything else, can be carried to excess. When one nsiders the proximity of such material to an open fire in an dinary dwelling-house, and the small risk one attaches to it, little ornamentation on a switchboard appears to be reasonle. There is no necessity, however, to make a switchboard a bject for rococo decoration, and, as mentioned before, there e fitter places for a clock than in a surmounting scroll. With a view to standardisation, another suggestion hails om America. One of the largest firms manufactures unit anels always on a standard size of slate. They make 4 different capacities on a panel 48in. by 16in. by $1\frac{1}{2}$in. ick, and a blank panel 28in. by 16in. by $1\frac{1}{2}$in. to go underath. They are bolted on to steel frames, and adapted for nlimited extension. The space required for a switchboard is ot of such great importance if correctly estimated when esigning the buildings. Too often, however, it has to go omewhere between two windows, in a cramped position, with little or no room for extensions. The best position is probably n a gallery extending down the length of the engine-room, xcept in belt or rope driven stations, in which case it should e parallel with the drives to be safe, in the event of an accident with the gearing. An elevated position such that the operator an see and signal a driver at the stop-valve of any engine is bout the ideal.

Though, perhaps, a little foreign to the subject a system of ngine-room signals might be conveniently touched upon here. t is too small a matter to be treated on under its own heading, ut, at the same time, it is important in the administration of uties from the switchboard. In large concerns a well-organised ystem is indispensable, and in small stations, therefore, northodox signs should be considered as bad form. The ractice of shouting and cat-calling about an engine-room, hough it may betoken hearty goodwill and enthusiasm among oung assistants and pupils, is, to say the least of it, undignified; uch cries should be reserved for personal accidents. A regulaion whistle or bell, whichever can be more clearly distinguished rom the usual hum, should serve to call the attention of drivers. he number of a machine can be indicated by displaying a tablet aving both sides painted the same. If the board can be seen rom every stop-valve, alterations of speed can be signalled by oving an extended hand and arm "up" or "down," the driver ignalling the normal speed by moving his hand rapidly back nd forwards in a horizontal plane. Where the view is blocked ifferent-toned bells or a number of strokes may be employed, ut is remarkable to find how easily such signals can be forotten or confused after being in daily use for months. Another ethod is to illuminate a small window having a word painted n it by means of a small lamp. Almost any method will answer he purpose provided that it is universal.

Turning once more to the question of standardisation, manufacturers have now had the opportunity of gleaning from innumerable specifications, and of silently witnessing some failures. Perhaps a pyschological treatise on the switchboard attendant is still required. There are without doubt some curious instances of irregularities due to absence of mind or fatigue. It is not at all uncommon to see a man feel the bearings and fill the oil-cups of a standing machine, but when it comes to the switchboard attendant signalling "raise speed" on a particular engine, the driver adjusting the governor of a standing engine, and the attendant signalling back "all right," the subject becomes distinctly interesting. Then there is the man with the laboratory training, who taps every instrument, including the clock and the almanac, before taking a reading. Fuses and plugs have been pulled out while carrying currents; there was a story once of the exciting current being switched off an alternator while running in parallel. Possibly designers have already, or can easily obtain, sufficient information of this description for their guidance.

Once launched on this fascinating theme ideas and suggestions spring like mushrooms. In the interest of science let us suppress the prolificacy of imaginations, born of watching and wakefulness, in the midnight hours. Leave such work to professional designers, who regard inspirations in the positive degree, and to men who live for "estimating," before whose searching gaze the colours and glories of originality pass and die away. The author has endeavoured to point the necessity of good standard work for switchboards, and to discourage the individual of designing propensities, among "resident engineers." He is aware that much has been done already towards establishing a standard, but has recently received replies to enquiries from several large manufacturing firms: "We have no standard, as we find all specifications differ." It should be reserved for the resident or consulting engineer to judge, a representative body of engineers to frame rules and regulations, and for designers and manufacturers to perfect details and study economical production.

In conclusion, the author desires to express his thanks to the gentlemen and firms who have rendered him liberal assistance in the preparation of this paper.

DISCUSSION.

Mr. C. H. Wordingham said that switchboards should be absolutely fireproof. His own switchboard at Manchester was fireproof, the only thing about it which was inflammable being the ebonite washers. The author said that a little panelling and moulding improved the appearance of the board. Perhaps it did, but it also increased the danger of fire. Besides that, a switchboard might look well without panelling and moulding. With regard to what Mr. Blaikie said about breaking current, at his own works they had a safety fuse which would cut out any large current on an emergency, but he hoped it would never be needed. As regarded the table of breakage given, he thought that was useless, as it was impossible to make any hard-and-fast rule about it. The author also mentioned automatic apparatus. That he thought was an additional source of danger. The less intricacy about the machines the better, was his opinion. The attendants in the station could do all that was necessary in case of a short-circuit or breakdown. Mention was also made of a particular make of fuses. He would like to ask if there was any danger of the oil in the apparatus igniting. The author, in another part of his paper, mentioned the Weston instrument. That was a very valuable invention. It had been made in England some years since, but at the time had not been taken up. As to rheostats, he thought that the more they were out of the way the better. They should be placed where they might be easily got at, but out of the ordinary way. As to the means of signalling between the engine and meters, he thought the objection to that was that it was too expensive. He agreed with the author that integrating meters would soon be universally used.

Mr. L. Andrews (Hastings) said that he thought the author had evidently not heard of the proverb about people who lived in glass houses throwing stones. The author objected to engineers designing their own machinery, but at the same time he went on to explain how it should be done. He (the speaker) agreed with Mr. Wordingham as to the unreliability of automatic cut-outs. People would not have anything to do with them because of their unreliability. Mr. Wordingham, however, went too far when he said that men should take the place of them. The automatic cut-outs would be very useful if they could be made reliable. He had one of his own there which he thought answered the purpose, and he would explain it at the end of the meeting to those who wished. Why did people put field fuses on their alternating-current machines? They were worse than useless; in fact, they were a source of great danger, because they would go just when they were not wanted to, through deterioration, and injure other machines.

Mr. Robert Hammond (who spoke as a representative of Newport) said that he always insisted on having inflammable switchboards. It was also most important that the board should stand on an inflammable base and not on a wood floor. He used iron for the framework, and had had to abandon the T-section in favour of a channel iron. He quite agreed with the Board of Trade rule that at least 4ft. should be left for the passage behind the switchboard. Hospital bars for testing purposes, or for use with a faulty feeder, should always be provided, and provision should be made for dividing the 'bus bars.

(Continued on page 721.)

Supplement to the "ELECTRICAL ENGINEER," June 10, 1898.

A. B. MOUNTAIN. A. BROMLEY HOLMES. J. H RIDER. J. E. STEWART.

[illegible] —The War Office is inviting
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...shot. Also for an electrical and mechanical draughtsman
...e preparation of plans and record drawings in connection
...the same. Particulars as to application, etc., are given in
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of them are referred to. We generally find that these engines are extensively used in direct-current stations, one reason being that direct-current low-tension stations are usually erected where land is valuable, and doubtless these high engines do allow of a very large amount of power being placed in a small station. There is one great thing to be said for high-speed engine-makers: they seem to have learnt much better than low-speed

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TO CORRESPONDENTS.

MUNICIPAL ELECTRICAL ASSOCIATION.

Mr. Gibbings, in his presidential address, did well to congratulate the association upon its success. The questions which it can discuss with some pleasure and profit will, for many years at any rate, increase in number, if not in importance. Up to the present time the association has had an open field, but as each main point is permanently or temporarily settled other points of detail will open out, and these are never-ending. It is not customary at any meeting to discuss a presidential address, so that the author is like a parson, and can tell some plain truths without fear of direct contradiction. In the present case the arguments of Mr. Gibbings would in the main be accepted by any reasonable body of men who knew aught of the subject, though on one or two points there may be differences of opinion. It will serve a useful purpose, perhaps, if we refer briefly to one or two of these points. In only one shall we differ altogether, that wherein the president says, "I think I might go so far as to say that in many towns and districts the ratepayers would show their preference, if a reliable ballot could be taken, that the supply of electricity should be in the hands of an independent company. Whilst this is, of course, no argument whatever against the desirability on general grounds of the undertaking being in the hands of a local authority, it is clearly enough an indication that the public consider that their requirements are likely to be better served by the company." We think this conclusion to be absolutely incorrect, and hence the inferences based upon it to be incorrect. In the first place, the ratepayers as a body seldom understand the subject, and have a vague idea that the suggestion of an authority to erect and equip a central station is merely a suggestion for spending some more of the ratepayers' money. The municipal electorate as yet is largely unable to differentiate between productive and unproductive expenditure. They do not yet understand that the authorities' business transactions are different from district and poor rates. It is the aim of certain men to preach false doctrines to ratepayers, to enhance and multiply the risks of electrical, water, or other municipal undertakings. They are men retained for company purposes, and the difficulty is to eradicate their teachings. When the ratepayers understand the subject there is no hesitancy, nor do they prove recalcitrant when they have full confidence in their leaders. This has been proved in several instances most conclusively, in that elections have been fought upon the special question of electric supply, and, in general, has resulted in the election of men who favour municipal rather than company action. Mr. Gibbings represents a northern town, one that has proved its knowledge of the difference between "productive" and "unproductive," otherwise it would not have spent some three millions upon water supply, nor have been the first municipality to undertake electric lighting; hence we wonder somewhat at his rendering of the attitude of ratepayers. The other question to which we would refer is that of standardisa-

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water supply, nor have been the first mu... pality to undertake electric lighting; b... we wonder somewhat at his rendering of ... attitude of ratepayers. The other que... to which we would refer is that of standar...

tion, and we think the first thing to do in this matter is to define what is meant by standardisation and what is to be standardised. Mr. Gibbings concludes his remarks less emphatically than he commences them, and very sensibly says "the object of the association should be, I think, to standardise the conditions rather than actual details of the various matters already mentioned." The only difficulty in the way of even this mild conclusion is that no premises are agreed. No one who heard the discussion upon Mr. Wordingham's paper could even suggest a basis of agreement upon a single point. The general feeling, not bluntly expressed perhaps, but plainly indicated between the lines, was that standardisation spelt "finality," that finality would not yet be welcomed, and, indeed, would be about the very worst thing that could happen to the profession and to the industry. Of course, everyone can see certain advantages that would accrue from the standardisation of apparatus in various directions, but such standardisation is impossible. As the number of central stations increase, there will be more and more approximation to uniformity. Experience will determine voltages, and, as Mr. Wordingham in his reply said, the question of periodicity will similarly be settled within a short number of years. The discussion upon Mr. Wordingham's paper was certainly one of the most healthy we have ever listened to, and if this convention had nothing more to show for its labours, would be good value for all the time and trouble spent upon it. In our opinion uniformity of practice is the natural outcome of extensions of business, but this is not the same thing as standardisation. The latter is inflexible; the former is flexible and allows improvement, while standardisation is against improvement. Why should a manufacturer attempt to improve while he can sell from stock?

OUR SUPPLEMENT.

With this issue each reader should receive a supplement containing portraits of the president and council of the Municipal Electrical Association. In another column will be found a brief account of the professional careers of many of these gentlemen. It is well that their colleagues and the public generally should know somewhat of the men who are making history so far as electric supply is concerned. It is the early workers who have to solve the difficult problems, and when they, from their knowledge and experience, determine the most perplexing of these problems their successors will have a far easier task to carry on the work. Although it is our duty sometimes to criticise, we always recognise the exceedingly good work the municipal electrical engineers are doing, and we are sure doing earnestly and faithfully in the interests of the municipalities. Ever eager to examine improvements brought to their notice, they are not less eager to initiate improvements, and many such have had their origin in the ranks of the municipal electrical engineers.

Electric Lighting at Aldershot.—The War Office is inviting applications for the appointment of an electrical engineer, who will be required to assist in the preparation of particulars and the supervision of the execution of electric lighting contracts at Aldershot. Also for an electrical and mechanical draughtsman for the preparation of plans and record drawings in connection with the same. Particulars as to application, etc., are given in our advertisement columns.

MUNICIPAL ELECTRICAL ASSOCIATION.

(Continued from page 719.)

DISCUSSION ON MR. BLAKIE'S PAPER (*continued*).

Mr. Hammond *(continued)*. Rheostats should not be placed behind a switchboard, where they heat the place up, and make the attendant uncomfortable, but in a separate room preferably below the switchboard. Mr. Hammond then gave some details of signalling gear for enabling the switch attendant to give orders to the man at the engine. At a station he had erected in Spain, colours instead of words had to be used on the engine-room indicator owing to the illiterate class of men employed.

Mr. C. J. Sutherland (Hanley) condemned the author's idea of placing the rheostats on the machines. In cases of fog, the attendants would have to be always running up and down the engine-room to regulate them. He had had experience of the oil fuses, and had not as yet had any trouble with them. With regard to Mr. L. Andrews's statement about the fuses on alternators, he had had experience of a case in which such a fuse did act properly. Four alternators were working in parallel, and through a hot bearing one engine was pulled up. The fuse of the alternator connected to the engine blew and prevented further fault in the supply. As regards the design of switchboards, no one wanted to design all the details. What was wanted was rather the best possible design for arranging existing patterns of switches and measuring instruments. In this way there was plenty of room for individual design.

Mr. Robert Quin (Blackpool) pointed out that Mr. Andrews had referred to two alternators in parallel, while in Mr. Sutherland's case four were in use. He had some oil fuses in his station, and had himself inserted one which formed a short-circuit. The result was frightening, but no damage was done. He found, however, that, due to the spring used, a definite fusing current was not obtained. Mr. Quin then described a fuse where the wire went through a hole and shutter without a spring acted in some way that gave great satisfaction, but without a drawing it was difficult to follow the details. He pointed out that the iron frame of the switchboard provided a large earthed contact, and that trouble might arise if the floor got impregnated with oil.

Mr. Sidney Evershed, who was invited to speak, said that the author's idea of providing a given break for a certain current and pressure was not correct. The spark at break depended on the self-induction of the circuit, and to attempt to check the spark too quickly meant greater destruction at the contacts. With a very large magnetic blow-out the current could be broken almost directly the contacts parted, and then the metal was melted and ran off in streams. Coming to the question of ammeters, Mr. Evershed remarked that it was impossible ever to get the same percentage accuracy at the low parts of the scale as at the upper end. With the potentiometer methods of measuring, errors of temperature were introduced which were difficult to prevent.

Mr. J. S. Raworth, while agreeing with the fireproof construction, said that even then the cable should always be led up through the floor, and not down from the ceiling. If the cables went up an arc was likely to follow them, and the insulation was more or less inflammable.

A vote of thanks was passed to Mr. J. R. Blaikie, whose reply will appear in the *Journal* of the association.

The third paper was by Mr. J. A. Jeckell, and was as follows:

Steam-Using Plant.

BY J. A. JECKELL, BOROUGH ELECTRICAL ENGINEER, SOUTH SHIELDS.

As the power in the vast majority of electricity works is obtained by means of plant driven by steam, it will be interesting, and the author hopes instructive, to consider this plant, and see whether increased efficiency may not be looked for in the future with regard to it. Owing to the fact that a large number of engines and boilers are necessary the length of steam-piping is often large, and the losses due to this are considerably more than in a steamship, where the length of steam-piping is of necessity very short. An appreciable amount may, however, be saved by a careful arrangement of the steam-piping, so as to have as little as possible in use during the long hours of light load, which are all too common in most electricity works. And, of course, the losses due to steam-piping, etc., are a very large percentage of this total consumption of steam during these times of light load.

We now come to the engines. These may be divided into four headings: (1) high-speed enclosed vertical; (2) low-speed enclosed vertical; (3) low-speed horizontal; (4) low-speed vertical.

No. 1 *Type.—High-Speed Enclosed Engine.*—The engines, on account of the speed they are run at, rarely have any pumps attached to them, and this should be remembered when any tests of them are referred to. We generally find that these engines are extensively used in direct-current stations, one reason being that direct-current low-tension stations are usually erected where land is valuable, and doubtless these high engines do allow of a very large amount of power being placed in a small station. There is one great thing to be said for high-speed engine-makers: they seem to have learnt much better than low-speed

engine builders the advantage of standardising plant. Direct-current dynamos do not so readily lend themselves to be driven at a low speed as alternators, so we find no public supply station with direct-coupled dynamos driven by low-speed engines in England, but, of course, there a few private plants, such as that at Liverpool-street Station, which are so driven. We generally find that when high-speed engines have been put down in the first place, in an extension the same type of engine is used. This holds good for slow-speed engines; from this it would appear that each kind has given such satisfaction that a change is not considered advisable. High-speed engines were and are frequently made tri-compound—namely, compound with three cranks—but now triple-expansion engines are by no means uncommon. The makers of these engines were credited with being of the opinion that triple-expansion engines were not economical at light loads; of course, as these engines frequently had three cranks and were run at a high speed, the turning moment was good, and therefore there was not as great an inducement to use triple engines as there was when the low-speed vertical engines were used. There is no doubt that the oil consumption in stations using enclosed engines is generally lower than that in stations where open-type engines are used; the most notable exceptions to this are the results obtained at Leeds and Oxford.

No. 2 Type.—Low-Speed Partly Enclosed Engines.—By these are meant engines such as are being manufactured by Messrs. Ferranti and others, running at about 150 revolutions per minute. These engines are so much part of the whole steam alternator that it is rather difficult to consider them separately, as the plant has to be considered as a whole, and as such will be mentioned later on. These engines are made compound.

No. 3 Type.—Horizontal Engines.—Of course this engine has stood the test of years, and is no doubt a very serviceable article. The maintenance on it is small, and when the dynamo is direct driven forms a plant very hard to beat for rough work, but its steam consumption is rather higher than electrical engineers generally like, though the price per kilowatt would be low.

No. 4 Type.—Low-Speed, Open-Type, Triple Vertical Engines. For a long time this type of engine was never used for driving electric light machinery. Why, it is hard to say. Of course, there were the Brush engines, which, however, were only compound. The first place where these were used, as far as the author knows, was at Oxford. In that case they drive the dynamos by means of belts. Probably everyone here knows that the Oxford engines are of the ordinary marine type, with the condenser fixed on to the engines. All the pumps, both feed, air, and circulating, are attached to the engine, and are driven by it. Thus, all the power for the pumps is obtained at a cost of a very small expenditure of coal, because the power to drive them is obtained from an engine using steam in the most economical manner possible. Thus the very large loss due to inefficient pumps is entirely obviated. This causes the pounds of coal used per unit generated at Oxford to be very low. Of course, there are other things that help this low consumption of coal there, such as economical boilers, high-class coal, use of batteries, etc. For some reason it used generally to be supposed that triple-expansion engines were only economical at full load—in fact, this opinion was held even by people who have had a very considerable experience in testing engines, and was almost the universal opinion when the author designed the South Shields station. There were no engines of this type in use for electric lighting, except those at Oxford. However, since the starting of the South Shields station several other engineers have adopted this type, which is a fairly good proof that they are very well satisfied with what they have heard concerning these engines. It used to be a very general thing in specifications to require a low consumption of steam at full load, and the author was the first engineer, as far as he knows, to require the steam consumption to be calculated on the average of the full, three-quarter, and half-load consumptions. It is very obvious that engines used for the generation of electricity in supply stations are very rarely run at full load; they may not unfrequently be run a good deal above full load, but in every station the load must necessarily vary very much. At South Shields, owing to the rise and fall of the tide, it was not possible to put the circulating pumps on the engines, and the only pump which is attached is the air-pump. The condensers are attached to the engines like those at Oxford.

The following are the tests of the two engines for South Shields: No. 580 had been run at the maker's works to get the stiffness off, but No. 581 had only been turned round for 24 hours when the test was made. No. 580 was tested by Mr. Wilson Hartnell and the author, and No. 581 by the author alone.

Report of Test of Triple-Expansion Engine, No. 580.—The engine was made by Messrs. J. and H. McLaren, of Leeds, to meet the specification of Mr. Joseph A. Jeckell, borough electrical engineer, South Shields, for the purpose of driving one of the 100-kw. alternators, to which it is to be coupled direct. The specification stipulated that the engine should be capable *of working economically* at full load, three-quarter load, and half load, as engines at electric light stations are required to work at varying loads. The engine was a vertical triple-expansion engine, having cylinders 9½in., 14½in. and 22½in. diameter, with a stroke of 24in. The condenser and air-pump form part of the engine, the latter being worked from the cross-head of the intermediate piston rod by means of levers and links. We tested this engine on Feb. 20, 1896, at the works of Messrs. J. and H. McLaren, Leeds, as follows: The engine was bolted to a foundation and the crankshaft coupled to a large friction brake. Steam was obtained from a locomotive-type multi-tubular boiler, and condensing water from the town's mains. Four gauges were fixed to the cylinders—one to show the steam pressure, two to show the pressure in the intermediate and low pressure steam-chests, and the last to show the vacuum. Six Crosby indicators were fixed to the cylinders,

SUMMARY OF TRIALS.

Triple-Expansion Engine with Surface Condenser. Trials made Feb. 20, 1896. Diameter of Cylinders: 9½in., 14½in., and 22½in. by 24in. Stroke. Engine No. 580.

—	First trial, full load.	Second trial, ¾ load.	Third trial, ½ load.
Time of trial (mins.)	121·68	120	123·16
Average steam pressure, high (lbs.)	163·67	162·28	161·10
Do. first intermediate (lbs.)	64·46	38·71	24·28
Do. second do. (lbs.)	7·5	1·464	8·8
Vacuum (inches)	26·75	27·89	28·80
Average temp. of condensing water	42°	40°	44°
Do. hot-well	—	82·6	73
Gross weight on brake in lbs.	1,655	911	758
Net load ,, ,,	1,385	876	716
Average revolutions per minute	123·4	128	122·2
Mean pressure on piston, high	44·61	36·32	34·05
Do. do. intermediate	29·67	18·12	13·48
Do. do. low	11·19	6·97	5·10
I.H.P. of high-pressure cylinder	41·84	35·34	31·63
Do. inter. do. do.	69·56	44·06	31·30
Do. low do. do.	66·12	42·74	29·86
Total I.H.P.	177·52	122·14	92·79
B.H.P.	165·73	108·74	84·67
Ratio of brake to I.H.P.	93·35%	89·01%	91·29%
Condensed steam in lbs.	4,680	2,890·7	2,160
Average temperature	108·5°	93·6°	73°
Jacket water in lbs.	322	259·5	229·2
Average temperature	178·2°	195·5°	199·6°
Total water (lbs.)	5,002	3,150·2	2,389·3
Water per I.H.P. per hour (lbs.)	13·89	12·89	12·54
Do. B.H.P. do. (lbs.)	14·88	14·88	13·76
B.H.P., including 2·1 %	—	—	—
Flywheel friction	167·8	110·8	86·9
Ratio of 2·1 % flywheel to I.H.P.	94·2	90·7	93·5
Water per augmented B.H.P. per hour	14·7lb.	14·2lb.	13·4lb.
Total water used per hour (lbs.)	2,466	1,575	1,163·9

Triple-Expansion Engine with Surface Condenser. Trials made April 9 and 10, 1896. Diameters of Cylinders: 9½in., 14½in., 22½in., Stroke 24in.

—	First trial.	Second trial.	Third trial.
Time of trial (hours)	2	2	2
Average steam pressure, high (lbs.)	155·91	160·33	157·25
Do. Do. intermediate ,,	69·25	37·5	23·33
Do. Do. low ,,	11·04	0·75	8·25
Vacuum (inches)	27·4	27·21	27·33
Average temp. of condensing water	—	—	—
Do. hot-well	107·62°	97·5°	90·2°
Gross weight on brake in lbs.	1,513	1,000	750
Net load ,, ,,	1,465	918·68	648·68
Average revolutions per minute	118·06	125·275	126·65
Mean pressure on piston, high	44·438	41·544	33·87
Do. Do. intermediate	28·46	17·12	—
Do. Do. low	15·076	8·307	5·22
I.H.P. of high-pressure cylinder	39·87	35·55	32·61
Do. inter Do. Do.	63·83	40·74	28·93
Do. low Do. Do.	85·26	49·85	31·67
Total I.H.P.	188·96	130·14	93·21
B.H.P.	167·7	111·6	79·62
Ratio of brake to I.H.P.	88·76%	85·74%	85·42
Condensed steam (lbs.)	4,634	3,211·5	2,228
Average temperature	107·62°	97·5°	90·2°
Jacket water in lbs.	329	74	98·5
Average temperature	200·9°	192°	201°
Total water (lbs.)	4,963	3,285·5	2,326·5
Water per I.H.P. per hour (lbs.)	13·13	12·62	12·48
Do. B.H.P. do. (lbs.)	14·8	14·72	14·61
B.H.P. including 2·1 friction	169·8	113·7	81·71
Ratio of ditto to I.H.P.	89·86	87·36%	87·68%
Water per augmented B.H.P. per hour	14·61lb.	14·45lb.	14·23lb.
Total water used per hour (lbs.)	2,481·5	1,642·75	1,163·25

two tubs were placed to receive the condensed water; each contained 360lb. of water when filled up to a gauge point. The surface of the tubs was contracted by means of thick boards, so that the level rose rapidly when near the gauge point. Scales were provided for weighing the jacket water; it was weighed 28lb. at a time. In order to make observations with convenience and accuracy, two men were appointed to note the pressures on the gauges and the temperature of the condensing water; two men were appointed to note when the tubs of condensed water were filled, and their temperature; two also to weigh the jacket water and take its temperature; one to read the spring balances on the brake; one to take the readings of the counter, and three others to take indicator diagrams. This left us free to superintend the whole and check the accuracy of the observations. We arranged to make observations at intervals of 20 minutes, the signal being given throughout within a fraction of a second. Attached to this report are given tables showing the results of all these observations. Our attention was particularly directed to accurately ascertaining the weight of steam condensed per brake horse-power, and also the mechanical efficiency of the engine. The friction brake used consisted of a flywheel 10ft. diameter with internal flanges, by means of which it was kept lined with water whilst revolving—a stream of cold water constantly running in, and a stream of hot water picked up by a skimmer constantly running out. On the outside of this wheel was a broad pit rope loaded at one end, with two spring balances at the other. We carefully measured (by means of plumb-lines and steel straight-edges) the distance horizontally from the centre of the shaft to the centre of the suspension, and weighed the load and also a portion of the rope, and allowed for the difference in the level of the two ends of the rope, and, in fact, in this, as in all other points, took every precaution to ensure accuracy. In stating the efficiency of the engine we have given it both as actually tested, with the brake acting as a flywheel, and also when an allowance of 2·1 h.p. is made, as we have since ascertained by driving the brake-wheel up to its speed (with rope removed but an equal weight bolted to its centre) by means of an electric motor, that the actual horse-power it absorbed is 2·1.

Referring to the summary it will be noticed that the mechanical efficiency of the engine is very high, varying from 89 to 93 per cent., when the friction of the brake-wheel itself is included, and from 90·7 to 94·2 if the friction of the brake-wheel is allowed for. In estimating the water per horse-power it must be observed that the condensed water from the jacket has been added, making the total about 7 per cent. more than it otherwise would be on the heavy load, and about 10 per cent. extra on the light load. In many published trials of steam-engines the jacket water has been ignored. In these trials the water per indicated horse-power with a heavy load was only 13·89lb. per hour, and on the light load 12·5 (about 11·3, excluding jacket water). The water per brake horse-power is 14·9 to 13·7 if the friction of the brake is included, as it must be, to compare it thoroughly with engines furnished with flywheels. If, however, the friction of the brake-wheel itself be deducted the water per hour varies from 14·7 to 13·4. Another satisfactory feature was the excellent vacuum maintained, and this in connection with the small friction of the engine causes these very economical results per horse-power not only to be maintained, but actually exceeded, when the brake horse-power was reduced one-half.

The following are the tests which were made after the engines were erected at South Shields and the alternators coupled to each engine:

TESTS OF STEAM ALTERNATORS AT SOUTH SHIELDS.

Load.	Efficiency A 242 E 580	Efficiency A 243 E 581	Water per kw. A 242 E 580	Water per kw. A 243 E 581	Water per I H.P. A 242 E 580	Water per I H.P. A 243 E 581
120%	—	71·8	—	23·2lb.	—	12·4lb.
Full	74	D 71·3	23·83lb.	25·75lb.	13·1lb.	13·7lb.
$\frac{3}{4}$	72·8	C 67·87	23·59lb.	25·65lb.	12·8lb.	13·0lb.
$\frac{1}{2}$	67·7	B 64·5	23·78lb.	27·3lb.	12·0lb.	13·1lb.
$\frac{1}{4}$	—	—	A 32·4 A lb.	—	—	—

Tests.	Water per hour used by engines.	Water per hour used by pumps and lost.
A	828	629
B	1,365	958
C	1,924	992
D	2,360	1,140

The air-gap in alternator 243 not quite right.

These tests agree very well with those taken at the maker's works. The alternators are iron-clad, with the wire of the armatures wound in tunnels; this, though an extremely safe construction, is not so sufficient by 10 per cent. as a copper armature, and this should be borne in mind when comparing the steam per kilowatt-hour with that used by other plants; though the author believes that even without this allowance the result of 24lb. of steam per kilowatt-hour, as an average of full, three-quarter and half-load consumption, has not been equalled, and certainly not if an allowance is made for the alternator being some 10 per cent. less efficient than one with a copper armature. It will be seen that the engines were not too small for the work, as might not unnaturally be supposed, by the fact that one was run for two hours at 20 per cent. over full load on test, and during last winter they were frequently overloaded.

One great advantage which follows if an engine is economical at varying loads is that the plant may be much larger, and there is no need of a small day-load plant, it being quite as economical to run a good triple engine at light loads as to have a day-load engine. This has been found to be the case in other stations. The author places much more reliance on the water per kilowatt-hour than on efficiency, because high mechanical efficiency is not necessarily synonymous with low steam consumption. For instance, a steam-alternator set with a copper armature and one crank on each side of the alternator has a very high mechanical efficiency; there is a very short shaft and only two bearings as compared with a set such as the South Shields plant, but in the former plant, as the engine is only compound, the steam is not used so effectively as in the latter plant, where the engine is triple expansion; hence it might easily follow that the one plant had a higher mechanical efficiency than the other, but the other plant take less steam per kilowatt-hour, which is the real goal aimed for. There are, moreover, in the opinion of the author, disadvantages in having the alternator between the cylinders of the engines. The electrical plant is not nearly so accessible as when the alternator is kept outside the engine altogether; again, the triple engine with the three cranks gives a much more even turning moment than the two-crank engine; moreover, if it is desired, the engine can be obtained from one maker and the alternator from another. The triple-engine set, however, takes up more floor space than the other, and the capital cost per kilowatt would be greater. Like everything else, the choice must in a great measure depend upon which of the various qualities is deemed the most desirable.

The following are some tests of other engines which have been sent to the author by Messrs. McLaren. He hoped to have been able to have given a table showing the results obtained by other makers, but the time at his disposal would not allow of it being made out.

TRIALS OF TRIPLE-EXPANSION ENGINE, No. 611, at Sheffield Electric Supply Station. Note.—These Tests were made with the Engine, as we found it, after running 12 months practically night and day. Diameters of cylinders: 9$\frac{3}{4}$in., 14$\frac{3}{4}$in., 23in., by 2ft. stroke.

Cylinder constants, deducting area of piston rods … ……	0·0087218	0·020375	0·0500357	—	—
	1st trial full load.	2nd trial $\frac{3}{4}$ load.	3rd trial $\frac{1}{2}$ load.	4th trial $\frac{1}{4}$ load.	Remarks
Date of trials ………	15/2/98	15/2/98	16/2/98	16/2/98	—
Duration of trial …	2 hours	2 hours	1 hour	1 hour	—
Total I.H.P. ………	231·45	173·97	139·34	100·4	—
I.H.P. high pressure	46·21	45·57	43·75	32 59	—
Intermediate ditto..	78·24	57·82	46·48	33·56	—
Low pressure ………	107·02	70·58	49·11	34·25	—
Mean effect. pressure H.P. … …………	35 35	34 85	33·36	24·95	—
Intermediate pressure H.P…………	25·62	18·93	15·18	11·00	—
Low pressure H.P..	14·27	9·41	6 53	4·57	—
Boiler pressure in pounds per square inch .. ……………	150	150	150	150	—
Vacuum (inches of mercury) …………	26	26	26	26	—
Revolutions per minute ……………	149·9	149·9	150·33	149 78	—
Total steam used per hour, including jackets ………	3,205lb.	2,390lb.	1,818	1,356	—
Steam per I.H.P. per hour …………	13·84	13·7ft.	13·77	13·50	—

This engine is driving its air-feed and circulating pumps.

OXFORD ENGINES.—Test of Triple-Expansion Engines made by J. and H. McLaren. Engine No. 394.

H.P. I.P. L.P.

Diameters of cylinders: 9, 14·25, 22·5 by 24in. stroke.

Dates of trial, Jan. 19, 1892; Jan. 21, 1892.

Type of engine: inverted triple-expansion.

Jackets ………………………	Not used.	…	Used.
Duration of trial ………………	245 minutes	…	246 minutes.

Type of boiler—locomotive.

Heating surface, firebox.. ……	116 sq. ft.	…	116 sq. ft.
,, ,, tubes ………	764 sq. ft.	…	764 sq. ft.
,, total …………………	880 sq. ft.	…	880 sq. ft.
Number of tubes ….. …………	106	…	106

Dimensions of tubes, 11ft. 1$\frac{1}{4}$in. × 2$\frac{1}{2}$in. outside diameter.

Material of tubes, steel.

Grate area	26 sq. ft.	...	—
,, ,, during trial	13 sq. ft.	...	13 sq. ft.
Number of firebars	80	...	80
Width of firebars in inches	$\frac{5}{16}$	...	$\frac{5}{16}$
,, ,, air spaces	$\frac{1}{4}$	...	$\frac{1}{4}$
Total heating surface to grate ratio	33·8	...	33·8
Area through tubes	2·92 sq. ft.	...	2·92 sq. ft.
Size o chimney, 24in. diameter, temporary 23ft. high.			
Total water used during trial	8,133lb.	...	6,796·5. Engine 57,865lb. Auxiliary 400. Jackets 620.
Water per hour	1,992	...	1,657·6
Total coal used	800	...	692
Coal per hour	195·9	...	163 9
,, ,, sq. ft. grate area per hour	15·09	...	12·6
Water evaporated per lb. of coal	10·16	...	11·11
Water evaporated from and at 212deg. F.	11·81	...	11·69
Average boiler pressure, 153lb.	157·69 (taken every 15 minutes.)		
Average height of water in glass	1·54in.	...	·84in.
Total number of revolutions	31,263	...	29,920
Revolutions per minute	127·6	...	121·6
Circumference of brake	30·8ft.	...	30·8ft.
Weight on brake	1,014lb.	...	946lb.
Pull on spring balance	70lb.	...	4·77lb
Net load	944lb.		941·23lb.
B.H.P.	112·8	...	106·85
Water per B.H.P. per hour	19·67lb.	...	15·513lb.
I.H.P. high press. (Richards indicators used on 19th, Crosby's 21st.)	50·27	...	40·55
,, inter. ,,	50 04	...	42·6
,, low ,,	44 9	...	39·38
Total	145·21	...	122·33
Water per I.H.P.	13·7lb.	...	13·54lb.
Coal ,, ,,	1·349lb.	...	1·339lb.
Brake ratio	89·67%	...	87·35%
Total condensing water	10,060 gals	...	9,695 gals.
Condensing water per hour	2,464 gals.	...	2,365 gals.
Proportion of ditto to feed water	12·37 to 1	...	14·41 to 1
Temp. of hot-well (taken every 15 minutes)	108° F.	...	95·18° F.
Temp. of feed tub (taken every 15 minutes)	102·5°	...	108·75°
Condensing water (taken three times during trial)	37°	...	36°
Discharge (taken every 15 minutes)	111°	...	98·18°
Smoke box ditto	474·7°	...	456·5°
Boiler-house (taken three times)	63°	...	68°
Engine-house ditto	51°	...	56 5°
Vacuum in condenser (taken every 15 minutes)	27·5	...	27·95
Vacuum smoke-box ditto	·13	...	·105
Barometer (taken twice)	29·21	...	29·08
Coal used	Ebbw Vale	...	—

NOTE.—Low-pressure cylinder not jacketed on those engines.

Condensing Plant.—Owing to the fact that a large number of the engines which are used for driving electrical plant are engines running at a speed which is generally considered too high for an air-pump to be attached directly to the engine, or for some other reason, the condensing arrangements seem to have not unfrequently been an afterthought, and the consequence is that separate condensing plant is used in a great many cases. The drawbacks to this system as compared with that of having a condenser attached to each engine seem, in the opinion of the author, to be considerable: (1) There is the disadvantage of having another supplementary plant, and, as is well known, supplementary plants are terrible steam eaters; (2) there is another plant to be kept in repair and oiled; (3) there are large exhaust pipes to be run to the condenser; (4) the condensing plant would require to be in duplicate, because if it broke down it would, to put it mildly, be inconvenient to have the engines only able to do three-quarters of their load, or the engines would have to be made large enough to give off their full power, non-condensing as well as condensing, in which case they would be costly for their normal output and uneconomical at light loads owing to their size; (5) the vacuum obtained in the low-pressure cylinder with a separate condenser a long way away is not nearly as good as when the condenser is close to or part of the engine; (6) as far as the author can judge, a condenser attached to each engine would cost less, and certainly would give less trouble than the separate ones. From the above it would seem desirable that, other things being equal, it is advisable that an engine should be used which allows of the condenser being attached to each engine and driven from it.

Pumping Plant.—This is a part of the plant which appears, as far as can be judged, not to have received the attention it deserves. The amount of steam which the pumps in a station can use is extraordinary, and it is surprising that makers are content to place on the market such very inefficient pumps. Certainly the ways of pump makers are, to say the least, curious. It appears that all pump makers, as far as the author knows, reckon that their pumps will have an efficiency of 100 per cent.—viz., the amount of water which they are guaranteed to lift is calculated upon every stroke being a full stroke and the pump barrel being full at each stroke. This, however, is not the case in practice; few pumps, if any, have a greater efficiency than 75 per cent. Moreover, many pump makers in tendering for a pump to do certain work are too ready to run a pump at an abnormal speed; in fact, the speed at which they run it would prevent the pump from having an efficiency of even 75 per cent. As mentioned before, it is doubtless the most economical plan, everything else being equal, to attach the pumps to the engine, especially if the engine is a triple-expansion one, because then the power is obtained with the least consumption of steam. Of course, pumps to lift water for circulating purposes, if driven by a motor, will be economical enough, but motors are not altogether satisfactory for pump work; and, again, in alternating stations motors are not very easily obtainable which will do the work well, and for pumps for feeding the boilers, which have to be run at varying speeds, electric motors do not lend themselves very well. Flywheel pumps have a large number of working parts, and direct-acting pumps are unfortunately very great steam eaters. There certainly is an immense field for a good, strong, economical pump, and one that can be depended upon, and it is to be hoped that makers of pumps, now that there is a demand for this class of pump, will be prepared to supply that demand.

Some of the vagaries of pumps and pump makers may be interesting. A short time ago the author was in the market for some pumps, and a firm in tendering for these pumps proposed to supply a three-throw pump driven by a compound engine. The pump had to do 3·7 pump horse-power, and the makers undertook that the amount of steam consumed would not exceed 21lb. per hour. The makers were extremely indignant when the author suggested he would be glad to know where he could buy the engine to drive the pump, as he had been looking for this engine for some time. Another tender was received; the pump makers undertook that the pump, which was a direct-acting pump, should only take 26lb. of steam per hour to do 1·7 pump horse-power. These instances tend to show how careless pump makers are with regard to their calculations, and it may surprise some people to know that one of the largest pump makers in the country, in calculating the size of a pump required to do a certain work, takes another manufacturer's list, and as his own pumps are of somewhat the same manufacture specifies for the size as given in his opponent's list; unfortunately, the list of the firm which is used is made out on the assumption that pumps will do 100 per cent., the result being that the gentleman who has borrowed the list is led somewhat astray.

The following are some tests of pumps which, unfortunately, the author has had to do with:

Pump	Lift.		Delivery.		Pounds of steam per hour.		Amount of water in galls. delivered per hour.
No. 1...	18ft.	...	22ft.	...	583	...	18,251
,, 2	18ft.	...	22ft.	...	730	...	13,384
,, 3...	—	...	into boilers	...	340	...	400
,, 4...	—	...	160 W.P.	...	390	...	373

These pumps were the duplex direct-acting, and were supposed to be very efficient. Moreover, these tests were made after the pumps had been thoroughly overhauled by the makers, and had been made as good as they could be made; therefore, what must have been the consumption of steam when the pumps had been working some time, it is too awful to contemplate. The best guarantee the author has been able to get is 50lb. per pump horse-power, and this only after considerable trouble, pump makers seemingly being very adverse to give an exact guarantee. One of the best-known pump makers in the kingdom, on being asked what steam the pumps tendered for by him would consume, said about 18lb. per indicated horse-power, with the best-quality Welsh coal. It is not quite obvious what difference the coal would make. It would be only reasonable to suppose that as the pumps are inefficient they, at any rate, might be depended upon to do their work; but this certainly is not the case with boiler feed pumps. There have been several breakdowns in stations owing to the failure of the feed pumps, and certainly station engineers well know that it is very few can say their pumps are not a considerable amount of trouble. It is quite a rare thing to find a station where the shift engineer can honestly say his pumps are really satisfactory, for it is the shift engineer who has the trouble with the pumps. One great source of this trouble is that makers will offer pumps too small for the work. Out of 14 tenders which the author received, no less than 10 included pumps which could not do the work unless they had an efficiency of from 80 to 150 per cent. Some of these remarks may seem somewhat hard on pump makers, but are much more than warranted by the author's experience, and if they can induce pump makers to place on the market fairly efficient and

thoroughly reliable pumps he will be more than satisfied; and now that pump makers know what is wanted it is to be hoped they will try and supply the demand, and not leave it so much to Americans, for it is not too much to say that a very large number of the best pumps used in Britain are made in America.

Since writing the above the following appeared in the *Electrical Review*, April 29: "The Chicago Electrical Traction Company are now alive to the saving by substituting electric motors for steam in driving auxiliary plant. Their large engines developed 217 h.p. on a water consumption of 3,903, or at the rate of 18lb. per indicated horse-power hours. The small engines used steam as follows: economiser engine, 38·4lb. per hour; stoker engine, 36·4lb. per hour; air and feed pumps, 685·0lb. per hour—total, 759·8lb. This is nearly 20 per cent. of the consumption of the main engines. This thoroughly bears out the author's opinion—namely, that auxiliary steam plant is extremely wasteful in the use of steam.

Discussion.

Mr. J. S. Raworth opened the discussion by commenting on the valuable character of the paper prepared by Mr. Jeckell. He had noticed that several of the papers to be read were more incentives to discussion than anything else, but Mr. Jeckell had given some most useful information. The tests showed that the idea so common amongst engineers, that the efficiency of a coupled set must be necessarily much below that at full load, was fallacious. In fact, there were two engine builders in this country who guaranteed that the efficiency of their engines $\left(\frac{\text{E.H P.}}{\text{I.H P.}}\right)$ should at half load be equal to that at full load. He agreed with the author that complicated valve devices should not be used, and did not advocate automatic expansion on the low-pressure side. A good vacuum was, however, required if light loads were to be negotiated efficiently. As regards the question of expansion gear on the low-pressure cylinder, a series of trials he had conducted some years ago proved that one invariable expansion was best at all loads. He agreed with the author in his condemnation of direct-acting steam-pumps. They were often good-looking, but very wasteful. Mr. Raworth then cited a case where a direct-acting steam-pump had taken 20 per cent. of the total steam required for a plant. He had introduced in this case a three-throw pump geared to a single cylinder engine, and by this means had reduced the steam consumption from 20 to 2 per cent. of the total. Mr. Raworth proceeded to compliment Mr. McLaren on his engines and classed him with Sankey as the two engine designers of the time.

Mr. A. S. Giles (Blackburn) said he had found the steam-pumps so wasteful that he had decided to use electrically-driven ones only. He had just obtained tenders for a pump to be driven by a double-wound armature, which would be controlled by a series-parallel controller, so as to get good efficiency over a wide range of speed. In this way a constant feed at different loads could be given.

Mr. J. H. Rider (Plymouth) commented on the necessity of avoiding complications in working parts. For this reason he did not care for the triple-expansion engine. The amount of coal saved by the triple-expansion engines cost so little per unit as compared with the other costs that he did not consider it advisable to use them. He believed in having a separate condenser for each set, and for simplicity advocated the ejector type of condenser, of which a number could be supplied from a large tank on the roof of the station. It was curious how little some makers knew about their own machinery. He had recently been obtaining tenders from pump makers for pumps which had to be driven by electricity. The power required to drive them was hence important, as he had to get motors to work them. After considerable pressure he got one prominent manufacturer to state a definite figure for the power required from a given pump. On calculation he (Mr. Rider) found that this was 10 per cent. more than the theoretical work to be done. On trial after delivery he found that the pump required a further 90 per cent. The maker on being expostulated with said that they had meant nominal horse-power.

Mr. J. H. Maclaren also complimented the author on his paper, and thought that with the addition of prices and discounts it would make a good manufacturer's catalogue. As regards Mr. Raworth's remarks, there was no difficulty in making an engine efficient at light loads. Thus one engine he had made for a day-load set gave the following figures for steam consumption per indicated horse-power at different loads: full load, 13·8lb.; three-quarter load, 13·7; half load, 13·7; and one-quarter load, 13·5. Of course, the engine was much forced at full load. He believed that triple expansion paid, and Mr. Rider was wrong to suppose it meant complication. A triple-expansion type was much more simpler than a compound with automatic expansion gear to both cylinders. The economy gained meant less first cost in the boilers and boiler-house. As regards a question asked, he had tried one compound engine at one-seventh of the full load, and even then had beaten the day-load set in the same station for steam consumption. With expansions of from 30 to 40 times as then obtained, all parts must be most carefully jacketed, and the steam jackets took more steam than the cylinders. Thus the steam-chests at the bottom of the cylinder, etc., were all jacketed. The vacuum also should be most carefully attended to, as a difference of 2in. in the vacuum made a great difference to the thermal efficiency of the engine. He believed in having the air-pump on the engine, so that the vacuum got right on to the piston. In some cases where long lengths of exhaust pipes were between the air-pump and the engine, a great waste occurred by loss of vacuum between the pump and the cylinder. As regards accessory plant, he had tested some steam-engines abroad some six years ago, when the little feed pump was found to take steam equivalent to 48 h.p (at 18lb. per indicated horse-power). Again, the steam-jets under the fires in this place took some 90 h.p. These large amounts explained difficulties which had been found with the capacity of the steam plant.

Mr. W. A. Chamen (Glasgow) said, previous to a question as to the figure for the four pumps given by the author, he supposed the amount of water delivered per hour was in gallons, as otherwise No. 4 pump took more steam from the boiler than the feed water it pumped in. He now referred to an electrical device for driving a pump which had been submitted to him recently. Instead of the double circuit armature described by Mr. Giles, the field-magnet frame was made to slide, so that the lines went more or less through a dummy core on the same spindle. He was having a pump delivered to the Glasgow works driven in this way. He was also using driving a friction gear, such as was employed in some of the London docks. These two specialities were manufactured by Messrs. Wimshurst and Hollick and Co. He was arranging his auxiliary plant, such as air pumps, so that there was one air-pump for each larger engine and one for each pair of smaller engines. The exhaust pipes would be so arranged that the steam consumption of any set could be determined in working conditions. The exhaust steam would be deviated to a tank on a weighbridge. He would ask if any members present could give him figures of efficiency of centrifugal pumps, as he could not get the makers to commit themselves. Of the plant now being made for Glasgow they had one 900-h.p. triple-expansion engine, one 750-h p. American compound engine, one 400-h.p. triple-expansion with four cylinders, and one 200 compound. He hoped in due time to lay the figures of the tests of these sets before the association.

Mr. J. H. Rider said he had the figures asked for by Mr. Chamen in an indirect way. He wrote to the makers to say he had heard that the efficiency of their pumps was only 40 per cent. They promptly replied, "No, it is 45 per cent."

The **President**, before calling on Mr. Jeckell to reply, said that they had had a most interesting discussion. As regarded steam trials, he had noticed that "no one believed the tests of other people unless they had made them themselves."

Mr. J. A. Jeckell, in replying, said that the triple-expansion engines could be made as efficient at light loads as compound engines. They had had great trouble with the feed water at South Shields, and had to use surface condensers. The river water was salt and dirty, and the town water even worse. They used an evaporator to get the make-up water.

After a vote of thanks to Mr. Jeckell, the meeting adjourned till Thursday.

The Dinner.

The second annual dinner of the association was held at the Holborn Restaurant on Wednesday, when a large number of members and guests were present. The dinner was served in the Royal Venetian Chamber, after a reception had been held in the Piscatorial Hall. The following was the menu:

Hors d'Œuvres.—Sardines à l'huile, olives, Frai de Hareng, Lyons sausage.
Soups.—Thick turtle, clear turtle.
Fish.—Salmon, Mousseline sauce and cucumber, whitebait.
Entrée.—Sweetbreads piqué polonaise, Punch à la Romaine.
Removes.—Lamb and mint sauce, chicorée salad, York ham and Madeira, new potatoes.
Roast.—Aylesbury duckling, peas.
Sweets.—Apricots à la Condé, strawberry jelly, Charlotte à la Russe, ice pudding.
Cheese, salad, dessert, and coffee.

After this had been successfully negotiated—and the work of the day had whetted the appetites of the members—the speeches were commenced by the usual loyal toast of "The Queen and Royal Family," proposed by the president. Two ladies came in to teach the members to sing "God Save the Queen," although we think they hardly required instruction. Still, the ladies first and the diners afterwards gave double effect to the sentiment of the first part of the well-known tune.

Councillor G. Pearson, proposing the toast of "The Guests," said they were very pleased to welcome the number of gentlemen present who represented contractors. He also liked to hear the kind way in which rival engine makers spoke of each other's productions, but such eulogies were to be received *cum grano salis*. The electrical undertakings in the various towns were dependent on the contractors for the success of their works. He would give those responsible for the machinery at Bristol a word of praise for the excellent way their apparatus had stood the test of time.

Mr. Mark Robinson, in reply, commented on the fact that the Municipal Association was the youngest of our

engineering associations, but that it possessed all the energy of youth. In a very short life it had accomplished a great amount of good work, and it was to the young men in its membership that one had to look for the prosperity of town lighting undertakings. He trusted that the association would continue to prosper, and that the sympathy between the contractors who do their best to perfect the various machinery required for electric lighting stations would continue.

The MAYOR OF SOUTHAMPTON (Mr. G. J. Tilling) proposed the toast of "The Municipal Electrical Association." He said that the progress of the association in the three years of its life had been most rapid. They now had about 160 members and associates, and it was a very good feature that chairmen of electric light committees were admitted into the ranks. That gave most valuable opportunity for those gentlemen to keep themselves informed of the progress of electric lighting, and also they could take part in the discussion of the many financial problems involved. He wished the association every success in the future.

Mr. C. H. WORDINGHAM, in reply, said, as a past-president, and one who had taken great interest in the association from its inception, he was most gratified by the remarks of the Mayor of Southampton. Much of the success was due to the enormous labour of their honorary secretary (Mr. A. B. Mountain), who had worked early and late to advance the welfare of the association. The objects of the association were not selfish, and he gave as an instance the standard clauses for specifications drawn up in conference with the Electrical Manufacturers' Association. The council had still more important work in hand, which would be referred to on Saturday. He was glad to see so many chairmen of electric light committees present.

Mr. J. RIDER, in a humorous speech, asked the members to drink the health of the contractors. They had not yet reached the stage of starting municipal electrical manufactories, and under the circumstances there was still hope for the contractors. In fact, the present manufacturers did turn out most excellent work. He hoped all would incorporate the standard clauses in their specifications.

Mr. J. S. RAWORTH, in reply, said contractors were always dry, always amatory, and always mercenary. They had to be mercenary, and even then could not earn such good profit as the central-station men. He hoped electrical machinery would be more standardised in future. He also referred to the most excellent pioneering work of the late Mr. P. Willans in the interest of all electrical engineers. He reminded those present that the Holborn Restaurant was one of the first places to be electrically lighted in England.

Mr. H. E. KERSHAW, proposing the health of "The Press," got in some telling remarks about the electrical Press in particular. The omniscience and power of making bricks without straw were referred to humorously when he stated that certain editors had always known a good deal more about the Shoreditch plant than those responsible for working the same. Still, they owed a great deal to the Press, and he believed that it did a vast amount of good work.

Mr. TREMLETT CARTER, in reply, compared the electrical Press to a curved mirror, which gave a distorted image of all that happened. We trust he spoke from his own practice, as although a curved mirror may make a curved line appear straight, the reverse is also true.

Before separating, Mr. W. A. CHAMEN, as one of the newest members, proposed the health of "The President," to which Mr. A. H. GIBBINGS replied.

The following is a list of those present: the Mayor of Southampton and Alderman W. Bone, Southampton; G. S. Ram; Alderman Hill and Councillor West, Coventry; J. Shaw, J. K. Lee, Councillor W. G. Millington, Hull; Alderman Calvert, Councillors Hesketh and Robinson, Huddersfield; A. B. Mountain, J. A. Swift, H. W. Kolle, H. E. Kershaw, R. Hammond, H. Hurst, C. Hawkins, A. Eckstein, J. Morton, H. Kilgour, G. A. Grindle, F. A. Leigh, Alderman Haigh, A. S. Giles, A. M. Sillar, E. M. Lacey, A. B. McLean, E. T. Ruthven-Murray, C. M. Dorman, J. W. Swan, J. Doherty, R. E. Crompton, T. K. B. Elphinstone, C. J. Sutherland, J. K. Rider, Dr. Panton, R. D. Miller, J. Saxon, A. Marr, A. B. Pescatore, J. Connolly, T. Connolly, C. D. Taite, S. E. Fedden, A. T. Snell, J. F. C. Snell, R. P. Wilson, H. L. P. Boot, C. S. Vesey Brown, L. Andrews, W. J. Hope-Johnstone, J. Darney, A. C. Publis, R. A. Hopkinson, G. S. Corlett, W. Mitchell, Alderman Higginbottom, C. A. Cowell, T. R. Wollaston, F. W. Couzens, W. Dieselhurst, W. Lackie, J. J. Steinitz, A. S. Barnard (engineer of Hull Corporation), W. B. Sayers, H. Alabaster, T. P. Wilmshurst, A. H. Gibbings, H. C. Bishop, R. C. Quin, Councillors Brodie and Grime, Blackpool; A. Lester Taylor, E. Worthington, C. A. Clarke, Councillor Pearson, Bristol; J. A. Jeckell, W. Arnot, J. E. Stewart, Sir H. Mance, the Lord Mayor of Manchester, W. H. Talbot, C. Nickson, G. E. Stephenson, Walker, Talbot, Tittensor, P. W. MacDougall, A. Hope, S. V. Clirehugh, W. A. Chamen, J. W. M. Munro, J Henderson, G. Millington, H. Human, Slater Lawes, E. Crossland, T. Parker, and the representatives of the Press.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared, and should be written on one side of the paper only. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time.

QUESTIONS.

80. Explain the working of a direct-current "booster," and show with diagram of connections and switch-gear how a "booster" can be used for charging the battery from the continuous-current public supply mains. If the voltage has to be "boosted" up 20 per cent., what efficiency would you expect from a given size of "booster"?—F. F.

71. What range of speed would you expect between no load and full load from 1-h.p. and 5-h.p. shunt motors respectively? Give actual figures if possible.—P. T.

ANSWERS.

Question No. 65.—Describe (with sketches) a good form of portable testing set suitable for measuring insulation resistance of dynamos, cables, etc.?

Best Answer to No. 65 *(awarded* 10s.*)*.—The Silvertown set, sketched below, is a very handy and accurate combination of instruments suitable for determining both the conductor and insulation resistance of dynamos, mains, etc. The whole set consists of two wooden boxes, one of which contains the galvanometer, key, resistance coils, etc.; and the other, the battery. The latter is generally divided into two lots of cells, one of about six low-resistance Leclanchés, for use with the Wheatstone's bridge, and the other of a greater number of small Leclanchés, to be used exclusively for any resistance of considerable magnitude, such as the insulation resistance of mains, etc. This latter battery is again subdivided, so as to be able to obtain E.M.F.'s varying from 50 to 100 volts, as may be found convenient. Care should be taken not to put this on a circuit of low resistance.

The sketch, Fig. 1, is a diagram, etc., of the case containing the instruments. It consists of a small wooden box, containing a galvanometer, an ordinary circular pattern Wheatstone's bridge and key, and a special arrangement at the top for taking insulation tests. The construction of the Wheatstone's bridge is so well known that it it is only necessary to describe the galvanometer. This consists of a coil of fine wire wound on a brass bobbin, with a small magnetic needle vibrating at its centre; the needle is mounted on a jewel, and to prevent injury during transit there is a small spring, actuated by the lid of the box, which holds it in one position when the latter is shut. On one side of the box is a controlling magnet, for affecting the sensitiveness of the instrument in exactly the

same way as is usual with an ordinary galvanometer. In testing the resistance of conductors, etc., Fig. 2 shows all of the connections that are necessary, the parts omitted being used exclusively for insulation tests. These are: (1) two circular dials, each containing nine resistance coils, each coil of one set being one ohm and of the other 10 ohms, so that any combination up to 99 ohms can be obtained; (2) the two proportional arms each containing resistances of 10, 100, and 1,000 ohms; (3) the galvanometer already described. The shunts have been omitted in this test as not being strictly necessary, although they may be very conveniently used before the balance of the bridge has been

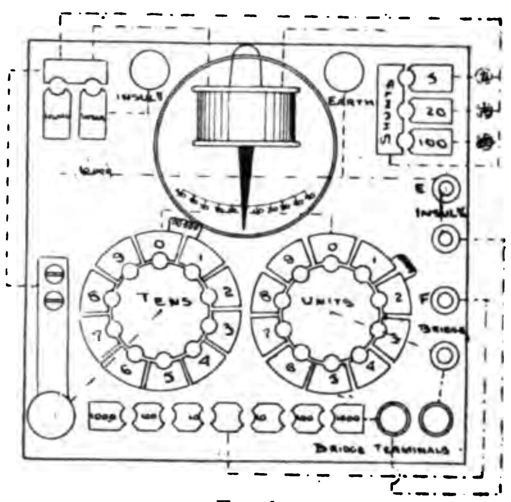


FIG. 1.

obtained. The battery is connected to terminals, B B′, by suitable leads ending in brass plugs, and the conductor to be measured to terminals, C C′; then, supposing when the balance of the bridge had been found, the plugs removed were 100 and 100 on the left and right hand of the proportional coils and 5 and 4 on the other two dials, then the resistance of the conductor would be 54 ohms. One place of decimals can be obtained in the usual way by observing the deflection of the galvanometer first when the 4 on the unit dial is unplugged and then the 5; supposing, in the first case, the throw of the needle was 30 to right and in the second 20 to left, then the resistance will be 54·6 ohms.

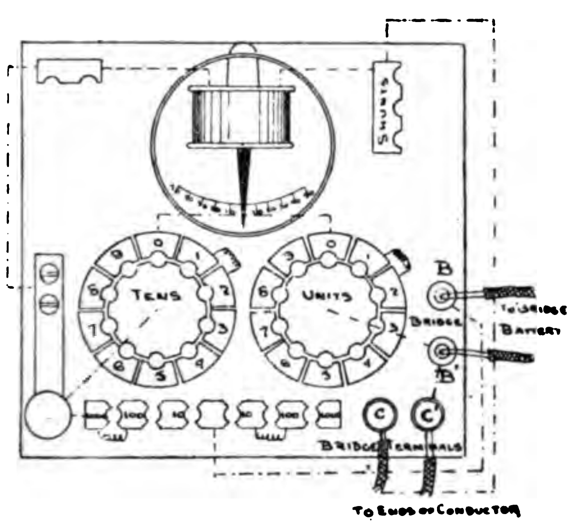


FIG. 2.

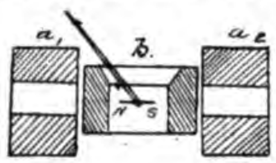
The measure of the insulation resistance of a conductor, machine, etc., is taken rather differently. It consists in first passing a current through a known resistance and noting the deflection of the needle, and then inserting in its place the conductor whose insulation resistance is to be measured. The parts of the instrument in use (Fig. 1) for this test are the galvanometer, the blocks marked insulation, and 10,000 ohms, and the three shunts. The leads from the "insulation battery" are connected to terminals, E F, and those from the conductor and its lead sheathing or earth terminals, marked insulation and earth. Then by inserting a plug in hole marked 10,000 ohms, with shunt $\frac{1}{99}$ being used, there will be a certain deflection of the galvanometer, and this would be the same as that by passing the whole current through one megohm. Let it be, say, 50 divisions, then by changing the plug to hole marked insulation, there will be a new deflection, say, of 25 divisions, then the insulation resistance will be $\frac{50}{25}$, or two megohms. If, of course, the shunt was changed to $\frac{1}{4}$, then it would be $\frac{50}{25 \times 5} = {\cdot}4$ megohm. By following out the connections, it will be seen that the key used in the bridge tests can be very conveniently used in this case for short-circuiting the galvanometer and bringing the needle quickly to rest.—H. BELL.

Answer to No. 65 (*awarded* 5s.).—One of the best forms of portable testing sets is the Muirhead. It has been specially designed for electric light engineers, and consists of a Wheatstone bridge with adjustable resistances for testing copper resistance, together with a constant coil of 10,000 ohms, for testing insulation by the direct-deflection method. The galvanometer is connected to the terminals marked G, to which a series of shunts, $\frac{1}{9}$, $\frac{1}{99}$, $\frac{1}{999}$, is also connected. On the right-hand side is a key which puts the galvanometer in circuit for either the C R, constant, or insulation test. The sliding contacts do away with all loose plugs. This advantage, and the great facility with which the tests can be made, will be obvious to inspectors and others who have to make rapid tests under all manner of conditions and adverse circumstances.

A great advantage with this testing set is that all the internal connections are so plainly engraved on the ebonite top that the set can be used by an ordinary wireman without the help of written instructions. The battery for these testing sets consists of 50 small dry cells for insulation testing and two large dry cells for C R tests. A commutator switch is provided for varying the number of cells. The whole is enclosed in a stout travelling case.—F. BRUTON.

Answer to No. 65 (*awarded* 5s.).—A convenient form of portable testing set has been invented by Mr. Evershed. It is extensively used for measuring the insulation resistance of electric light wiring, and of dynamos and cables in course of construction, for testing street cables while being laid, and for similar purposes. It consists of a small magneto-generator of special construction capable of developing an E.M.F. of 200 volts when driven by hand at a speed of between 60 and 70 revolutions per minute, and an ohmmeter giving direct readings of the insulation resistance in ohms and megohms. In the construction of the ohmmeter there are three coils, two of them, shown at a_1 and a_2, are placed with their planes parallel, and are joined in series, while a third coil, b, is placed between them with its plane and magnetic axis at right angles to the coils a_1 and a_2. The needle, $r\ s$, is lying in its zero position in the centre of the coil b, and along the common axis of the coils a_1, a_2. In the case is placed a small, weak bar magnet, not shown in sketches, which adjusts itself so as to always neutralise the effects of the earth's magnetism upon the needle, and consequently the only magnetic forces acting on the needle

are those due to the current in the coils. A current passing through the coils a_1 a_2, which are of a high resistance and coupled as a shunt to the generator terminals of the instrument, tends to keep the needle in its zero position with its length along the common axis of the coils a_1 a_2, but its length is also parallel to the plane of the coil b, and any current passing through this coil will deflect the needle more or less, its position of rest



Sketch showing Section of Coils and Position of Needle and Pointer.

depending upon the relative strengths of the currents in the magnetising coils and deflecting coil.

Let r_1 represent the resistance in the coil a_1,
r_2 " " " a_2,
R " " " b,
E the E.M.F. of the generator,
x the insulation resistance under test,

then current in the magnetising coils $= \dfrac{E}{r_1 + r_2}$, and

the current in the deflecting coil $= \dfrac{E}{x + R}$.

The coils a_1 a_2 are connected to the E.M.F. only, consequently the current in them, and the force which the needle is urged to its zero position, is distinctly proportional to the E.M.F. The coil b is connected to the E.M.F., but has the resistance to be measured joined in series with it. This resistance is very high, and the current through b, which tends to deflect the needle, is inversely proportional to it. The deflection of the needle, which is indicated on the scale by the pointer, is proportional to the E.M.F. and inversely proportional to the resistance, but the same source of E.M.F. is used for both branches of the circuit. Any variation, therefore, affects equally the deflecting and magnetising currents, and, therefore, the deflection of the needle is simply inversely proportional to the resistance under test, that of the coil b being small. When the resistance is infinity, no current flows through the deflecting coil, and the needle remains at zero; but as the resistance is lowered, the deflection of the needle proportionally increases, and it becomes a simple matter to calibrate the instrument so that the pointer shall indicate directly the value of the resistance required in ohms and megohms. The scale of the instrument is so divided to read from 0·1 to 10 ohms with very fair accuracy, and a shunt is provided which shunts one of the coils, thus reducing the sensitiveness of the instrument to one-tenth its former value, which will now read from 10,000 to 100,000 ohms.

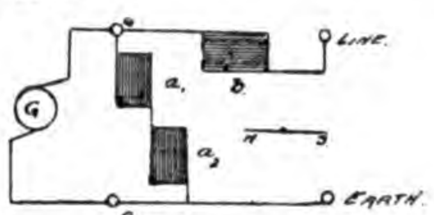
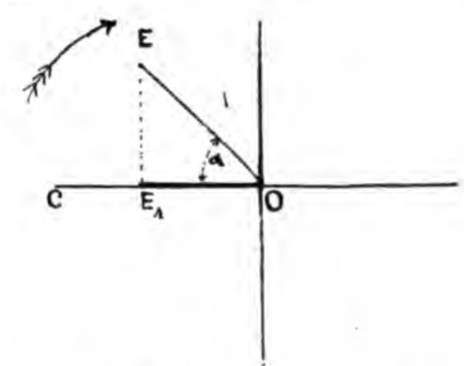


Diagram of Connections of Coils.

All that is necessary to measure the insulation resistance of any cable is to couple both its ends, one to the earth and the other to the line terminals of the instrument, and connect the generator to the ohmmeter at the terminals marked G_1 G_1, turn the handle of the generator, and the pointer at once points to the value of the resistance on the scale. This direct-reading form of ohmmeter is extremely useful for dynamo builders, instrument makers, and others, for use in workshops and other places where a Wheatstone bridge is difficult to manage, as its portability and the simplicity of the method of reading enable observations to be made under any conditions and by wholly unskilled workmen, thus enabling defects to be discovered while work is in progress. It is well known that tests of insulation resistance made with less than working pressure are quite worthless, and while batteries to give 100 volts are costly and heavy and give constant trouble, a generator if kept clean will last for several years without other attention than an occasional oiling and cleaning. This form of testing set is very portable—in fact, the ohmmeter and generator can both be carried in a case measuring 15in. by 7½in. by 8in. high.—R. B. B.

Question No 66.—The product of volts and amperes does not always give true watts in an alternating-current circuit. Give examples where there is a wide difference between this product and true watts expended.

Best Answer to No. 66 (awarded 10s.).—The product of amperes by volts in an alternating-current circuit does not always give true watts, from the fact that the current may be lagging behind or leading the E.M.F. The amperes and volts are taken as √ mean square values. A circuit having self-induction causes the current to lag, and one with capacity causes it to lead. A simple diagram will explain the method of computing the power in these cases. Representing current and E.M.F. by *st* lines revolving in a certain direction from a fixed centre, O, and starting from the horizontal line, O C, to represent current, we see that the E.M.F. line, O E, has advanced from the base line by an angle α. We see that the E.M.F. is leading, or generally that the current is lagging behind the E.M.F. by an angle α.



The true watts are O C by that component of O E which is in phase with O C. By dropping a perpendicular from E to O C, the line O E_r is the E.M.F. in phase with O C. The true watts, therefore, are O E_r × O C, but O E cannot be measured; it is only O E that we know, but $\dfrac{O\ E_r}{O\ E} = \cos \alpha$, and hence O E_r = O E cos α. Therefore, true watts = O E × O C × cos α.

A good example, in which a wide difference may exist between true watts and amperes by volts, is that of an alternator running as a synchronous motor. If the motor is driving a steady load, then the power or true watts given to the motor is a constant quantity. But by altering its field excitation we can make the armature current vary, although the E.M.F. and the work it is doing are constant. Over-exciting the field magnets causes the armature current to lead, whilst under-exciting causes the current to lag. By thus varying the field, and taking readings on the ammeter and voltmeter of a 40-kw. alternator, the following results are obtained:

Armature current, C.	Volts, E.	Apparent watts, E × C.	True watts, W, constant throughout = 12,500 by Thomson wattmeter.	Angle of lag (calc.) $\cos \alpha = \dfrac{W}{E\ C}$
7·1	2,000	14,200		28°
7·5	2,000	15,000		33°
8·5	2,000	17,000		43°
9·2	2,000	18,400		48°
10·1	2,000	20,200		52°
11·1	2,000	22,200		55·5°
13·8	2,000	27,600		63°
15·2	2,000	30,400		66°
18·6	2,000	37,200		70·5°

The above results furnish many examples in which there can be a wide difference between the product of amperes and volts and the true watts actually expended.—S. J. M.

Answer to No. 66 (*awarded* 5s.).—The product of the amperes and volts in an alternate-current circuit is usually spoken of as the apparent watts, the true watts depending upon the amount of inductance and capacity in the circuit, the former giving the current a tendency to lag behind the impressed volts, the latter tending to neutralise the effects of inductance. So V (volts), X A (amperes) = apparent watts, and V A cos θ = true watts, θ being the angle of lag. The ratio between the true and apparent watts is called "the power factor," therefore cos θ being the multiplier which converts the apparent into the true watts is simply the power factor for the circuit considered. It is important from a practical point of view to have this ratio as large as possible. Where inductance and capacity are negligible quantities, the mean true power in watts is equal to the product of the E.M.F. (in volts) and the current (in amperes). The presence of inductance in a circuit has the effect of displacing the current relatively to the E.M.F., as in Fig. 1. Should this displacement

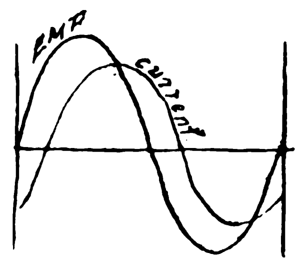


FIG. 1.

be 90deg. the mean value of the product of the current and E.M.F. (assuming simple harmonic functions) which are in quadrature (90deg.) is equal to nothing (Fig. 2), as the positive half waves of the dotted curve are equal in every respect to the negative ones, therefore the power factor in such a case will be 0. In closed magnetic circuit transformers with open secondaries the angle of lag approaches nearly to 90deg. A bank of incandescent lamps, or a closed magnetic circuit transformer fully loaded, is an arrangement for which the power factor is practical

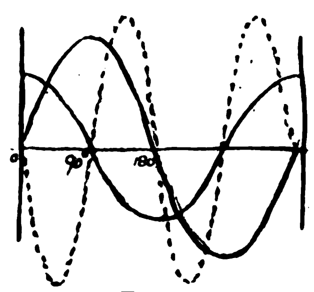


FIG. 2.

unity. Alternate-current motors, open magnetic circuit transformers (loaded or not), closed magnetic circuit transformers with open secondaries, are cases where the power factor will be very small. The following table will show the difference between true and apparent watts for an inductive (motor load) and non-inductive (lamps load) of a case from actual practice, the same (single-phase) alternator and instruments being used in both cases.

Motor Load.

Amperes.	Volts.	Apparent watts.	True watts by wattmeter.	Power factor.
28	2,040	57,120	28,100	·51
34	2,040	69,360	37,120	·53

Lamp Load.

Amperes.	Volts.	Apparent watts.	True watts by wattmeter.	Power factor.
28	2,040	57,120	48,700	·85
34	2,040	69,360	59,200	·86

—J. F. M.

Answer to No. 66 (*awarded* 5s.).—Perhaps the most striking example is when the inner and outer of several miles of a concentric main are connected to the terminals of an alternator. In this case a large condenser current flows into the main, even although there is no load on it. This is strikingly shown by the large current required to "charge" the mains of the London Electric Supply Corporation between London and Deptford. From Dr. Fleming's experimental results it appears that it required 11·4 amperes to charge No. 1 main, which was nearly 6½ miles long. As the pressure of supply was 10,000 volts this gives 110·4 apparent kilowatts, and yet the true watts expended were under 2 kw.

Another striking case is when open iron circuit transformers are used on an alternating-current circuit. The magnetising current of a 6-kw. "Hedgehog" transformer is about 1·2 amperes when the primary pressure is 2,400 volts. This gives 2,680 apparent watts, but the real watts measured by a non-inductive wattmeter are only about 150. The ratio of the true watts to the apparent watts is called the power factor of the circuit. The power factor in the first case given is 0·018, and in the second 0·063.—J. C. R.

GLASGOW TRAMWAYS.

THE GLASGOW GAS AND WATER DEPARTMENTS ON THE ELECTROLYSIS OF STREET MAINS AND PIPES.

Ever since it was resolved to work the Springburn tramways by means of the electric current, there has been much concern in the Glasgow Gas and Water Departments on the subject of the electrolysis of the street mains. The first result was the formation of a joint special sub-committee of the two departments for the consideration of the matter, and then they remitted the question to the new electrical engineer to the city, Mr. W. A. Chamen, feeling confident that his deliverance on the question would be one on which they could rely with the utmost trustworthiness. Mr. Chamen took the matter in hand, and at a recent meeting of the sub-committee he had his report ready, and he proceeded to read it—the representatives of the sub-committee present being ex-Bailie Osborne (of the Water Committee), ex-Bailie R. M. Mitchell (convener of the Committee on Gas Supply), and ex-Bailie Wallace (of the tramways department). The report was as follows:

GLASGOW CORPORATION.

Gas and Water Departments.

Gentlemen,—In accordance with your instructions to consider and report as to the prevention of electrolysis of the gas and water mains along the Springburn tramway route, I beg to submit the following report:

I have made a careful examination of the system of bonding the rails together, and have also made electrical tests of the resistance of the rails themselves, and of the bonds, by passing heavy currents through and measuring the fall of potential in them.

I find that the electrical resistance of steel rails is about ten times that of pure copper of equal section, or, in actual figures, the resistance of 42ft. of rail is ·0003575 of an ohm. The sectional area of the rails is 10in. The resistance of the copper bonds, including the points of junction or contact with the rails, measured with two bonds in parallel as they are actually being laid, averages ·000066 of an ohm. The length of line from Springburn to Mitchell-street is about 13,400ft. The rails measure 45ft. from end to end, and there will, therefore, be 300 rails to each line of each road.

Only 43·66ft. of each rail can be relied upon to carry current, and the bonds bridging over the fishplate will be responsible for carrying the current over the remainder of the distance. The total resistance of one rail only, from end to end of line, including bonds will, therefore, be ·13127 of an ohm. As there are four rails, which are cross-coupled in parallel about every 135ft., the total resistance of the whole line will be ·03282 of an ohm.

It is difficult to estimate the amount of current which these rails may be required to carry, but with 20 cars running on this route (this being the number which the tramway department inform me they propose to run), I think that an average current o 25 amperes per car throughout the route will be somewhere about what will be found to be required in working.

The tramway generating station is not at the extreme end of the Springburn route, but some 2,300ft. on the homeward side of it. The resistance of the line from that point to the terminus in Mitchell-street will be about ·0278 of an ohm, and the current which will have to be carried by the rails along that portion will be about 400 amperes.

The whole of this current will not, of course, be carried throughout the entire length, but it will be used by cars distributed at approximately equal distances throughout the route. Taking this into account, the fall of potential between the tramway in Mitchell-street and the generating station will be about 5·56 volts.

The Board of Trade regulations, issued on March 6, 1894, are very stringent, and provide for the regular testing and record of the number of cars running, the maximum working current, the maximum working pressure, the maximum current for the earth connections, leakage current, and the fall of potential in the return (that is to say, in this case, in the rails). Clause 7 of these con-

ditions requires that if at any time such difference of potential exceeds the limit of seven volts, the company—that is to say, the undertakers—shall take immediate steps to reduce it below that limit.

I understand that the tramway department are not putting in any return feeders to assist in carrying back the current at present, but if the Board of Trade limit of seven volts shall be exceeded, they will doubtless be able to put in a return feeder in one of the six pipes which they are laying beneath the tramways.

Provision is also made in these regulations for limiting and ascertaining the amount of current which may return to the generating station through the earth or by any other channel than the rails themselves; and some elaborate conditions are set out for the purpose of enabling the owners of any pipes to ascertain at any reasonable time that the conditions being laid down are being complied with.

Turning now to the actual construction of the bonds, and the probability of their maintaining a good connection with the rails, I would draw your attention to the sample bond in a piece of steel plate which has been cut open in order to show in section how the contact is effected, and also to the two sample bonds. The copper bond is about 28in. long and ·46in. in diameter. It is forged at the end to form a boss about $\frac{7}{8}$in. in diameter and $\frac{9}{16}$in. in depth, with a shoulder on one side. The boss is punched through the centre with a taper punch, the hole measuring $\frac{1}{2}$in. at the large end—that is to say, in the shoulders. The hole in the rails is made a good fit for the boss by means of a reamer having a slight taper. This operation is performed immediately before the bond is inserted, care being taken to have the larger end of the hole on the side of the rail away from the shoulder of the bond. The boss of the bond is, before insertion, carefully cleaned with a smooth file.

When inserted in place, a drift is driven through to expand the bond tightly into the hole, and also to prepare the way for the permanent steel pin, which is then driven right home so as to be flush with the copper boss at both ends. You will observe that, in driving in the drift and the steel pin, the far end of the boss is considerably expanded outwards over the edges of the hole, so that it is impossible for it to draw out. In addition to this, the taper of the hole itself is in such a direction as to resist the withdrawal of the boss even if the outer end were cut off.

I think this method of bonding rails will prove entirely satisfactory, and do not at all expect that there will be any trouble whatever through their working loose. In some forms of bond the pin or key is driven in from the opposite side of the rail to that on which the bond itself lies, thus necessitating holding up while the operation is performed. But with this type of bond the action of driving in the drift pin forces the shoulder hard home into its proper place. Each joint is, after completion, carefully painted over with a preservative compound to prevent corrosion and the entrance of moisture to the surfaces, and it might perhaps be an advantage to treat the whole bond in the same manner, in order to reduce all chances of corrosion to a minimum.

I do not think, therefore, that so long as the limit of seven volts fall of potential between the most distant points on the line and the generating station is not exceeded, there will be any fear whatever of electrolysis of gas or water mains.

In all those cases in which trouble has occurred the fall of potential over the rails has far exceeded this limit, being as much as 50 or, possibly, 100 volts.—I am, gentlemen, your obedient servant, W. A. Chamen.

The Special Joint Sub-Committee having considered the foregoing report, and received verbal explanations from the electrical engineer on the matter thereof at a recent sitting, resolved as follows: (1) To report that if the tramways department observe and carry out the rules and regulations of the Board of Trade in respect to the construction and maintenance of the electrical tramways on the Springburn route, there does not appear to be any danger of the gas and water mains and pipes along the route being injuriously affected by electrolysis from the action of the return currents along the tramway rails or otherwise; (2) that the electrical engineer should report to the engineers of the gas and water departments respectively any further facts or circumstances which may from time to time hereafter come to his knowledge in regard to any of the matters dealt with in his report.

COMPANIES' MEETINGS AND REPORTS.

METROPOLITAN ELECTRIC SUPPLY COMPANY.

An extraordinary general meeting of the Metropolitan Electric Supply Company, Limited, was held on the 7th inst at Winchester House to consider a scheme with reference to the consolidation of the founders' shares with the ordinary shares of the Company.

The **Chairman**, Sir Eyre Massey Shaw, read a return which was presented that morning by the engineer, showing that during the last 12 months 63,000 lamps had been connected, as against 47,000 for the preceding 12 months. "The total number of lamps connected to date amounted to 394,000. and they had on their books applications for 13,000 more." He then moved the following resolution: "That it is expedient that the special rights and [illegible] of the 100 founders' shares in this Company, whether with regard to dividend, capital, reserve fund, or otherwise should cease and be abolished upon the terms that each registered holder of a founders' share or founders' shares in the Company should upon having such his share or shares converted into one ordinary share or shares have the option of subscribing for 225 ordinary shares in the Company at par in respect of each founders' share so held by him And that the draft agreement for the purpose submitted to this meeting be, and the same is hereby, approved. And the directors of this Company be, and they are hereby, authorised to adopt the said agreement and to affix the seal of this Company thereto, with full power to assent to any modifications in the agreement which they think expedient in the interests of this Company, either before or after the adoption thereof."

Sir James Pender seconded the motion.

Mr. Boning asked what claims the founders' shares possessed upon the Company.

The **Chairman** said the matter was very simple, and the solicitor would explain it.

Mr. Barlow (the solicitor) said that the founders' shares had the right to participate in one moiety of the profits after the payment of 7 per cent. dividend to the ordinary shareholders in the Company, and they had also the right to express a voice in saying how much should be carried to reserve fund and to depreciation fund. That gave a large preponderating interest to them in that way over the ordinary shares. Then, again, in the assets of the Company, in the event of a winding-up, the founders' shares shared equally with the ordinary shareholders, after the ordinary shareholders had been paid in full, in any surplus.

Mr. John Newton supported the proposal, which he believed would bring about peace and success in the future. They would get a satisfactory settlement, and the position of the Company would be strengthened. Founders' shares he regarded as an iniquity. They were a curse to any company which had them, and there was a brand upon any company having founders' shares, and investors were very much disinclined to put money in such companies. By carrying out this proposal the Company would be in a united position, they would be able to earn a dividend, and they would be able to contend with the factions which would be brought against them, especially vestries and vested interests.

Mr. Garner asked whether the founders' shareholders unanimously accepted these terms.

The **Chairman** said that he did not think that there was any objection.

A **Shareholder** said that it seemed to him the second clause in the resolution was likely to over-ride the first.

The **Chairman** said that that was not so, and nothing whatever would be done to over-ride the essential principle of any clause.

The resolution was carried unanimously.

A vote of thanks to the directors concluded the meeting.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY, LIMITED.

The forty-ninth ordinary general meeting of this Company was held at Winchester House on the 8th inst.

The **Chairman** (Mr. J. Denison Pender) referred to the loss the Company had suffered through the death of Lord Sackville Cecil, whose knowledge of the electrical business had been of considerable value, but they had since been fortunate enough to secure the services of Sir John Wolfe Barry. The income for the half-year ended Dec. 30, 1897, amounted to £100,300, while for the previous half-year it was £79,133, thus showing an increase of £21,000, all but £1,000 of which was from message receipts. After providing £3,200 for debenture interest and sinking fund, there was a credit balance on the half-year's business of £69,580, which with the £7,221 brought forward from June 30 made £76,801. The usual interim dividends for the September and December quarters amounted to £39,000, and £25,000 had been transferred to the reserve fund, which left the sum of £8,662 to be carried forward; £4,139 was given as a bonus to the staff to commemorate the sixtieth year of her Majesty's reign and also the twenty-fifth anniversary of the foundation of the Company. He moved the adoption of the report and statement of accounts, which was agreed to.

LONDON ELECTRIC SUPPLY CORPORATION.

Lord Wantage presided at an extraordinary general meeting of this Company on the 7th inst., at which a resolution was submitted by which it was sought to reduce the capital of the Company from £1,250,000, divided into 200,000 ordinary shares of £5 each and 50,000 preference shares of £5 each, to £850,000, divided into 200,000 ordinary shares of £3 each and 50,000 preference shares of £5 each, such reduction to be effected by cancelling capital which had been lost or was unrepresented by available assets to the extent of £2 per share on each of the 111,000 ordinary shares which had been issued.

The **Chairman** stated that in 1897 there had been a profit of £16,588. Their lamp connections at the end of the year were 123,730, as compared with 106,474 at the corresponding period of 1896—a rate of progress equal to nearly 20 per cent. Referring to the resolution before the meeting, he said it was obvious that a certain amount of the capital of the Company had been lost in the first years of its existence owing to their being a pioneer company. It was necessary that the lost capital should be worked off, and they had come to the conclusion to reduce the shares to £3. That would not lessen any dividend that might come to the shareholders. He suggested that the preference shareholders should

cations, etc., may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W., upon payment of £1, which will be returned to bona fide tenderers. Tenders by June 21.

Victoria (Australia).—Tenders are invited by the Council of the city of Hawthorn for the supply and erection, or for the supply only, of: (Section A) buildings only; (B) boilers, water-heater, pumps; (C) engines, dynamos, switchboard, mains, sub-mains, transformers, meters, arc lamps, insulators, testing instruments; (D) supply of poles and their erection; running of the plant for three years. Specifications and forms of tender can be obtained at the office of the Agent-General for Victoria, Lieut.-General Sir Andrew Clarke, G.C.C.M., Victoria Office 15, Victoria-street, Westminster, London, S.W., on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Tender for Electric Lighting," and addressed to the Mayor of Hawthorn, Victoria, Australia, on June 24, at 5 p.m.

RESULTS OF TENDERS.

Belfast.—The Corporation have accepted the tender of Mr. W. H. Drennan for the electric lighting of the new police offices and cells.

Derby.—The tender of Messrs. Ferranti, Limited, at £400, has been accepted for alterations to the switchboard; also that of Mr. G. Fairclough for oils.

Liverpool.—The Corporation have accepted the tender of Messrs. Willans and Robinson, Limited, for two compound engines and dynamo at £6,530 each, and for one triple-expansion engine and dynamo for electric traction at £6,939.

Sheffield.—The tenders of the British Thomson-Houston Company, Limited, have been accepted for the electric equipments and the Peckham trucks for the 13 cars on order from Messrs. Milnes and Co., at £433 6s. 8d. per car, and for 12 single-deck cars, including electrical equipment and trucks, at the sum of £617. 16s. 8d. per car.

Hyde.—The Technical Instruction and Free Library Committee have accepted the tender of Messrs. Laidlaw, Scholes, and Co., 72, Temple-street, Chorlton-on-Medlock, Manchester, for the supply and fixing of the wires, fittings, gas-engine, dynamo, etc., necessary for the installation of electric light in the new technical school and free library.

BUSINESS NOTES.

Halifax.—The Corporation inaugurated their electric car route on June 9.

Electric Railway and Tramway Carriage Works, Limited.—This Company went to allotment on Tuesday.

Nelson.—The Town Council have decided to further oppose the Burnley Tramways and Electric Lighting Bill.

Keswick.—The Urban Council have decided to transfer their electric lighting order to a company for 42 years.

Newcastle-on-Tyne.—The Corporation have asked Dr. Hopkinson to report upon an electric tramway system for the city.

Lancaster.—Owing to the large increase in the consumption of electricity during the year, the committee are prepared to put down fresh plant.

Stockton-on-Tees.—Mr. H. P. Boulnois held an enquiry on the 9th inst. into an application of the Town Council to borrow £30,000 for electric lighting.

New Address.—Mr. William H. Drennan, electrical engineer and contractor, 25, Fountain street, Belfast, has removed to 22, Wellington-place, Belfast.

Folkestone.—The Lighting Committee of the Corporation require an additional £1,500 this year to pay for the extra cost of lighting the streets by electricity.

Commercial Cable Company.—The directors of the Commercial Cable Company have declared a quarterly dividend of $1\frac{3}{4}$ per cent. on the capital stock, payable on July 1 next.

Doncaster.—The Board of Trade have issued the new provisional order to the Corporation empowering them to supply electricity throughout the whole area within their jurisdiction.

Royal Electric Company of Montreal.—The directors have declared a dividend on the share capital for the quarter ended May 31 of 2 per cent., being at the rate of 8 per cent. per annum.

Royal Palaces.—We hear that when the Queen leaves Balmoral there will be an installation of electricity in the castle. The Electric Construction Company, Bushbury, are supplying the dynamos.

Chorlton.—The Guardians have resolved that the installation of electric light in the union offices should be carried out. Dr. Rhodes said he voted for this, not as a matter of economy, but as a matter of health.

Leigh.—The plans and estimate of proposed electricity works for the District Council have been approved, and application will be made to the Local Government Board for sanction to borrow £10,500 for the purposes of the proposed works.

Bognor.—A committee has been appointed to consider the expediency of lighting the public thoroughfares by electricity, with instructions to report to the Council as to its economy and efficiency, and what saving to the ratepayers might be effected by *replacing it for gas.*

Devonport.—The town clerk has been directed to make enquiries with a view to the acquisition of the property adjoining the Corporation property at Pottery Quay, which Prof. Kennedy considers a suitable site for an electric light station.

Bexhill.—The Local Government Board have sanctioned the Urban District Council's proposal to borrow £20,000 for the purposes of electric lighting. The committee's report recommending that the necessary steps be taken for the purpose of carrying out the work has been adopted.

Great Northern and City Railway.—The size of the electrical locomotives required to haul the Great Northern Railway Company's suburban trains, referred to elsewhere, which will consist of 11 coaches accommodating 500 passengers, will be very moderate compared with some of those in successful use elsewhere.

Chatham.—The Light Railway Commissioners have recommended the Board of Trade to authorise the construction by a limited liability company of extensive lines of tramways, to be worked by electricity on the overhead trolley system, for connecting the borough with New Brompton and populous suburbs.

Tipton.—At the monthly meeting of the Council, a letter was received from the Midland Electric Corporation accepting the suggestion that on condition that the objection be withdrawn the question of price be submitted to arbitration, the maximum being 3d. per unit, the promoters paying fees and cost of agreement.

Ryde.—The Ryde Pier Company are making preparations for the season by improving their electric railway, and placing it on a stronger and better foundation. They are also constructing a covered station at the pier head, so that visitors to the pavilion will be under shelter. These improvements will cost £14,000.

New Firm.—We are informed that Mr. J. T. Niblett has resigned his position as general manager to the Lithanode Electric Storage Company, and has entered into partnership with Mr. Malcolm Sutherland. In future the firm will trade under the name of Niblett and Sutherland, electrical engineers, 61, Chandos-street, Strand, W.C.

Darwen.—The Town Council will include in its application for a loan an item of £100 for arc lamps and pillars. Both the Darwen and Blackburn Corporations have this week given notice to the Blackburn and Darwen Tramways Company of their intention to purchase so much of the tramway undertaking as is situate within their respective boroughs.

Cheltenham.—The electrical engineer submitted to the last meeting of the Council alternative estimates of the cost of providing arc lamps for lighting Gloucester-road from High-street to the Lansdown Castle, and the Tewkesbury-road from the Gloucester-road to the High-street railway station; and a scheme estimated to cost £3,855 was adopted.

Belfast.—The Council have decided to make a charge of 7d. per unit for the current supplied for lighting purposes for the first hour and a half, and 2d. per unit for each subsequent hour; 4d. per unit for current supplied for motor and heating purposes for the first hour and a half, and $1\frac{1}{2}$d. per unit for each subsequent hour; and 5d. per unit for church lighting.

Personal.—We understand that Mr. H. H. Hall, A.I.E.E., has voluntarily resigned his position as engineer to the Electric Lighting and Fittings Corporation, Limited (late John Haynes Lighting Company, Limited), in order to join the Walsall Electrical Company, Limited, which firm he now represents at 6, Central-chambers, 17A, South Castle-street, Liverpool.

Barnes.—The Board of Trade have issued a provisional order to the Urban District Council empowering them to supply electricity throughout the whole of the area within their jurisdiction, excluding Hammersmith Bridge. The Board reserve the right to revoke this order should the Council fail to lay distributing mains through certain specified streets within two years from its confirmation by Parliament.

North Devon Telegraph Extensions.—The petition of the Chawleigh and Kingsnympton Parish Councils to the Postmaster-General for telegraphic communication in their towns has now been granted. Chulmleigh will be the central office for the district, and a telephone will be erected between Chulmleigh and Chawleigh, and from the latter place to Witheridge; and an A B C telegraph between Chulmleigh and Kingsnympton.

Limerick.—At a recent meeting of the Fishery Board a letter was read from Mr. F. J. Fuller, C.E., Dublin, engineer to the Shannon Electrical Syndicate, stating, with reference to the various questions put by the Board of Conservators, that he hoped to be able to furnish them with as detailed a statement as possible at an early date. It appears that the syndicate has purchased some land at Castleconnell. The work will probably be proceeded with at the end of the year.

Sheffield.—The Tramways Committee, having considered the question of roller bearings for tramcars, recommend that the British Thomson-Houston Company be requested to fit one truck of the 25 cars now on order with roller bearings of the Roller Bearings Company, and another with those of the Mossberg Company, and that the British Thomson-Houston Company be requested to construct the new trucks to allow of these roller bearings being put in, if the tests prove satisfactory.

City of London.—The Streets Committee are considering the desirability of approaching the City of London Electric Light Company, Limited, with a view to the acquisition by purchase of so much of that company's undertaking and plant as is situate within the City, together with the company's electric light generating station at Southwark. The London County Council have been asked to appoint representatives to attend the

conference between representatives of the Council and London local authorities on the subject of the telephone system.

Aston.—The District Council have received a communication from the secretary of the Birmingham and Aston Tramway Company, stating that the whole of the permanent way between the city boundary and the station was about to be entirely repaved, whilst the work of putting into a proper state the remaining portion of the system within Aston was being pushed forward. The Council have notified the Board of Trade that they did not press for the enquiry in reference to the general condition of the lines of the company pending the carrying out of the work.

Bridgwater.—At the monthly meeting of the Somerset Drainage Commissioners, the Clerk read letters from the Board of Trade and from his legal agents in London stating that the clause which had been drawn up for the protection of the Commissioners' interests, with a view to insertion in the Bill promoted by the Bridgwater Corporation, had been struck out, it being held by the Board of Trade that their interests were sufficiently safeguarded without it. From this view the agents appeared to dissent. It was resolved that the clerk be instructed to petition to get the clause inserted.

Birmingham.—The City Council on the 7th inst. passed the following resolution: "That inasmuch as the City of Birmingham Tramways Company have failed to carry out their arrangements with the Public Works Committee, and have, through their chairman, Mr. Ross, made statements as to the reception of authority from some member or members of a committee of the Council to proceed with work which the Council had not sanctioned, and such statement neither being substantiated nor withdrawn, this Council instructs the Public Works Committee not to reopen negotiations with the said company."

Dublin.—Major Cardew, inspector of the Board of Trade, has held an inspection of the new electric line between Haddington-road and Nelson's Pillar. He was accompanied by Mr. Anderson, J.P., secretary and manager of the company; Mr. Astrow, engineer-in-charge of the new electric service; and Mr. Towle, electrical engineer. One journey was made from Haddington-road to the Pillar, and the line and rolling-stock were found to be in good order. As some of the underground work still remains to be completed, it is likely that the new service will not be open for traffic for a few days yet.

Rochdale.—At the monthly meeting of the Rochdale Council an enquiry, what progress had been made by the sub-committee on electric lighting? elicited the reply that the committee were making all the preparations in their power to be able to commence building operations as soon as the necessary powers were obtained. The matter was in the hands of the lawyers. When the Corporation got the power they were seeking they would be able to go on with the work satisfactorily and speedily. Already they had ordered certain machinery which took a long time to make, the order having been given out conditionally on the Corporation securing the powers they were seeking from Parliament.

A Dynamo Factory.—Messrs. Mavor and Coulson, Limited, of Glasgow, have issued an extremely well-illustrated description of their works at Mile End, which is the only one of the kind in Scotland, and in facilities for the rapid, economical, and accurate production of high-class electrical machinery compare most favourably with the best and most recent factories of the country. The illustrations show the machine and erecting shop, the radial drill, a 10-ton electric crane, testing-room, toolroom, generating plant, brass and winding shops, foundry, shaft forging and turning, milling, key seat in shaft, core pressing, and so, *ad infinitum*, down to the complete motor and switchboard.

Dudley.—Notwithstanding that it is intended to convert the Dudley and Stourbridge tramway line into an electric tramway—and work is already going on with that object—a formal renewal of the license to work it by steam power is required, the existing license having nearly expired. Sir Francis Marindin, inspector to the Board of Trade, visited the neighbourhood on Friday last and inspected the line in view of the application for a renewal of the old license, and he was met by officers of the British Electric Traction Company (who have acquired the line) and several representatives of local authorities. Sir Francis went over the whole of the line, and will report in due course to the Board of Trade.

Hull.—The arrangements for the commencement of the construction of the electric tramways and the repaving of the main streets with wood are nearly complete. The first rail of the new system was laid on the 2nd inst. by the chairman of the Works Committee (Alderman Larard) at the south end of Porter-street. The members of the Corporation met at the town hall at half-past two o'clock, and then proceeded in carriages to Porter-street, at the close of the ceremony returning to the town hall for refreshment. In the evening Alderman Larard entertained his colleagues on the Works Committee—the Mayor, sheriff, and chairmen of the various committees—at dinner, at which ladies were also present.

Colwyn Bay.—On June 2 Colonel J. T. Marsh, R.E., Local Government Board inspector, held an enquiry into an application made by the Council for sanction to borrow £2,000 for the purpose of lighting the promenade with electricity. The Clerk said the Board of Trade had approved of the scheme. Mr. Clirehugh, consulting engineer, gave details of the scheme, which proposes to light the promenade with 24 arc lamps, with columns 21ft. high. The mains were so constructed so that the lamps could be alternately lit or extinguished from the generating station. Mr. W. Davies opposed the scheme on the ground that it was not large and ambitious enough. He was in favour of an electric scheme for the whole of the town.

Middlesbrough.—Another meeting of the Streets Committee was held on Friday last in relation to the laying of the track for the new electric tramway service, the ground of complaint being that the scoriæ brick paving was considerably above the level of the rails. As previously stated by us, at a previous meeting a resolution was passed allowing three months in which to give the bricks opportunity to settle, upon an undertaking that if at the end of that time they were not level with the rails the company would make them so. Now the former resolution has been rescinded, and a resolution passed instead that the Corporation consistently oppose the granting of the license till the pavement is made on a level with the rails.

Glasgow.—The Corporation Tramways Committee propose to extend the tramway line in Paisley-road from the Glasgow boundary at Three Mile House to Paisley. The following notices of motion have been tabled: (1) that, in view of the large surplus at the credit of the tramways, and the saving which would be effected by the adoption of electric traction, the Tramway Committee be instructed to reduce experimentally the fares on the Springburn route; (2) that, in view of the transition state of the tramway system by the introduction of electric and other power, it is inopportune to make any alteration in the general manager's salary, and that consequently the Tramway Committee's proposal to raise Mr. Young's salary by £250 be not approved.

Aberdeen.—Mr. Alfred Blackman having resigned his appointment as electrical engineer in consequence of having received a similar appointment in London, the Town Council at its last meeting passed the following resolution: "That the best thanks of the Council be tendered to Mr. Blackman for his services during the time he held office as electrical engineer in Aberdeen." The Lord Provost said that, when they came to appoint a successor to Mr. Blackman, they should place him in such a position that no city of the same size as Aberdeen would be able to induce him to leave. It was remitted to the Gas and Electric Lighting Committee to advertise for a successor to Mr. Blackman, the duties and salary to remain as at present—the committee to submit a list of candidates to the Council.

Africa.—We extract the following from the *British and South African Export Gazette*: "The Town Council of Kingwilliamstown are considering a scheme for the electric lighting of the borough. The Queenstown (Cape Colony) Municipality has also an electric light scheme under consideration. The Durban Town Council have recently ordered two additional miles of cable and a condenser. The Natal Government estimates for the year ending June, 1899, make provision for additional telephone plant to the extent of £4,900. Electrical lifts for the new premises of Messrs. Thorne, Stuttaford, and Co., Johannesburg, are on order with Messrs. R. Waygood and Co., Limited, London, S.E. An electric elevator, manufactured by Messrs. Easton, Anderson, and Goolden, has been supplied to the Luipaardsvlei gold mine."

Birmingham.—The General Purposes Committee of the City Council have just issued their report, in which they recommend the City Council to purchase the undertaking of the Birmingham Electric Supply Company, Limited. The committee state that the commercial success of electric lighting is now ascertained beyond dispute, and important developments of its usefulness may be expected. The committee offered to give the company, subject to certain conditions, 10 guineas per share, or £420,000, taking over the undertaking as a going concern with all its assets and liabilities as from Jan. 1 last. The directors have expressed their willingness to recommend acceptance of this offer by their shareholders. It will be necessary for the Corporation to obtain parliamentary sanction for the purchase and the borrowing of the necessary capital.—*Financial News.*

Blackpool.—At Wednesday's meeting of the Town Council the Chairman of the Electric Lighting and Tramways Committee said that there was a net profit of £2,306 on trams and £1,819 on electric lighting for the last year. The concessions it was proposed to make were no meter rents and a uniform rate of 5d. per unit for places of worship. The salary of the borough electrical engineer was increased by £100. The net surplus profit, after providing for a reserve fund, is to be applied "to the improvement of the district, or in reduction of the capital moneys borrowed for electricity purposes." A new tramway was opened on the 8th inst. connecting Fleetwood with Blackpool, on the electric haulage system. The length of the line is 10 miles, and it completes a chain along the Lancashire sea coast of fully 25 miles. It is proposed to extend the tramway along the Ribble Valley to Preston, which will make the line the longest in the kingdom.

Personal.—The staff of Messrs. Crompton and Co., Limited, entertained Mr. W. A. Chamen, chief engineer of the Glasgow Corporation, late engineer-in-chief of the contract department of Messrs Crompton and Co., Limited, at dinner at the White Hart Hotel, Chelmsford, on Tuesday last. Mr. F. R. Reeves, secretary and general manager of the company, was in the chair, supported by Mr. L. Brunton, the works manager, and Mr. H. Stevenson, chief engineer of the contract department in succession to Mr. Chamen. The chairman presented Mr. Chamen with a gold watch and chain on behalf of the staff of the company as a token of the esteem in which he was held, and Mr. J. Bickmore, the vice-chairman, presented an illuminated address subscribed for by the foremen of the Arc Works as an especial mark of his invariable courtesy and kindness to the foremen. Mr. Chamen made a suitable reply, and proposed success to Crompton and Co.

Electric and General Investment Company, Limited.—We are informed that, subject to the completion of the audit, the directors at a Board meeting held on the 7th inst. decided to recommend to the shareholders the payment of a further dividend

upon the capital paid up on the ordinary shares at the rate of 30 per cent. per annum for the six months ended May 31 last, together with a bonus of 10 per cent., making, with the interim dividend of 10 per cent. already paid, a total dividend of 35 per cent. for the year, and also to recommend a dividend of £50 on each founders' share for the year. The trustees for the founders' shares reserve fund propose to distribute to the holders of such shares a sum of £20 per share out of the proceeds of investments sold and dividends received in respect of the founders' reserve fund, making, with the before-mentioned dividend, a total distribution of £70 on each founders' share. The dividends, etc., will be payable on June 28, 1898.

Eastern Telegraph Company.—The Royal assent has been given to the Eastern Telegraph Company's Act, 1898, which provides for the conversion of the existing 6 per cent. into $3\frac{1}{2}$ per cent. preference stock and for other purposes. Every holder of existing preference shares is entitled for every fully-paid £10 share to receive £18. 10s. of the new $3\frac{1}{2}$ per cent. stock. The certificates of the existing preference shares for which the new stock is to be substituted must, before the issue of the stock, be delivered up to the Company for cancellation, and the certificates of the new preference stock will then be issued gratis in exchange to the holders of such shares. The final dividend on the 6 per cent. preference shares for the quarter ended June 30 will be paid on or about July 1 next. The dividend on the new $3\frac{1}{2}$ per cent. preference stock will accrue as from July 1 next, and will be paid quarterly on the same dates as those on which the dividend on the 6 per cent. preference shares has hitherto been paid.

Brighton.—The *Brighton Gazette and Sussex Telegraph* says: "The Town Council had a lesson in financial morality on Thursday. It was more particularly addressed to the Lighting Committee, with a kind of general application to the other committees. It was brought about by the report of the committee named asking for permission to borrow £56,300, when required, during the current year for machinery and appliances at the electricity generating station. The point was whether the goods to be purchased were in the nature of renewals or additions to the present plant. If the former, the cost should be met out of the income of the undertaking, and not with borrowed capital. Alderman Sendall pressed home the importance of the principle involved, and several other members emphasised the necessity of running the undertaking on 'sound financial lines.' Some of the committee did not take altogether kindly to the criticism of their management, and 'sound finance' was the catch word for the rest of the afternoon."

Barnsley.—The Town Council on June 7 agreed to the report of the Park and Lighting Committee recommending that Mr. Miller, electrical engineer, be instructed to prepare plans, estimates, and details of the proposed scheme of electric supply in the borough; and that the borough surveyor prepare plans and estimates of the buildings required in connection with the scheme; and that the town clerk be directed to ask the Local Government Board's sanction to borrow £23,322. 15s., the estimated cost of the works. On the question of tramways the committee reported interviews with the British Insulated Wire Company, Limited, and representatives of the Worsborough Urban District Council on the subject, recommending that the Council invite companies to submit schemes and give their consent to an application by one of such companies for a provisional order empowering them to construct and work tramways in the borough and neighbourhood. After considerable opposition, this minute was carried out.

Watford.—The following report of the Electric Lighting Committee has been adopted by the Urban District Council: "The committee considered the terms on which electric light should be supplied to large consumers, and recommend that the following discounts be allowed: In cases where the amount annually paid by a consumer exceeds £50 and does not exceed £100, 5 per cent.; exceeds £100 and does not exceed £250, $7\frac{1}{2}$ per cent.; exceeds £250, 10 per cent. Mr. Judge stated that he was willing to accept these terms for the buildings erected and now in course of erection on the Watford House Estate, provided that the Council would supply such light before July 31 or Aug. 31 next, and that he was willing to enter into an agreement for a definite term. He stated that he would wire all such buildings, and he estimated there would eventually be at least 1,200 lights, of which 300 would be fixed before the date above mentioned. The committee recommend that temporary arrangements be forthwith made to give a supply of electric light to the Watford House Estate in July or August next at the expense of the Council."

Liverpool.—The adjourned meeting of the City Council was held on Friday last, the Lord Mayor (Right Hon. John Houlding) presiding. Discussion was resumed of the recommendation of the Generating Stations Committee to accept the tender of Messrs. Willans and Robinson, Limited, Rugby, for the supply of two compound engines and dynamos at the price of £6,530 each, and one triple-expansion engine and dynamo at the price of £6,939, subject to a deduction of $2\frac{1}{2}$ per cent. upon the respective amounts. To this an amendment was moved: "That before ordering the high-speed engines mentioned in the recommendation, the special committee be requested to obtain the unbiassed opinion of Sir Benjamin Baker, Sir Frederick Bramwell, Mr. Kincaid, of London, Mr. Pearson, of New York, or some other acknowledged authority of eminence and experience in electric traction upon the two questions—(*a*) the unit of power, (*b*) the type of engines, it would be best for Liverpool to adopt in the projected 10,000-h.p. power station at Pumpfields." After discussion a vote was taken, with the result that the amendment was lost by 49 to 12, and the recommendation of the committee therefore adopted.

Penarth.—The Board of Trade have granted a provisional order to the Penarth Electric Lighting Company, Limited, empowering them to supply electricity throughout "the whole of the urban district of Penarth." The order is to come into operation immediately after it has been confirmed by Parliament, and the company are required to lay distributing mains within a period of two years from that date. Provision is made in the order to enable the Urban District Council to acquire the undertaking of the company "after the expiration of 15 years from the commencement of this order," and, in the event of this right being exercised, the District Council will be allowed to make a net profit of 5 per cent. upon the electricity supplied, calculated on the aggregate capital expended on the undertaking. In the event of the surplus exceeding the 5 per cent. limit, the Council "shall make such a ratable reduction in the charge for the supply of energy as in their judgment will reduce the surplus to the maximum rate of profit." The surplus is to be devoted to the improvement of the district "or in reduction of the capital moneys borrowed for electricity purposes."

York.—At the monthly meeting of the City Council, Alderman Agar, in moving the confirmation of the minutes of the Streets and Buildings Committee, which were carried, referred to the refusal of the committee to allow the York Tramways Company the use of electrical power in the haulage of their cars. He said this action had been taken exception to, but he was satisfied that if those who took exception to it knew that the company would use that power by overhead wires suspended on standards, they would at once see that that would cause a great block in their narrow streets, and that the committee had done right. The Electric Lighting Committee reported that the Local Government Board had issued their sanction to the borrowing of £20,000 for electric lighting purposes, the money to be repaid within a period not exceeding 25 years from the date of borrowing. Prof. Kennedy reported that Messrs. Crompton and Co. now found that they could not recommend the lowest-priced engines accepted by the Corporation. The committee therefore had decided to instruct Messrs. Crompton to obtain the better-class engines mentioned in the tender, and the cost of the plant would therefore be increased from £8,176 to £8,654. It is expected that some time within the next 12 months the electric light will be established in the city.

Simplex Steel Conduit Company, Limited, Birmingham.—No doubt a reliable and accessible conduit system is in every way superior and more desirable than wood casing, but the interior conduit system, which is finally to supersede wood casing, must be cheap in first cost and in erection, for by this means alone can the electric light be brought within reach of the small consumer. The system for interior wiring introduced by the Simplex Steel Conduit Company is made of light enamelled steel tubing. It is said to result in an all-round reduction of 50 per cent. in the first cost of installation work. The following advantages are claimed for this system: Economy in first cost, erection, and maintenance; lightness (the $\frac{5}{8}$in. tube is No. 20 gauge, and weighs but 4oz. per foot run); simplicity (no previous knowledge required); durability (being enamelled steel it is very durable); mechanical protection (perfect immunity from damage by nails, etc.); sightliness (as sightly as ordinary picture rods); accessibility at all points on the system; permanent high insulation maintained throughout the system. It appears that a wireman can erect a complete system without the aid of joiners. No screwed couplings are used and no special tools required. The firm turn out every part of a complete system which is equally applicable for surface or concealed work.

Winchester.—The Winchester Electric Light and Power Company have submitted to the City Council a proposal containing the following: The cost of the proposed lamps will be as follows: 20-half night arc lamps of 1,000 c.p. each, 40 half-night incandescent lamps of 10 c.p. each, including carbons, trimming, cleaning, repairs, and maintenance, £20 per lamp per annum, £400; 440 incandescent lamps of 20 c.p., including renewals, cleaning, repairs, and maintenance, £2. 12s. 6d., £1,155—total, £1,555; as against an expenditure at present 502 lights, at about £2. 12s. 6d., £1,313, or an increase of £242, which is, of course, due to the cost of the arc lamps. These 20 arc lamps would replace some 60 existing burners. The comparative costs would be therefore: 20 arcs, £400; 60 gas jets, £158—increase, £242; but the candle-power of these two services may be fairly stated thus: 20 arcs of 1,000 c.p., 20,000 candles; as against 60 lights of 20 c.p., 1,200; or, even supposing that all the mantles were all new, 60 lights of 40 c.p., 2,400, or an increase of 17,600, or $8\frac{1}{2}$ times more light for $2\frac{1}{2}$ times the cost—that is, light for light, the electric lamps would give more than three times as much light for the same cost. The candle-power of the two services for the whole city would be therefore: 20 arcs of 1,000 c.p., 20,000 candles; 440 incandescents of 20 c.p., 8,800—total, 28,800; as against 502 lights of 20 c.p., 10,040; or an increase of 18,760 candles, or nearly double the light.

Accident.—An enquiry was held on Saturday last, before Dr. Danford Thomas, at the Marylebone Coroner's Court, into the death of Mr. John Brooke Goodman, aged 23, who had acted as assistant superintendent to the Central Traction Company, who are contractors to the Central London Railway, now in course of construction between Hammersmith and the City. He was employed to inspect the electrical lighting apparatus used in making the line, but occasionally he visited the workshops of the railway. On the afternoon of Wednesday, the 1st inst., he entered the Oxford-circus Station to assist in the readjustment of the belt of a dynamo, but the work had already been done and the machine had been started again, and was going at the rate of 200 revolutions a minute. There were two other persons in the shed, but apparently neither of these could exactly account for the accident which happened. They suddenly heard a noise, or thud, and one

then saw Mr. Goodman fall. He was at once placed in a cab and conveyed to the Middlesex Hospital. But he was already dead, and, indeed, could not have survived for more than a very few minutes. There was a deep cut on the forehead, and the base of the skull was severely fractured, while a small bone of one of the arms was broken. The Coroner expressed the opinion that in all probability the deceased had come in contact with the moving machinery, and had been struck first in front and then behind in rapid succession. The jury returned a verdict of accidental death.

Eccles.—The Electrical Engineer reported at the last meeting of the Town Council as follows: "Buildings—Great progress had been made, the brickwork, with the exception of the chimney, being almost completed. The ironwork for roof is to be delivered this week. The architects have expressed a wish that the chimney should be allowed to stand three weeks, half of which has elapsed, to ascertain whether there is any signs of settlement. Plant—I have visited Messrs. Johnson and Phillips's works at Charlton, near London, and should anticipate, from inspection of the plant, that delivery will take place about the end of July. I have also inspected the engines at Messrs. Browett-Lindley's works, and find that good progress has been made since my last report. They should be ready within two months. Mains—Messrs. Glovers have completed the manufacture of practically all the mains, and I shall test them at their works this week. Mainlaying will begin directly after Whitsuntide, and will not occupy more than a month. From the general condition of the plant at the various manufacturers' works I should anticipate being able to supply current by the end of August, unless special circumstances arise. Tenders were submitted from firms willing to undertake the wiring of premises in the borough." The Town Clerk reported the applications which had been received by him from persons desirous of having a supply of electricity. It was resolved that the electrical engineer be instructed to submit an estimate of the cost of laying additional mains for private and street-lighting in various streets.

Hastings.—The special committee appointed by the Town Council to consider the Hastings, Bexhill, and district light railways have received terms proposed by the promoters of the Hastings, Bexhill, and district light railways (electric) scheme for the advantage and protection of the ratepayers and public, and been in negotiation with them thereon, the result of which is that the promoters are prepared, subject to the approval of the Light Railway Commissioners and the Board of Trade, to incorporate provisions in the order agreeing to contribute £5,000 for street widening, etc. After a lengthy debate the matter was referred back for further consideration. The Public Lighting Committee have had before them a communication from the Local Government Board with reference to the application of the Council for sanction to borrow the sum of £58,000 required for the purpose of the undertaking of the Hastings and St. Leonard's-on-Sea Electric Light Company, Limited, requesting that the Board may be furnished with (*inter alia*) a copy of a report by a competent engineer and valuer upon the works comprised in the undertaking, including particulars of the age, condition, efficiency, etc., of the several works and plant, and they recommended that Mr. P. M. B. Grenville, of 19, Old Queen-street, Westminster, S.W., who had been recently consulted by the borough engineer in connection with the installation of the Corporation's works at Waterworks-road, be instructed to make the necessary report, and that the company be requested to afford him all necessary facilities for the purpose. It has been decided to ascertain whether the Local Government Board would accept Mr. Grenville's estimate.

New Issue.—The list of the Great Northern and City Railway Company opened on June 6 and closed on June 9. The present is an issue of £780,000 in 4 per cent. preferred ordinary "A" £10 shares at par and of £780,000 in 5 per cent. deferred ordinary "B" £10 shares at par. The prospectus states that the Great Northern and City Railway (about three miles in length), in direct connection with the Great Northern Railway, will afford a short through communication between Finsbury Park Station, where the various suburban lines of the Great Northern Railway converge, and Moorgate-street, in the City of London. This railway is to be provided with three intermediate stations. The motive power will be electricity; but the railway will differ from other electric railways in that both tunnels will be 16ft. in diameter, and will take the Great Northern Railway Company's heaviest suburban trains, consisting of 11 vehicles, with a seating capacity of 500 passengers. The company has entered into a contract for the amount of the share and debenture capital of the company with Messrs. S. Pearson and Son, Limited, of Westminster, who have recently completed the Blackwell Tunnel, for the construction and equipment of the railways and works in accordance with the company's Acts, including land, buildings, rolling-stock, electrical installation, motors, etc., with all parliamentary, legal, engineering, administration, and other liabilities and expenses whatsoever during construction, including the payment of interest. It will be noted that the contractors assume all risks of compensation and damage by tunnelling or otherwise, and that the company will enter upon a completed line, fully equipped with rolling-stock and in working order.

Leeds.—At a meeting of the Parliamentary Committee of the Corporation on the 2nd inst., the provisional order which has been obtained relating to the purchase by the Corporation of the undertaking of the Yorkshire House-to-House Electricity Company was discussed. The Corporation have to pay stock bringing in 5 per cent. per annum on the capital properly expended by the company, and satisfaction was expressed that a term of 40 years was allowed for the repayment of the money to be borrowed for the purpose. This term of repayment is a much longer term than has been granted to many other corporations in regard to the institution of electric lighting. The Local Government Board at first proposed to allow only 30 years for repayment, but upon further representations being made to them they extended the term for another 10 years. An advantage of proceeding in this case by a provisional order, and not by a private Bill, was that in that way the risk of a poll as to the propriety of proceeding with such Bill has been avoided. It is well known that the Sheffield poll cost over £1,000. The City Council at a recent meeting decided to extend the electric tramways to the Headingley, Chapeltown, Hunslet, and Dewsbury road sections, and Dr. Hopkinson, consulting electrical engineer, of London, under whose charge the Kirkstall and Roundhay sections were laid, was engaged to carry out the work. The Tramways Committee met yesterday, says the *Leeds Mercury* of the 7th inst., and had a consultation with Dr. Hopkinson, and an Electrical Sub-Committee was appointed to confer with that gentleman with regard to the enlargement of the generating station, the necessary engines, and other details. Estimates will shortly be obtained, and the work will then be proceeded with without delay. Alarm has occasionally been caused by the breaking of a guard-wire, but the single wires which were at first in use are now being replaced by three-strand wires, which will be much more durable. Leeds has had no experience of the breakage of the trolley wires, which are four-tenths of an inch in thickness, but a model of an apparatus was exhibited to members of the committee, the object of which is to prevent accident to life or limb in the event of an overhead wire breaking, by automatically shutting off the current. The apparatus, for which a provisional patent was obtained last month by Mr. Ralph Bostock, licensed victualler, and Mr. Frank Arthur Cheetham, silk spinner, Brighouse, is attached to the poles, and it is claimed for it that as soon as a wire breaks the current between the poles is shut off. Mr. Hannam (the chairman) and other members of the committee thought favourably of the invention, but suggested to the patentees that it should be tested with trolley wires of the same thickness as those in use in Leeds, a suggestion which they decided to adopt.

PROVISIONAL PATENTS, 1898.

MAY 31.

12200. Improvements in fittings for gas and electric pendant lamps and the like. John Morris, jun., Strangeway's Hotel, Evershot Station, Dorset.

12201. Improvements in quadruplex and multiplex telegraphy and to apparatus for use in connection therewith. Sidney George Brown, 9, Queen's-road, Bournemouth.

12220. Improvements in or connected with electrically-driven vehicles. Charles Jeantaud and Wenceslas Camile Rechniewski, 47, Lincoln's-inn-fields, London.

12232. Improvements in telemotor apparatus for working steering, telegraphing, indicating, and other apparatus from a distance. Andrew Betts Brown, 121, West George-street, Glasgow.

12237. An improved A B C transmitter for telegraphic purposes. William Milner and Charles Clement Vyle, 23, Southampton-buildings, Chancery-lane, London.

12241. Multiplex and duplex printing telegraph. Albert Silbermann, 111, Hatton-garden, London. (Complete specification.)

12268. Improvements in insulating means for electric furnaces. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The Aluminium-Industrie Aktien-Gesellschaft, Germany.)

JUNE 1.

12313. Improvements in secondary batteries or electric accumulators. Frank King, 47, Lincoln's-inn-fields, London.

12321. Improvements in electric batteries. Edmund Edwards, 65, Chancery-lane, London, (Philip Albert Emanuel, United States.) (Complete specification.

12322. Improvements in electric batteries. Edmund Edwards, 65, Chancery-lane, London. (Philip Albert Emanuel, United States.) (Complete specification.)

12323. Improvements in electric batteries. Edmund Edwards, 65, Chancery-lane, London. (Philip Albert Emanuel, United States.) (Complete specification).

12325. Improvements in apparatus employed in wireless telegraphy. Guglielmo Marconi, 24, Southampton-buildings, Chancery-lane, London.

12326. Improvements in apparatus employed in wireless telegraphy. Guglielmo Marconi, 24, Southampton-buildings, Chancery-lane, London.

12347. Improvements in electric railways or tramways. Josef Julian Steinbach, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

12349. Improvements in microphones. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

12350. Improvements in electric alarms. Siemens Bros. and Co., Limited, and Julius Ebel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

12351. Improvements in portable telegraphic apparatus. Siemens Bros. and Co., Limited, and Julius Ebel

Birkbeck Bank - chambers, Southampton - buildings, Chancery-lane, London. (Complete specification.)

JUNE 2.

12362. **Improvements in gearing or mechanism for reversing propellers of steamships, electric launches, road vehicles, or any other kind of machinery requiring reverse motion.** Gershon Bowmar, 355, Earlsfield-road, London.

12365. **Improvements in portable electric lamps for use in mines and other places.** Sydney Ferris Walker, Cardiff Electrical Engineering Works, Severn-road, Cardiff.

12423. **Improvements in electric switches.** Albert Vandam and Thomas Herbert Marsh, 322, High Holborn, London.

12431. **Improvements in apparatus for the production of electricity in railway carriages and other vehicles.** Edwin James Preston, of the firm of J. Stone and Co., 77, Chancery-lane, London. (The Gould Coupler Company, United States.)

12437. **Improvements in or relating to electric arc lamps.** Charles Oliver, 31, Southampton-buildings, Chancery-lane, London.

13438. **Apparatus for indicating leakages or escapes of current from electric conductors.** Martin Kallmann, 18, Southampton-buildings, Chancery-lane, London.

JUNE 3.

12446. **A new or improved hub for generating electricity for use with velocipedes and other vehicles.** John English Preston and Benjamin Wharton, 27, Martin's-lane, Cannon-street, London.

12461. **Improvements in and relation to "fenders" for electrical and other tramcars, motorcars, and such like vehicles.** John William Towle, 9, Westland-row, Dublin.

12471. **Improvements in electrically - propelled motorcars.** Léonce Coudat, 47, Lincoln's-inn-fields, London.

12511. **Improvements in or relating to incandescent electric lamps.** Otto Riebensahm, Joseph Pleichati, Hans Friedeberg, and Ernest Krüger, 322, High Holborn, London.

JUNE 4.

12562. **Improvements in or relating to electric motors and the transmission of power therefrom.** Fawcett, Preston, and Co., Limited, and Charles Alphonso Matthey, 55, Chancery-lane, London.

12580. **Improvements in the manufacture of conduits for electric cables or conductors and in the method of securing the said cables or conductors therein.** Frederic Chiesman and Sidney Chiesman, 55, Chancery-lane, London.

12604. **Lunaria electric cycle and carriage lamp.** Stafford Godfrey Hamilton, 15, Upper Montagu-street, Montagu-square, London.

12606. **Improvements in electrical firing keys.** Charles Ambrose McEvoy, 24, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1897.

11594. **Switch for controlling from a distance electric motors for working guns, hoists, projectors, cranes, capstans, or other electrically-operated apparatus.** Martinez.

11594a. **Application of electricity to the working of artillery.** Martinez. (Date claimed under Patents Rule 19, May 10, 1897.)

12469. **Method of arranging the coils of a set of electrical resistances and means for manipulating the same.** Reeves.

14085. **Means for producing continuous-current effects from alternating electric-current generators.** Behrend.

14198. **Electric arc lamps.** Worsley.

14923. **Alternate-current motors.** Soames.

15607. **Method of effecting multiplex telegraphic and telephonic communication and apparatus for that purpose.** Imray. (La Société Anonyme pour la Transmission de la Force par l'Electricité.)

18717. **Controllers for electric motors.** Short.

27494. **Method of and means for regulation of alternating-current systems.** The British Thomson-Houston Company, Limited. (Steinmetz.)

30719. **Machine for surfacing and polishing rolls, particularly the rolls of rolling mills worked by an electric motor.** Breitenbach and Breitenbach.

30917. **Electrically-operated clocks.** Bürk.

1898.

2991. **Double arc lamps.** Mathiesen.

3259. **Construction of apparatus for producing and receiving Hertzian electric waves.** Ducretet.

5863. **Incandescent electric lamps and processes for manufacturing them.** Voelker.

6223. **Conductors for electric railways.** White. (Seaton.)

8085. **Electric light decorations.** Pollock.

8713. **Generators for electrical igniters in gas or like engines.** *McInnerney.*

TRAFFIC RECEIPTS.

Liverpool Overhead Railway.—The traffic receipts for the week ended June 5 were £1,869, as compared with £1,324 in same week of 1897, being an increase of £545.

Birmingham Tramways.—The traffic receipts for the week ending June 4 were £4,199. 16s. 0d., as compared with £3,766. 19s. 2d. for same week in 1897, being an increase of £432. 16s. 10d.

Dover Tramways.—The traffic receipts for the week ending May 28 were £147. 1s. 2d. The total receipts for the year 1898 are £2,357. 0s. 3d. The mileage open at present is 3 miles.

Bristol Tramways.—The traffic returns for the week ending June 3 were £3,717. 3s. 0d., compared with £2,461. 14s. 7d. for same period of last year, being an increase of £1,255. 8s. 5d.

South Staffordshire Tramways.—The traffic returns for the week ending June 3 were £869. 17s. 6d., as compared with £617. 14s. 10d. in same week of 1897. The aggregate receipts for the year are £13,315. 0s. 0d., as against £13,166. 9s. 11d. in the same period of the previous year.

City and South London Railway.—The returns for the week ended June 5 were £949, compared with £945 for same week of 1897, being an increase of £4. The total receipts for the half year amount to £23,627, compared with £23,335 for the same period last year, being an increase of £292.

Dublin S.D. Tramways.—The traffic receipts for the week ending June 3 were £817. 1s. 8d., as compared with £578. 6s. 0d. in the corresponding week in the previous year, being an increase of £238. 15s. 8d. The number of passengers carried was 113,193 in 1898 and 87,882 in 1897. The aggregate returns up to date are £10,315. 4s. 10d., as compared with £10,627. 17s. 7d. last year, being a decrease of £312. 12s. 9d. The mileage open is the same as last year—viz., 8 miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	[illegible]
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	[illegible]
—— 6 p.c. Cm. Pf., 30,001-40,000 (iss. at £2. 10s. pm., all pd.)	4	[illegible]
Brush Company, Ordinary	2	[illegible]
—— Non. Cum., 6 per cent. Pref.	2	[illegible]
—— 4½ per cent. Debenture Stock	100	[illegible]
—— 4½ per cent. 2nd Debenture Stock	100	[illegible]
Callender's Cable Company, Debentures	100	[illegible]
—— Ordinary	5	10-11
Central London Railway, Ordinary	10	[illegible]
——	6	[illegible]
—— Pref. Half-Shares	1	[illegible]
—— " "	5	[illegible]
Charing Cross and Strand	5	[illegible]
—— 4½ per cent. Cum. Pref.	5	[illegible]
Chelsea Electricity Company	5	[illegible]
—— 4½ per cent. Debentures	100	[illegible]
City of London, Ordinary	10	[illegible]
—— Prov. Cert. 90,001-100,000	5	[illegible]
—— 6 per cent. Cumulative Pref.	10	[illegible]
—— 5 per cent. Debenture Stock	100	[illegible]
City and South London Railway, Consolidated Ordinary	100	69-71
—— Ordinary	2	[illegible]
—— 4 per cent. Debenture Stock	100	[illegible]
—— 5 per cent. Pref. Shares	10	[illegible]
—— " " " '96	10	[illegible]
County of London and Brush Provincial Co., Ordinary	10	13-14
—— " " "	4	[illegible]
—— 6 per cent. Cum. Pref.	10	[illegible]
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	[illegible]
—— 5 per cent. Debentures	—	[illegible]
Crystal Palace District, Ordinary 5 per cent. Stock	100	[illegible]
—— Preference 5 per cent. Stock	100	[illegible]
Edison and Swan United Ordinary	3	[illegible]
—— 5 per cent. Debentures	5	[illegible]
—— 4 per cent. Deb. Stock, Red.	100	[illegible]
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	3	[illegible]
Electric Construction, Limited	2	[illegible]
—— 7 per cent. Cumulative Pref.	2	[illegible]
—— 4 per cent. Perp. 1st Mort. Deb.	100	[illegible]
Elmore's Copper Depositing	1	[illegible]
Elmore's Wire Company	2	[illegible]
W. T. Henley's Telegraph Works, Ordinary	10	[illegible]
—— 7 per cent. Preference	10	[illegible]
—— 4½ per cent. Debentures	100	[illegible]
House-to-House Company, Ordinary	5	[illegible]
—— 7 per cent. Preference	5	[illegible]
India Rubber and Gutta Percha Works	10	[illegible]
—— 4½ per cent. Debentures	100	[illegible]
Kensington and Knightsbridge Ordinary	5	[illegible]
—— 6 per cent. Pref.	5	[illegible]
London Electric Supply, Ordinary	5	[illegible]
Metropolitan Electric Supply, Limited, Ordinary	10	[illegible]
—— 4½ per cent. First Mortgage Debenture Stock	100	[illegible]
National Telephone, Ordinary	5	[illegible]
—— 6 per cent. Cum. First Pref.	10	[illegible]
—— 6 per cent. Cum. Second Pref.	10	[illegible]
—— 5 per cent. Non. Cum. Third Pref.	5	[illegible]
—— 3½ per cent. Deb. Stock, Red.	100	[illegible]
Notting Hill Company	10	[illegible]
Oriental, Limited, £1 shares	1	[illegible]
—— £5 Shares	5	[illegible]
—— £4½ shares	4	[illegible]
Oriental Telephone and Electric Company	1½	[illegible]
Royal Electrical Company of Montreal	—	[illegible]
—— 4½ per cent. First Shares Mortgage Debentures	100	[illegible]
South London Electric Supply, Ordinary	2	[illegible]
St. James's and Pall Mall, Limited, Ordinary	5	[illegible]
—— 7 per cent. Pref.	5	[illegible]
—— 4 per cent. Deb. Stock, Red.	100	[illegible]
Telegraph Construction and Maintenance	12	[illegible]
—— 5 per cent. Bonds	100	[illegible]
Waterloo and City Railway, Ordinary	100	[illegible]
Westminster Electric Supply, Ordinary	5	[illegible]
Yorkshire House-to-House	5	[illegible]

NOTES.

Continental Telephone Rates.—The new tariff of rates between Brussels or Antwerp and Cologne or Düsseldorf is fixed at 2s. for a conversation of three minutes, and at 1s. between Verviers and the latter-mentioned town.

Society of Arts.—We would remind our readers that the conversazione of this society will be held at the Natural History Museum, Cromwell-road, S.W., on Wednesday next, 22nd inst. The reception by Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I., chairman, and the other members of the council will commence at 9 p.m.

Cable Interruptions.—The Eastern Telegraph Company informs us that the cable between Mozambique and Lorenzo Marquez became interrupted in the early part of this week. As the cable between San Thome and Loanda has been interrupted off the mouth of the Congo since the 3rd inst., this last interruption cuts off all telegraphic communication with South Africa. It is hoped that the cable will be restored in four days.

Physical Society.—At the meeting of the above society at the rooms of the Chemical Society, Burlington House, at 5 p.m. on Friday, June 24, the following papers will be read and discussed: (1) Exhibition of an Apparatus illustrating the Action of Two Coupled Electric Motors, by Prof. Carus-Wilson. (2) Exhibition of Weedon's Expansion of Solids Apparatus, by Mr. J. Quick. (3) "On the Theory of the Hall Effect in a Binary Electrolyte," by F. G. Donnan, M.A., Ph.D.

Electricity in Italy.—While there is just now a conference of a financial group in Vienna for the purpose of forming a company for the laying down and working of electrical plant in Italy, in which it appears the Allgemeine Elektricitäts-Gesellschaft is participating, we hear from Milan of the formation of a very strong syndicate, consisting of prominent Vienna and Berlin houses, for the same purposes. The seat of the company to be formed by the latter is Milan, and we are informed that they are sure of the contract for the lighting of Bologna.

The Royal Society.—At the annual meeting of the Royal Society for the election of Fellows, held on Tuesday in the society's rooms in Burlington House, the following were elected Fellows of the society: Henry Frederick Baker, M.A., Prof. Ernest William Brown, Dr. Alexander Buchan, M.A., Sidney Frederic Harmer, M.A., Arthur Lister, F L.S., Lieut.-General Charles Alexander McMahon, Prof. William Osler, M.A., Hon. Charles A. Parsons, M.A., Prof. Thomas Preston, M.A., Prof. Edward Waymouth Reid, M.B., Alexander Scott, M.A., Albert Charles Seward, M.A., William Ashwell Shenstone, F.I.C, Henry Martyn Taylor, and James Wimshurst.

San Ildefonso-Tlalnepantla.—The Westinghouse Electric and Manufacturing Company has closed a contract for 20 300-h.p. two-phase generators, with switchboard and transformers, for the San Ildefonso-Tlalnepantla transmission system, near the city of Mexico. The current is to be utilised for lighting and power in the city. The generators are to be direct-connected to waterwheels. Transmission will be three-phase at 32,000 volts. The terms of the contract call for its completion by March 1, 1899. The introduction of so large an installation of American apparatus marks a long step forward in the electrical development of the abundant sources of water power in Mexico.

Two Hundred and Twenty-Volt Lamps.—Mr. J. C. Fish sends to the *Electrical Engineer* of New York some details of the high-voltage lamps prepared by the Shelby Electric Company. In this incandescent lamp a flashed filament is employed; this filament is long, and is wound in four complete turns. Three of these are anchored to a small glass stem rising from the base of the lamp. In the tests made by the Shelby Electric Company it has been demonstrated very thoroughly that a paste connection, or deposit of paste on the anchors, cannot be satisfactorily used in a high-voltage lamp, as the carbon is necessarily so thin that the least amount of oxygen permitted to enter the lamp will certainly destroy it. This has also necessitated the use of platinum wire for anchors. The Shelby Electric Company, it may be added, have produced for experimental purposes a number of 500-volt lamps.

Literary Hash.—It is difficult at all times to arrange the articles in a technical paper so that the illustrations coincide in position to the references with them in the text. Failure to secure this often gives the reader trouble unless a complete system of footlines is adopted. Our French contemporary *L'Electricien* in its last issue, however, gets into trouble over its composition, even without illustrations. Thus we were glancing over a description by M. Andreoli of his new ozoniser when we suddenly came on some unintelligible paragraphs. After some time we found they had strayed out of an article on the rapid determination of the efficiency of transformers. But, again, this article was not complete, as other parts had also run over into a description of the electric incandescent lamps devised by Dr. Auer. A prize offered for the best rendering of these two pages would give interesting results.

Paris Cabs.—The Paris correspondent of the *Daily Telegraph* announces that horseless vehicles hereafter intended to ply for hire in the streets like the ordinary cabs of commerce are now undergoing trials by the authorities. Thirty automotors have been entered for competition, and of these 11 electric vehicles and one impelled by petroleum were run recently on a long journey in the suburbs at different rates of speed. The same cars are also sent through the crowded thoroughfares of Paris from the Quai Michelet at Kevallois right away to the Porte Maillot, the Champs Elysées, on to Saint Mande, in the eastern portion of the metropolis, and back again. This makes a journey of 36 miles, which is about the average of ordinary cab trips according to the regulations of the companies. The experiments are to continue for several days, and a great step will then have been made towards the proposed introduction in Paris of automotors as conveyances of public utility.

Financial Considerations.—It will have been noticed by our readers that electric light shares have been weak for some time past. There are various causes for this, but we do not hold with some writers in the untechnical Press that the new Welsbach electric mantle is one of these. If this should prove to be anything like what its projectors anticipate, it means a very cheap illuminant, but our London companies are now also able to supply a cheap light in competition. One of the chief reasons for the slight decline in value of the electric light shares is the application of the Marylebone Vestry for a provisional order which would compete with the Metropolitan Company. The fear is that if this is granted, as appears likely, other vestries will follow the lead, and establish works in competition to the company already supplying their district. The provisional order for the Marylebone Vestry comes before the House of Commons this week for confirmation, so that definite news will soon be to hand.

Municipal Electrical Association.—At the business meeting for members and associates only, held on Saturday last, it was resolved to hold the next convention in Bristol, and Mr. H. Faraday Proctor was elected president. Mr. J. H. Rider, of Plymouth, and Mr. G. H.

Cottam, of Hampstead, were elected vice-presidents; Mr. Wilmshurst, Halifax, and Mr. J. F. C. Snell, Sunderland, being elected members of the council, and serve three years. Bailie Maclay, Glasgow, and Dr. Panton, Bolton, were also elected members of the council, each to serve one year. Mr. G. H. Cottam was re-elected hon. treasurer, and Mr. W. A. Godfrey hon. auditor. The President stated that the council had had such valuable help from Councillor Pearson, of Bristol, that they found with extreme regret the fact that under the constitution he was not eligible to serve upon the council during the coming year, and with the idea of retaining his valuable help and his great knowledge of legal matters, it was considered desirable by the council to ask the association to appoint Mr. Pearson as hon. solicitor, and he was elected unanimously. The appointment of hon. secretary was left with the council.

Electricity in Bulk.—The municipal authorities of London are somewhat needlessly alarmed by the recent report of the Joint Committee on Electrical Energy. After the representative conference of these authorities held last Tuesday to discuss the telephone question had disposed of that business, it proceeded to discuss the question of the supply of electricity in bulk. The following resolutions were passed: "That this conference regards it as essential to the interests of London as a whole that the present purchase clause of the Electric Lighting Acts, which applies to defined areas, should also be made to apply to such companies as propose to supply electrical energy in bulk to the whole of London, without regard to area." It was further agreed: "That, while preserving intact the rights of the local authorities with regard to electric lighting and energy, it is desirable that the London County Council should be in a position to undertake, if it so determine, and if so requested by the local authorities, the supply of electrical energy in bulk for the convenience of any districts desiring to be so supplied, provided they do not become competitors of such local authorities." It appears to us that the first resolution is an absurdity, and the second not needed.

Institution of Engineers and Shipbuilders in Scotland—(The Sheffield Conference).—The summer meeting of the above institution opened at the Cutlers' Hall, Sheffield, on Wednesday morning last, under the presidency of Mr. George Russell. The Lord Mayor (Alderman Franklin), the acting Master Cutler, and the local reception committee formally received the visitors, after which papers were read and discussed until the adjournment for luncheon. In the afternoon the visitors had an opportunity of inspecting the works of Charles Cammell and Co., John Brown and Co., and Walker and Hall. The institution dinner took place at the Cutlers' Hall in the evening. Thursday morning was devoted to visiting the works of Thomas Firth and Sons, Vickers, Sons, and Maxim, Joseph Rodgers and Sons, Mappin and Webb, Samuel Osborn and Co., and Seebohm and Dieckstahl. In the afternoon a visit was arranged to Welbeck Abbey. In the evening there was a reception at the town hall by the Lord and Lady Mayoress. To-day (Friday) is given up to an all-day excursion to Bakewell, Haddon Hall, and Chatsworth, and on Saturday the visitors return to Scotland. Prof. F. W. Hardwick, of the University College, is the honorary local secretary.

Electricity in Japan.—Prof. I. Fujioka, a leading authority in Japan on electric subjects, recently delivered an interesting lecture in New York on electrical development in the Flowery Land. Of this lecture the following abstract appears in the *Financial News*: "The telegraphic system in Japan, which is controlled by the Government, comprises, he said, 12,000 miles of land lines and 388 of submarine cables, besides the cable to Formosa, some 800 miles long. The number of messages sent in a year exceeds 22,250,000, while the traffic with foreign countries reaches 150,000 dispatches. The telephone is steadily growing in favour. The first exchange was opened in 1890, and in 1896 there were 540 miles of lines and 3,232 subscribers. Nearly all the larger cities and towns are lighted by electricity, and in Tokio alone there are more than 50,000 lights. The construction of electric street railways has not kept pace with the development in other branches of electrical industry. In Tokio, which has a population of 1,500,000, there are only two working. Presumably the Government does not favour harnessing the lightning, as although 30 companies recently arranged to take out charters, only two were granted licenses to carry on business. These, however, when their lines are completed, will add an aggregate of 400 miles to the existing tracks."

Street Railway Engineers.—The *Street Railway Journal* gives in this month's issue some truths about our manufacturers, or, rather, our want of manufacturers, of electric plant for tramways and light railways which should be carefully read. When, however, we read the articles in the same issue on our "independent consulting engineers" we find matter for criticism. By independent consulting engineers we in England mean engineers who are not associated with contractors, not but that there may be independent contractors' engineers. Proceeding to describe the consulting men of England, our contemporary places Sir Benjamin Fowler and Sir Benjamin Baker at the head, with about 12 lines describing their careers. We fancy Sir John Fowler is meant. Then they place Mr. H. F. Parshall, who undoubtedly is responsible for a large share of the design of the traction work in this country, but in the capacity of a contractor's engineer. Mr. Parshall gets 47 lines about his career. After this we get a few more English engineers, such as Mr. Joseph Kincaid (of Messrs. Kincaid, Waller, and Manville) and Mr. Alfred Dickinson. These two gentlemen get short notices, and then Dr. John Hopkinson, the pioneer of electric traction and the designer of the first lines both for light and heavy work, is dismissed with five lines. Still, Prof. A. B. W. Kennedy, who is responsible for both the Waterloo and City line and the Central London, is treated even worse, as we are only told that he and Prof. Unwin are frequently called in consultation on electric railway enterprises.

The London United Tramway Bill.—This Bill is now before the Select Committee of the House of Commons. The evidence of Mr. Clifton Robinson, the managing director and engineer of the company, to the committee is worthy of notice. As reported in the *Times*, he stated that 8½ millions of passengers were carried over the existing lines, which it is proposed to work electrically, last year. He had had considerable experience of other tramways, and that experience taught him that the introduction of electric traction doubled the volume of traffic. He estimated that if such traction were introduced, and the proposed extensions were made to Hounslow and Hanwell, the company would carry 25 millions of passengers every year. His experience further showed that, with the advent of electricity, the best results would be obtained by the reduction of fares by at least one-half. The fares charged on workmen's cars would be half the ordinary fares. As far as he knew, there had never been an accident owing to the use of overhead tramway wires. In cross-examination, Mr. Robinson said that the County Council had at present the right to approve or negative the use of electric traction within the county of London. The company had sent three deputations to the County Council, one of them being supported by the Hammersmith Vestry. Having been

unable to overcome the County Council's ill-advised obstruction to a popular mode of traction, the company had resolved to appeal to Parliament. It was the case that the company proposed to substitute the Board of Trade as the controlling authority in connection with these matters for the London County Council.

Electrolysis and Electrolytic Conductivity of Certain Substances Dissolved in Liquid Ammonia. The *Journal* of the Chemical Society publishes the following abstract of a paper by Mr. Hamilton P. Cady on the above subject: "The dissociative power of liquid ammonia on dissolved substances has been tested by determining the electrolytic conductivity of the solutions. Ordinary commercial liquid ammonia was used, its determined conductivity being 71×10^{-7}. The presence of a small amount of water does not seem to have a measurable effect on either the conductivity of ammonia alone, or of solutions of substances dissolved therein. When a small quantity of a soluble salt is added to the ammonia the solution becomes an excellent conductor. In the case of sodium or potassium salts the solution turns blue during electrolysis, but becomes colourless again when the current is shut off. When a current is passed through a solution of an ammonium salt in ammonia there is a violent evolution of gas but no signs of a blue coloration. In neither of these experiments could any evidence be detected of a blue coloration that might be ascribed to the presence of free ammonium. When a current is passed through solutions of salts of silver, copper, or barium the metals are deposited on the cathode, but there is no sign of a blue colour. A solution of sodium in ammonia is of a bright-blue colour, and is an excellent conductor. There is no deposit on the electrodes, no gas is evolved, and the blue colour is not altered by the passage of an enormous quantity of electricity. If only a little sodium is present the colour becomes more intense round the cathode. There is no polarisation current. Whilst regarding his results as preliminary, the author concludes that ammonia seems to possess the power of dissociation of dissolved substances to as great an extent as water, and in most cases the ions seem to travel even faster in it than in water. The work is to be continued."

Telephone Conference.—A conference of the representatives of the County Council and the various London local authorities was held at Spring-gardens on Wednesday last to consider the vexed question of the London telephone service. Mr. T. McKinnon Wood took the chair, and claimed that the gathering was the most thoroughly representative that had ever met together. The following resolutions were passed: (1) "That, in the opinion of this conference, the present telephone service of the London area, as supplied by the National Telephone Company, is both inefficient and inadequate; that the charges, as compared to those made by the same company in the provinces, are much too high; and that these disadvantages to London are largely due to the abandonment by the Post Office of that principle of competition which was expressly adopted prior to 1892 for the protection of telephone users." (2) "That this conference views with alarm the action of the Post Office in using for the benefit of the National Telephone Company its special powers as to the breaking-up of streets, as instanced in the recent case of the Commissioners of Sewers and the Post Office, and urges the Select Committee on Telephones, which is now sitting at the House of Commons, to preserve intact that control over the streets which has hitherto been vested in the municipal authorities." (3) "That, in the opinion of this conference, the telephone service is of such general public importance and calculated to become of such general benefit that it ought no longer to remain exclusively in the hands of a trading corporation, but to derive from it the greatest good at the lowest cost, and worked by the Government as part of the postal service of the country." (3) "That, in the event of the Post Office not undertaking a telephone service, it is desirable that the local and central authorities of the London telephone district should at once combine to secure an efficient and cheap municipal telephone service." It was also agreed that Mr. Benn should lay the views of the conference before the Select Committee on Telephones.

Cheaper Telephones.—General Webber's evidence before the Parliamentary Select Committee on the telephone question covered a wide field. Thus, he expressed the opinion that the enormous capital charges of the National Telephone Company, due to watered capital, effectually prevented them reducing their charges to anything like the level which prevailed in other countries. One reason for a higher charge in England was, he thought, the necessity of conveying the wires largely underground, although in London this step has yet to be taken. Two overhead wires could be constructed for the price of one carried below the surface of the ground. This part of his evidence is, we think, open to question, as regards London, at least. It is a mistake to compare the cost for one or two wires. With a successful and popular exchange in London the wires would mount up to the hundred thousand, and the cost of overhead wires would increase more than *pro rata*. Again, the cost of underground wires decreases with the number, so that the position may be reversed. General Webber also stated that he considered that the Telephone Company had failed to establish a general system of telephones largely because of the immense area they had to cover, and he was of opinion that the Post Office was the only body capable of establishing and maintaining a really satisfactory service. At present the service was only of use to men in a large way of business or possessed of large means. Thus, the small shopkeeping class did not use the telephone because they had been unable to obtain a cheap enough service. General Webber proceeded to describe the local or "regional" telephone system, about which he read a paper at the Ipswich meeting of the British Association. The scheme he advocated had, he said, already proved a success in Canada. The only objection to it was that a man would have to be fetched to the call office in order to enable his correspondent to communicate with him. In conclusion, he said that under the present circumstances he considered the Post Office had made a mistake in refusing to grant licenses to municipalities. Some years ago competition was allowed in Manchester, with the inevitable result that charges had been materially reduced.

Arcoliers.—We believe if the average electrical engineer was asked when away from business what an arcolier was, the reply would be that he was not conversant with ancient history, but that it was a species of gondolier. The *Electrical World* solves the difficult problem, or perhaps it has coined the difficult word, which is a descendant of the gasolier. Hence we derived the electrolier, and if the fitting is used to support a number of arc lamps, it seems it is to be called an arcolier. Welsbacholiers will soon be added to our vocabulary. At any rate, one great arcolier in the centre of the garden of the Madison-square Electrical Exhibition is equipped with no less than 37 five-ampere enclosed arc lamps, and gives an illumination which makes the 2,200 incandescent lamps previously used look very weak and red. It is estimated that this arcolier, with two smaller ones carrying 16 arcs each and one arc in place of each of the 28 rosettes of 12 incandescent lamps each now

in use, would give a far more brilliant illumination than the present system. This would require some 500 amperes at 110 volts in place of the 1,200 amperes now used. While it is an unsafe thing to attempt to base exact comparisons on the relative aggregate candle-power of different systems of lighting, our contemporary gives the following rough comparison: Twenty-two hundred 16-c.p. incandescent lamps aggregate 35,000 c.p. when new and perhaps 30,000 c.p. average, with a current consumption of about 1,200 amperes, while 100 arc lamps of the type now in use, with 5 amperes and 80 volts at the arc, would consume about 500 amperes, and, rating them at the value of 400 mean spherical candle-power each, would give 40,000 aggregate candle-power. The light of the arc lamp is far whiter and a better imitation of daylight than the more reddish hue of the incandescent, while the disagreeable bluish features of the open arc are subdued by the opalescent shades of the enclosing globes. Of course, in small apartments, the increased diffusion of a few incandescents over one arc lamp is an advantage, but where the comparison is between scores of arc lamps against hundreds or thousands of incandescents, the source of light is so well distributed in either case that there is no advantage on this score. The fact remains that the expenditure per candle-power of an arc lamp is about one watt, or at the most $1\frac{1}{2}$ watts, per candle-power, while that of an incandescent averages nearly four watts per candle-power.

City and Guilds Institute Exhibition.—Lord Herschell opened an interesting exhibition at the Imperial Institute on Thursday, the 9th inst., of specimens of work executed by students of technical classes in London and in the provinces which are held in connection with the City and Guilds of London Institute. Mr. W. Bousfield occupied the chair, and there were present, amongst others, Sir Frederick Abel and Sir P. Magnus. In declaring the exhibition open, Lord Herschell said that the greater number of specimens did not represent the finished works of expert artisans, but merely the exercises of student apprentices, executed in three or four hours under the strain and pressure of examination. On the other hand, some of the exhibits showed what the students were able to do with more time at their disposal, the candidates in many subjects being required to supplement the work done in the examination room by specimens of handicraft executed during the session or during the fortnight or three weeks preceding the date of the examination. In nearly all the examinations of the institute which admitted of the double test, practice was combined with theory; but no candidate was permitted to exhibit specimens of his practical skill who did not present himself for a written and strictly educational examination in the technology or principles of his craft. After giving figures as to the extent of the work of the City and Guilds Institute, Lord Herschell showed how the institute was assisting in the present commercial warfare and competition. The whole course and practice adopted tended to train the craftsmen and artisans of the future into workmen who would do good work and good work rapidly. After alluding to the advantages of the metric system and expressing wonder that a practical people like Englishmen should have for so long a time disregarded them, he said that what was now being done would aid the country much in the present stress of competition with other nations, and the work which the institute were doing deserved the hearty sympathy of all who desired to see, he would not say their own supremacy, but that they were not beaten in the race. They never need be beaten and they never would be if they kept awake and did all they might and could do to compete with their rivals. We are indebted to the *Times* for the above extracts.

Tramway Plant. — Our contemporary the *Street Railway Journal*, of New York, has in its June number a long editorial article on "The World's Manufacturing Facilities for Electric Railway Apparatus." It states that only five countries at present manufacture such plant, and these are the United States, Great Britain, Germany, Belgium, and Switzerland. The editor writes as follows about our manufacturers: "Great Britain possesses, we believe, but two establishments actually manufacturing railway dynamos and motors. Their total output to date is quite insignificant, and it is probably true that not 200 British-built motors are now in operation at home and abroad. British energy, usually so potent in the search for new opportunities of profit-making, has seemingly almost wholly overlooked this field until too late for taking advantage of its best opportunities. Moreover, even now, strange to say, the possibilities are understood by but few, and to but slight extent, and apparently little effort is being made by British manufacturers to extend their facilities or meet the conditions imposed. The recent engineering strike is responsible for many things deplorable to Great Britain's well-wishers—among others, for an accumulation of orders so great that many of the larger manufacturers are unable to guarantee deliveries short of eight, twelve, or even, in some cases, eighteen months. This has proven a golden opportunity for competition in both home and foreign markets, and by the time this unusual congestion is relieved, American and German machinery of all kinds will be firmly seated 'on trial' in places where, under normal conditions, British machinery would have gone. British manufacturers seem to regard this present congestion of orders as but a temporary matter, and, curiously enough, they appear to be making no provision for remedying it by increasing their factory facilities or reorganising their present ones to secure a greater output. Moreover, the power of the trades unions in Great Britain is such that, unless the most drastic changes are made in the methods of handling labour, British manufacturers will be hopelessly handicapped certainly in the particular branch of work under discussion. To-day the principal electric railway equipment business in Great Britain and in foreign countries financially dependent upon London is done by companies and individuals representing American manufacturing concerns and controlling their British patents." This indictment is, we regret to say, true in substance, although, at least, three of our large firms are now laying down special machinery for building tramway motors. Still, we are behind in the race, and, knowing the fact, we trust our manufacturers will not be content until the leeway is made up. Of the German industry, the editor says: "In Germany is and will be found competition of the sharpest and most intelligent kind. The German manufacturer is bright, pushing, capable, and far-sighted. With interests and connections all over the world, and with unlimited capital at low rates of interest available for operations at home, there has been during the past few years a development of national enterprise worthy of the highest admiration."

Liquid Hydrogen.—At the Chemical Society on the 2nd inst., Prof. James Dewar, LL.D., F.R.S., read a paper on the boiling point and density of liquid hydrogen, from which we take the following facts: The boiling point of liquid hydrogen at atmospheric pressure was determined by a platinum resistance thermometer. This was constructed of pure metal, and had a resistance of 5·3 ohms at 0deg. C., which fell to about 0·1 ohm when the thermometer was immersed in liquid hydrogen. On reduction of

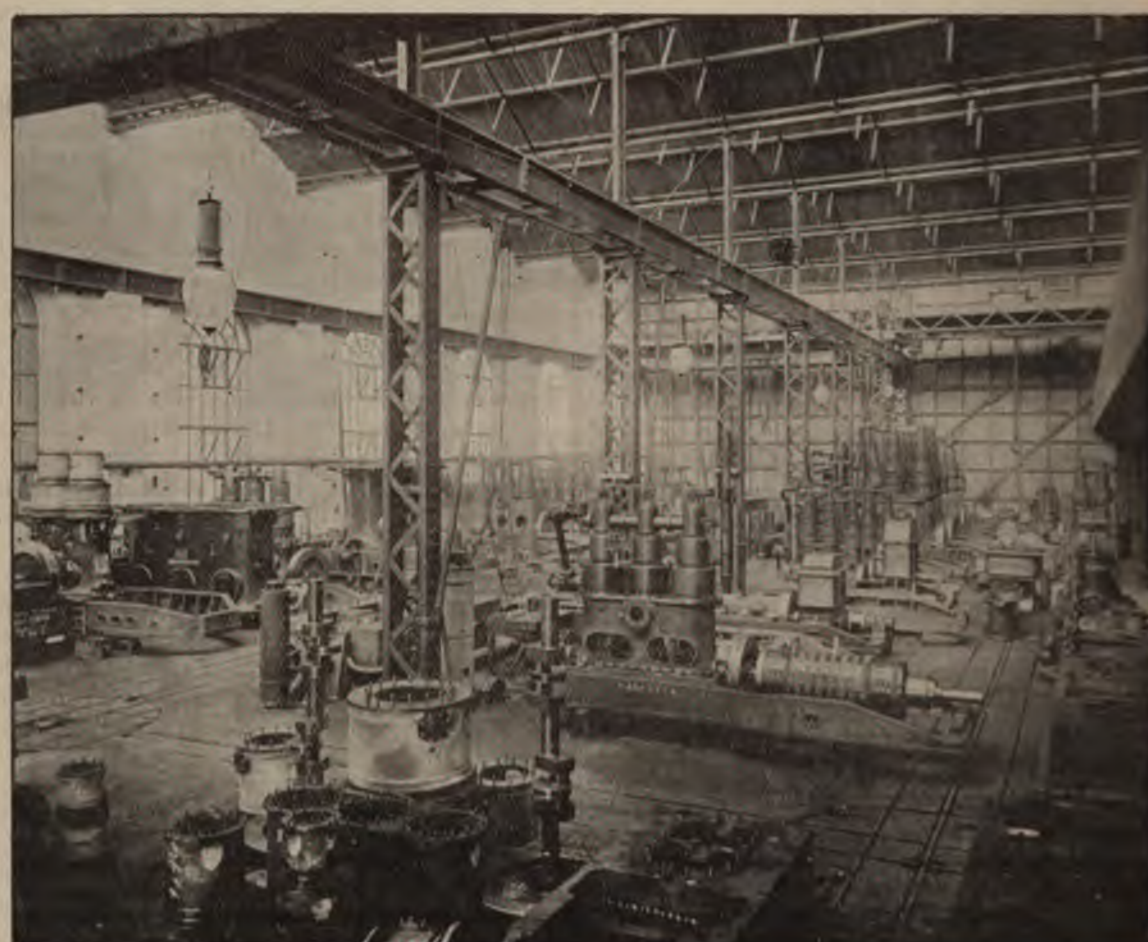
this resistance to normal air temperatures, the boiling point is found to be −238·2deg. and −238·9deg. respectively by two methods, and to be −237deg. by a Dickson formula calculated for this thermometer. The boiling point of the liquid is, therefore, about −238deg. C. or 35deg. absolute. It may be inferred, says the author, that the critical point of hydrogen is about 50deg. absolute, and that the critical pressure will probably not exceed 15 atmospheres. As molecular latent heats are proportional to absolute boiling points, the latent heat of liquid hydrogen will be about two-fifths that of liquid oxygen. From analogy it is probable that the practicable lowering of temperature to be obtained by evaporating liquid hydrogen under pressures of a few millimetres cannot amount to more than 10deg. to 12deg. C., and it may be said with certainty that no means are at present known for approaching nearer than 20deg. to 25deg. to the absolute zero of temperature. The platinum resistance thermometer used had a zero point of −263·2 platinum degrees, and when immersed in boiling liquid hydrogen indicated a temperature of −256·8deg. on the same scale, or 6·4 platinum degrees from the point at which the metal would become a perfect conductor. The effect of cooling platinum from the boiling point of liquid oxygen to that of liquid hydrogen is to diminish its resistance to one-eleventh. The approximate density of liquid hydrogen at its boiling point was determined by measuring the volume of the gas obtained by evaporating 10 cubic centimetres and is slightly less than 0·07, or about one-sixth that of liquid marsh gas, which has a density of 0·41 and is the lightest liquid at its boiling point hitherto known. It is remarkable that, with so low a density, liquid hydrogen is so easily seen, has so well defined a meniscus, and can be so readily collected and manipulated in vacuum vessels. As hydrogen occluded in palladium has a density of 0·62, it follows that it must be associated with the metal in some other state than that of liquefaction. The atomic volume of liquid hydrogen at the boiling point is about 14·3, the atomic volumes of liquid oxygen and nitrogen being 13·7 and 16·6 respectively at their boiling points. The density of the gas at the boiling point of liquid hydrogen is 0·55, or about one-half that of air, and is eight times that of the gas at ordinary temperatures. The ratio of the density of hydrogen gas at the boiling point to that of the liquid is approximately 1 : 100, as compared with a ratio of 1 : 255 in the case of oxygen. The specific heat of hydrogen in the gaseous state and in hydrogenised palladium is 3·4, but may very probably be 6·4 in the liquid substance. Such a liquid would be unique in its properties, but as the volume of 1 grm. of liquid hydrogen is about 14—15 cubic centimetres, the specific heat per unit volume must be nearly 0·5, which is about that of liquid air. It is highly probable, therefore, that the remarkable properties of liquid hydrogen predicted by theory will prove to be susceptible of explanation when they are compared with those of liquid air, volume for volume, at corresponding temperatures as defined by van der Waals.

Competitive Provisional Orders.—The Electric Light Provisional Order Bill No. 12 was read a second time in the House of Commons on Tuesday last. This Bill is to enable the local authorities of Bermondsey and Marylebone to lay down mains for the supply of electric energy, although it can be done by private enterprise under statutory powers which have been already conferred. We deal with the results of the proposed opposition to the existing electric light companies in another "Note," but the following extract from the *Times* of speeches for and against the Bill are of interest: "Mr. Cripps, in moving the rejection of the Bill, remarked that the Bill raised some of the most important questions which could possibly be raised in connection with our industrial policy, and there was a principle involved, which, if sanctioned by the House, applied not only to electric lighting companies, but to all industrial companies, whether for the construction of tramways or the supply of gas and water. The question was whether a private company authorised by Parliament to carry on an industrial undertaking, and which had admittedly carried out all its obligations to the public, should by means of rate-aided competition, be liable to what was, in substance, expropriation without compensation. This was an insidious and dangerous infringement of the recognised principle of security—that every man should be compensated before his property—particularly property guaranteed under an Act of Parliament—could be attacked or depreciated. No private enterprise could, in the long run, hold its own with rate-aided competition. They came back to the pure question of principle of whether it was fair, where a company had invested its capital on the security of Parliament that the concession was for 42 years, that the ultimate purchasing authority should be allowed to come in, and by means of rate-aided competition to depreciate the company's property or to crush out private enterprise altogether. Mr. Stuart said the speech of the member who moved the amendment was an argument against the Act of 1888; it was now quite out of date. This was no new raid of an unusual kind. In the Act of 1888 it was distinctly provided that the grant of authority to any undertakers to supply electricity within any area 'shall not in any way hinder or restrict the granting of a provisional order to the local authority.' Mr. Ritchie explained the position of the Board of Trade in regard to this matter. Applications for provisional orders were not received by the Board of Trade from the local authorities of Bermondsey and Marylebone alone. In one case the local authority and a private company, and in the other case the local authority and two private companies, applied for provisional orders for a second supply of electric lighting in their respective districts. The Board of Trade had to consider, first, whether or not any additional provisional order should be granted; and if a provisional order were to be granted, whether it was to be granted to a private company or to a local authority. He had no hesitation in deciding that it would not meet with the approval of Parliament if the Board of Trade were to reject the application from the Vestry and to give the additional provisional order to another company. The member for Stroud (Mr. Cripps) had contended that as long as the existing company was properly discharging its duty no second order should be granted in the locality. The meaning of that was that a monopoly was to be given in each area to the company which first obtained the order. That was not only contrary to the public interest but absolutely contrary to the direction of Parliament. The Act of 1888 clearly showed the intention of Parliament to be that a second order might be granted in any locality, either to the local authority or to another company. Subsequently to the passing of that Act an enquiry was held by Major Marindin as to the conditions under which provisional electric lighting orders might be granted in the Metropolis, and he laid it down distinctly that two companies might be granted an order in each area. Therefore it could hardly be said that a company applying for an order after the Act of 1888, and after this enquiry of 1889, did not do so with its eyes open to the possibility of competition. After full discussion the Bill was read the second time, and referred to the committee for consideration in detail.

MUNICIPAL ELECTRICAL ASSOCIATION.

Excursion to Rugby.

After the business meeting on Thursday, all the members who wished to visit Messrs. Willans and Robinson's works at Rugby were conveyed by brakes to Euston Station, where two special trains were found waiting. In these the members and several other guests of the firm were conveyed to Rugby, and educated to be dissatisfied with anything but special trains in future. On the way down a liberal lunch was served, all present being the guests of Messrs. Willans and Robinson for the day. Again, on the way back, a well-served dinner was provided, so that at 9 p.m. a satisfied and happy batch of mortals scattered from Euston after having done a full day's work in half a day. At Rugby the whole of the large new works of the firm were thrown open for inspection, and the guides provided explained the various shops as the visitors passed through them. After tea in the messroom a vote of thanks to the firm was proposed by the President and seconded by Mr. Bromley Holmes and passed unanimously. Mr. Mark Robinson, in reply, thanked those present for their hearty reception of the vote of thanks. They as a firm were only too pleased to welcome the Municipal Electrical Association to their works. He proceeded in a few concise and well-chosen sentences to explain how the firm standardised their work, and always manufactured in quantity. He also referred to the good relations existing between them and their workmen. Captain Sankey then said a few words on the question of gauges, and Mr. Eaton-Shore, the works manager, gave some information as to the system of piece-prices which the firm have adopted. By it a price slightly higher than the ordinary is fixed, and the workman takes half the difference between his time-rate and the piece-money he earns in a given time. The other half goes to the firm. By this system there is every inducement for the men to make all they can, and the firm also benefited by the extra energy expended.



The Erecting Shop at Messrs. Willans and Robinson's Rugby Works, taken last April.

The following few notes give some idea, with t illustrations, of the general arrangement of the works.

The Victoria Engine Works, Rugby, are situated up a piece of land containing about 23 acres, lying upon t south side of the London and North-Western Railw about half a mile to the west of Rugby Station. A sidi from the railway runs into the erecting shop and t loading shed, and gives access for railway trucks to t foundry. The entrance to the works is by a priv approach road from the Newbold-road, with entrance ga and lodge. The general offices face the open space n this entrance. On the ground floor is a large drawi office, lighted by windows on three sides, under t management of Mr. J. H. Street. On the opposite side the entrance hall is the accountant's department. Upsta are the Board-room, directors' rooms, and the secretar and commercial offices. The building is partially warm by hot-water pipes, and is of course lighted by electrici Each department has separate communication with t works, by an entrance at the back of the building.

On passing the time office, a road, or rather a bro asphalted path with railway lines alongside it, runs acro the entire site, nearly parallel with the railway, and t principal buildings front on to this road or path, a therefore face north or to the railway. The princip buildings stand side by side, separated by alleys, some which are utilised for outdoor storage, etc. All t buildings are constructed in bays running north and sout divided in some cases by brick piers and arches, b generally by lattice steel stanchions, which carry travell girders. At a higher level the stanchions carry cr girders, running east and west. These support rolle steel gutters and light principals, the latter carryi weaving-shed roofs, the ridges and gutters of which r east and west. The light is from the north. T stanchions or piers are in all cases spaced at 20ft. centr in their respective north and south lines. Hence all t buildings are covered by a practically uniform system roofing of 20ft. span, with the principals and other pa

rchangeable. The width of the north and south bays, "traveller bays," is varied according to circumstances. mmencing from the far, or western, end, the principal ces and buildings are as follows: First, a foundry, 200ft. p, consisting of two 40ft. bays, one commanded by a ton rope-driven crane. The ovens and charging platm, with cupola, are in the west bay, adjoining which also an engine and boiler house, and other buildings. the east side is an annexed bay, 25ft wide and about ft. long, fitted as a store for small castings. Between and the boiler shop is an alley 40ft. wide for storage heavy castings, commanded by a 10-ton electric crane. second shop is a boiler shop, 100ft. deep, consisting of 40ft. bays and two of 35ft. The building is finished, awaits the boiler-making tools. The Niclausse watere boiler will be constructed here. At the back is a porary smiths' shop. The machine and erecting shops in all 240ft. deep by 300ft. wide. They consist of a

by 20ft., isolated from each other by thick party walls, and arranged to be lighted from outside only. The front or north bay is carried up to form a photographic printing room, with arc lights for printing. The design of this building differs entirely from that of the others described.

The contents of the buildings are too numerous for detailed description, but attention was specially directed, in the machine shop, to the large double milling machine, and the vertical boring machine, in the first or large bay; to the grinding lathes, etc., in the tool room; to the method of testing cylinders for accuracy, which was shown in the main cross gangway; and to the shop engine and boiler.

The works are under the management of Mr. James Eaton-Shore, the works manager.

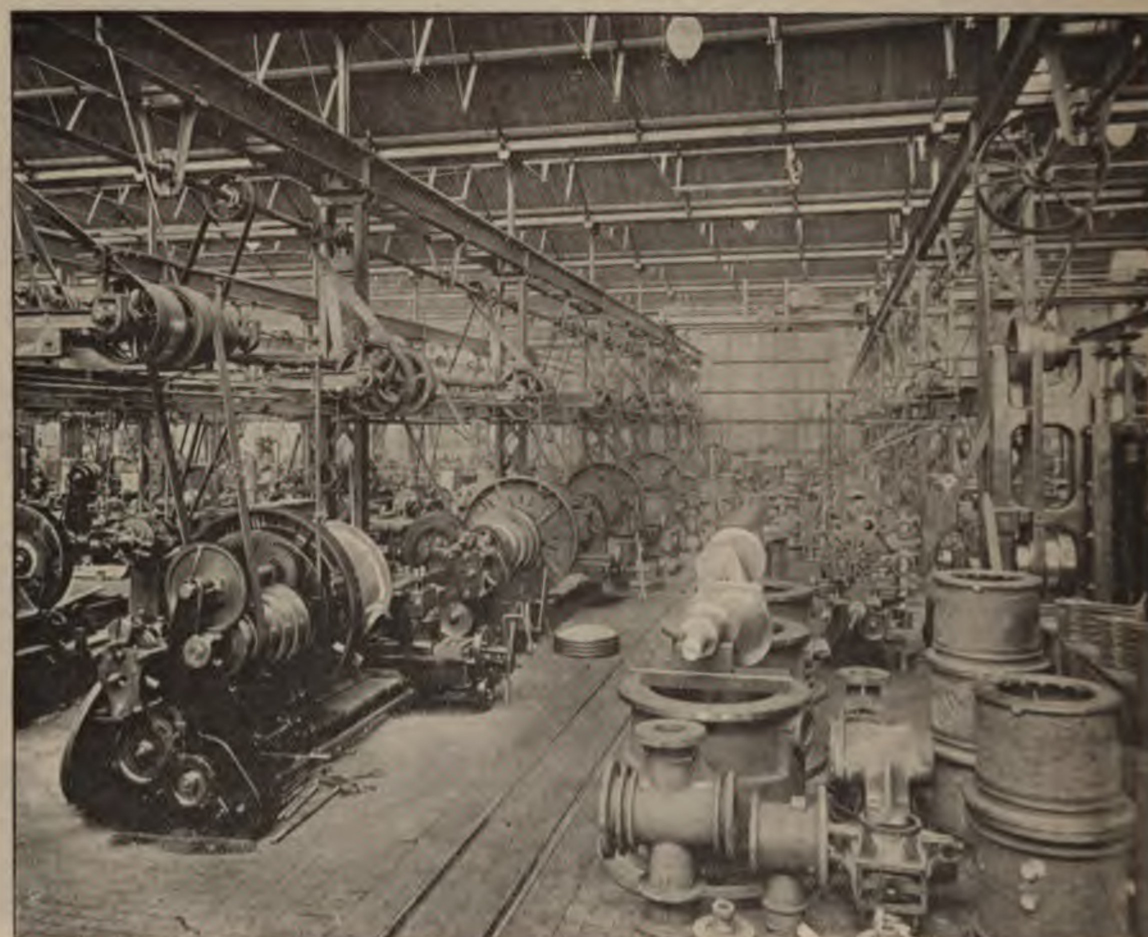
The testing department lies outside the gates of the "works" proper, but is connected, by a 3ft. gauge tramway, with the erecting shop, from which engines are brought for

The Large Bay of the Machine Shop at Messrs. Willans and Robinson's.

y 40ft. wide, containing the larger tools; five ordinary achine bays, 22ft. wide between centres of stanchions; e general store bay, 22ft., partly used for fitters; two anufactured store bays, 22ft. each; and two erecting shop ys, 40ft. each. All the bays are provided with electric avellers. The front, or north end, of all the machine d store bays is devoted, on the ground floor, to the tool om, to the works engine and boiler, and to various stores. the gallery overhead are the offices of the works anager. The erecting shop is distinct from the machine op, though in the same building. A gallery at the north d carries the erecting foreman's office, and another llery along the west side is being fitted with racks and ns, in which to store the smaller parts of engines in hand r erection, when drawn out from store, and pending the me when the assembling of the parts is completed and e actual erection taken in hand. Then comes the packing op and forwarding department, and after that the patternaking shop, which forms one building with the above, it the two are divided by a party wall. The pattern ores consist of a group of five chambers each about 50ft.

test after completion. The main building of the testing department, unlike the others, fronts to the south, and measures about 110ft. by 100ft. It has five north and south bays (22ft. centres), commanded by electric travellers. The roof is of the weaving-shed pattern, as elsewhere, with northern light. A part of the building forms the boilerhouse, in which are four Niclausse boilers of 250 h.p. each, made by the company. With some exceptions every engine is tested here under steam before going away, and if circumstances require it can be tested for steam consumption per indicated horse-power, per electrical horse-power, or per brake horse-power. One of Froude's water-brakes, made by Messrs. Mather and Platt, is kept in readiness for testing engines up to 700 h.p. The testing department forms a striking feature of the company's works. It represents an expenditure of many thousands of pounds, to produce, as some may think, no direct money result. Needless to say, this is not the opinion of the directors. The knowledge accumulated in the carrying out of so great a number of tests, under conditions strictly comparable, with appliances of undoubted accuracy, and with all

disturbing causes eliminated, is in their view of the greatest possible value to the company and to its customers. The east bay of the building is devoted to the company's own lighting and power station, from which are run the electric cranes and various motors. An accumulator house, resistance house, coal store, etc., will be found in annexes to the north of the building. Attention was directed to the system of jointed steam-pipes, to allow of the rapid coupling up of engines brought in for test; to the flexible connections for exhaust, and the portable condensers and air-pumps which can be placed quickly in position by each engine; to the system of tanks and weighing machines for weighing the condensed water from each engine under test, and the arrangements for recording the results; and to the standard instruments for testing and verifying the electrical measurements. After test each engine is dismantled, partly to see if all is right, and partly to enable the records to be corrected in case the drawing-office



The Cylinder Bay of the Machine Shop at Messrs. Willans and Robinson s.

instructions have been in any way varied during construction. The engine is then re-erected (unless of large size), and returned to the packing shop for dispatch. The testing department is under the management of Mr. P. A. Low, A.M.I.C.E.

THIRD ANNUAL MEETING.

The second day's proceedings were opened by the reading of the following paper:

On the Necessity for Uniformity in Plant and Apparatus.

BY C. H. WORDINGHAM, A.M.I.C.E., M.I.M.E., M.I.E.E., CITY ELECTRICAL ENGINEER, MANCHESTER.

The principles enunciated by Dr. John Hopkinson in his classical paper on the cost of electric supply are now fully appreciated by the majority of supply engineers, municipal and other, but it is doubtful whether they recognise that their own field of labour is but one very small, indeed insignificant, plot in the wide area to which these principles apply. Man facturers of all engineering products have to face the sa problem—viz., the production of articles the cost of which made up of two items, one independent of the quantity so the other practically proportional to that quantity.

In the case of manufacturers, the standing charges compri the establishment of the works—*i.e.*, the cost of land, buil ings, engine power, machinery and tools, drawing-office sta patterns, etc.; the establishment of offices, and in ma cases of showrooms, with staff of clerks, travellers, et the holding of a stock to supply the demand without dela while to these standing expenses must be added t salaries of a number of engineers, managers, etc., w must be ready to design the articles manufactured, a who must be kept up-to-date in the latest practic often at great cost. The running expenses are wag for labour, skilled and unskilled, fuel, oil, etc., for runni the works, repairs to machine and other tools, raw materi Probably no better example of high cost could be taken th the manufacture of submarine cables. In this case both ite are greatly exaggerated. A large amount of very expensi machinery occupying great space and extensive buildings h to be provided and kept in good order, to be used perhaps o in the year, and when it is required it frequently happens th the work is of an urgent nature, and manufacturing has to kept going day and night for a few weeks, necessitating ove time and high rate of wages, together with excessive wear a tear of plant, while the cost is still further augmented by t fact that the cable is probably of a special size and design.

Now let us examine into the means by which the cost manufacture may be reduced. Assuming that all that possible has been done to economise by the choice of a s where land is cheap, by suppression of superfluous cost in t erection of buildings by skilful design to avoid unnecessa handling of goods, by the absence of display in offices, et what remains to enable the manufacturer to reduce his cost One thing pre-eminently, restriction of the number of typ and sizes of the articles produced. To produce, say, a dyna machine or an engine a number of calculations have to be mad then a series of drawings must be prepared, next the pattern and, finally, the tools. All this means large expense, and only one article is made the whole cost has to be charged that article, and this standing cost may completely swamp comparison the cost for material and labour, whereas if thousand such articles were required, the fixed cost, bei

divided amongst them all, would be only one-thousandth part of what it was in the case of one. By limiting the number of patterns, it becomes possible to devote more time and attention to perfecting the design and the tools necessary for the manufacture, hence higher efficiency is gained in conjunction with reduced costs, for, though the provision of the tools requires a slight addition to the standing cost, it is quite inappreciable when divided among the number of articles sold, and there is a corresponding saving effected in labour.

The subject as a whole is a very wide one, but this paper must necessarily be confined to the particular case of electric supply stations, and the author hopes to be able to show that, even limited to this small area, the question is of great importance. At present every engineer, in designing a station, seems to think it incumbent upon him to have something different in his station to that in every other. One fixes upon some peculiar declared pressure, involving special designs for every lamp, motor, radiator, or other consuming device that is to be attached to the circuit. Another wants alternating current of special periodicity, or transformers of an unusual capacity, or in a case of some unheard-of shape. Another wants extra large boilers, or dynamos of a capacity different to any stock size. Another requires cables of a size necessitating strands of some odd gauge of wire. No doubt this is not wholly intentional, but arises partly from want of thought, partly from ignorance, and partly, it is to be feared, from a feeling that manufacturers are a kind of inferior race, who cannot possibly know as much as the engineer, and who must do as he tells them. Now it is essential to success, both mechanically and financially, that the engineer and manufacturer should mutually strive to secure it; the manufacturer must endeavour to carry out the engineer's objects, and the engineer must subordinate the details of his scheme to the convenience of the manufacturer. No man can know everything thoroughly, and it must be admitted that a manufacturer who devotes his whole time and energy to the production of a particular class of machinery, or apparatus, must know more about that particular class than the engineer with whom it is but one item out of the many comprising his whole scheme. Only those men whose standing in the profession is assured dare to admit and recognise this; the second-rate men fear that their doing so will be construed into a confession of ignorance or incompetency.

As an evidence of the want of uniformity now existing, I have made enquiries as to the practice as regards certain points, and, through the courtesy of the engineers running the stations, have obtained the following information. The particulars relate to 109 stations, in 46 of which continuous current is employed, in 55 alternating, and in eight both alternating and continuous. First, as regards declared pressure, the following table gives the number of stations and the various pressures declared:

TABLE A.—Declared Pressures.

Declared pressures. Volts.	Continuous current.	Alternating current.
50	—	1
50—100	—	2
84—103	—	1
90—100	1	—
100	3	29
100—200	10	10
100—105	1	1
102	—	2
102—205	—	2
105	2	1
105—210	3	1
107—214	1	—
110	3	2
110—220	8	1
113	1	—
115—230	1	—
150	3	—
200	2	4
210	1	—
210—420	1	—
220	4	1
220—440	3	—
230	3	—
Total	51	58

In addition to the above, a few stations give special pressures for special reasons. One station varies its pressure according as the transformer is made by one or other of two manufacturers. Another, which normally supplies at 100 volts, supplies at 102 by special arrangement with a "lunatic asylum" (!) A third supplies at 113 volts, but naïvely recommends 110-volt lamps. Apparently this station is not run on the same lines as those in which the declared pressure is "102½ volts." Incidentally, it may be remarked that the permission given by the Board of Trade to vary the declared pressure in different districts is practically never taken advantage of, while as against this, one station, in defiance of all Board of Trade regulations, boldly declares a pressure of 420 volts.

The next point of importance in which the practice differs is the question of periodicity in alternating stations. The periodicities are set forth in the following table:

TABLE B.—Periodicities—Periods per second.

3 at 40	6 at 83
7 at 50	1 at 83·5
1 at 58	1 at 83—100
6 at 60	1 at 87
1 at 67·5	at 87·5
1 at 74	2 at 90
3 at 75	2 at 93
1 at 75—80	17 at 100
1 at 77	1 at 125
2 at 80	—
	58

The size and pressure of the generators is the next point of interest. It did not appear worth while to tabulate the pressures generated in low-pressure stations, as the declared pressure is a sufficient indication of the pressures used. As regards the high-pressure generators, however, the following table shows the pressures generated:

TABLE C.—High Pressures Generated.

Pressure. Volts.	Continuous. No. of stations.	Alternating. No. of stations.
1,000	3	3
1,000—1,050	1	—
1,400	1	—
1,800	—	1
1,800—2,000	1	—
2,000	1	35
2,000—2,100	—	5
2,000—2,200	—	3
2,000—2,500	—	1
2,050	—	1
2,100	—	4
2,110	—	1
2,200	—	1
2,400	—	1
2,500	—	2
3,000	—	1
Total	7	59

The size of generator is very important, and here, again, there is a most extraordinary discrepancy in the sizes employed. These are tabulated in Table D. Without entering into the number of machines, which do not very greatly affect the question, the following sizes are in use:

TABLE D.—Size of Generating Unit.

Continuous		Alternating		
K.W.	K.W.	K.W.	K.W.	K.W.
10	80	20	62	150
12	88	22	66	154
15	90	23	70	160
20	100	25	72	165
25	112	26	75	175
27	120	30	80	180
28	125	32	81	187
30	140	33	82	200
33	150	35	84	210
37	180	36	85	222
40	200	37	88	225
50	210	40	90	250
52	212	44	100	260
60	250	45	110	300
64	300	50	120	350
65	350	55	125	360
66	400	57	130	380
70	600	58	135	390
75	1,500	60	140	—

Enquiries as to whether standard sizes of mains, meters, etc., were employed showed that in many instances such is not the case, the sizes being chosen haphazard according to requirements. The above figures will serve to show the utterly chaotic state of central-station practice as regards standardisation in this country at the present time, and very little consideration is necessary to show that the difficulties to be coped with by manufacturers in consequence must be enormous, and that, for the reasons stated at the beginning of this paper, the price of plant and apparatus to users must be very largely augmented, without there being any corresponding additional profit to manufacturers. The additional cost is, in fact, pure waste, and benefits nobody.

No doubt it is inevitable, in the early stages of any industry, that there should be great diversity of practice; indeed, it is desirable that things should not become stereotyped until the best has been discovered, but we have surely now arrived at a time when we can make up our minds on such subjects as those enumerated above, and it is of vital importance that the matter should be settled soon, for each new station that is to be built perpetuates its own set of quantities.

The most important point of all is the declared pressure, for this affects every consuming device as well as generators, or transformers if used. While it should be so fixed as to admit

of as economical distribution as possible, it should not involve a loss to the consumer in wasteful resistance, or in enhanced price for lamps specially fragile or difficult to manufacture. The author ventures to think that, taken all round, 100 volts and multiples thereof is the most convenient pressure, and the one most likely to meet with general acceptance. In the first place, it is that most largely used at the present time, and it meets the conditions named above, since two ordinary arc lamps, or one enclosed, can be made to burn steadily at 100 volts, the waste in resistance being reduced to a minimum, while for the first multiple—viz., 200 volts—there is little difficulty in obtaining single incandescent lamps. Moreover, it gives a convenient pressure across the outer conductors, a pressure suitable for tramway working, while allowing a good margin for loss on low-pressure feeders, without necessitating a higher pressure at the generating station, or transformer station, than 500 volts, which is the limit of low pressure fixed by the Board of Trade. Incidentally, 100 volts is very convenient for mental calculations, and for meters whem ampere-hour instruments are employed.

In passing, it may be remarked that a good deal of doubt appears to exist as to the exact meaning of the Board of Trade definition of low pressure—viz., whether 500 volts is the limit at the station, or at the network, end of the feeder, and an authoritative interpretation of this would be very acceptable. Other directions in which standardisation is necessary may be mentioned here—viz., the adoption of standard candle-powers for incandescent lamps. It would appear that no more than four sizes below 100 c.p. are really necessary. A little consideration will show that, quite apart from the question of manufacture, the limiting of the number of sizes would enormously reduce the amount of stock that has to be held, and hence a large amount of capital uselessly locked up would be set free. The number of sizes of arc lamps might very well be reduced. Three would suffice for all ordinary purposes. If this were done, not only would the cost of production be greatly lessened, but the ease of replacement of damaged and worn-out parts, and the cheapening of carbons, together with convenience in obtaining them, would be a great gain.

As regards motors, it is probably not worth while to make anything smaller than 2 h.p. whatever it is intended to drive, except, perhaps, in the case of ventilating vans. The bulk of the demand will probably be for motors under 25 h.p., and three sizes between this and 2 h.p. should suffice. So long as a supply of alternating current continues to be given to consumers, the question of periodicity will affect the stations concerned nearly as greatly as does the question of declared pressure, and it is, therefore, as important that some definite understanding should be come to. The variation at present, as will be seen from the table, is as great as or even greater than in the case of pressure. The question of periodicity will always be an important one, as there can be little doubt that two or three phase current will be generated in many stations in the future, though probably it will not be supplied to consumers.

Next in order of importance, perhaps, is the size of generating unit in the station. It was recently necessary for the author to go into this matter somewhat carefully, and he was astonished to find at what an early period in the development of a central station it becomes possible and safe to employ large units. There are practically four factors governing the choice of the unit of the plant. They are (1) the initial capacity of the station; (2) the probable ultimate capacity; (3) the steps by which it is permissible to increase the capital expenditure; (4) the percentage safe overload of the plant.

It may be mentioned here that, in the author's opinion, it is preferable to have reserve plant in the shape of machines with considerable margin of possible overload beyond maximum economical load than in the form of spare machines, for the latter are only of use in cases of actual breakdown, while in the former case the reserve is always ready to be called into play at a moment's notice, and there is no delay due to having to start up another machine in case of sudden demand, whether from a running machine having to be switched out or from an abrupt change in weather. Further than this, the same amount of reserve can be attained more economically. The conditions to be fulfilled then are, that if any one machine break down, the remaining machine shall not be overloaded more than a definite amount, say 33 per cent., 25 per cent., or 20 per cent. If the last-named figure be adopted, this means that the first installation of plant must consist of six machines of equal capacity; their size will depend on the initial capacity of the station. When extensions have to be made, the increment of plant will depend upon the increment of capital permissible. The condition that any one unit may break down without overloading the plant 20 per cent. allows of either one, two, or more machines being added. The amount of increase of capital will be a minimum if only one machine be put down, but this course is open to the serious objection that it means a number of machines all differing in size after the first six, hence absence of interchangeability of plant and an unsightly station. It would appear most convenient to increase the plant by pairs of machines, since this gives a symmetrical arrangement, allows of reduction of spare parts, and renders the machines convenient multiples of one another. Time does not admit of a particular case being worked out, but if this be done it will be seen that a large size is soon reached, and after a certain point the rule cannot be carried out, as it leads to engines of impracticable size. It then becomes necessary to add each time one or more machines of the same size. It would be a matter of great interest to learn from engine and dynamo builders what is the upper limit of size of generator. It will thus be seen that we begin with six machines with parts interchangeable, and finish with a certain number of machines depending on the size of the station, also having the parts interchangeable, and between we have a number of machines of varying sizes. In very large stations put down on a sufficiently generous scale, all the units may be of the same size, but the author maintains that the initial number should not be less than that number which allows of one breaking down without overloading the remainder more than the specified amount; and it cannot be considered safe to put down one or two large machines to begin with, and to trust to good workmanship and design to avoid mishap. On the above principles it should not be a difficult matter to work out a series of machines which will provide for stations of all ranks, and yet be limited in number.

Next may be considered the question of mains, both as regards the conductor and the insulation. It is greatly to be desired that only a few sizes of conductors should be decided upon. The author has endeavoured to show elsewhere that of necessity the size of main required in a given street is largely a matter of guesswork, hence it should not be a difficult matter to agree upon standard sizes that may be such that they can be made up from ordinary S.W.G. wires. If this were done, a manufacturer could afford to stock a great deal of wire, and one source of delay in delivery would be avoided. Again, it surely should be possible to settle upon standard tests for dielectrics of different kinds for given pressures, and if this were accomplished, manufacturers could stock cable actually ready for delivery. The advantage of this will be fully appreciated by central-station engineers, for instead of each one having to store for his own requirements, he would be able to order from stock and save the expense of cable stores and their attendants, besides being able to meet unlooked-for extensions at short notice, while the aggregate stock and, therefore, the capital locked up would be much less than if there were a number of separate stores.

We next come to accessories, such as service cables, transformers (in the case of alternating supply), main fuses, meters, maximum recorders, meter boards, etc. Here again the cry must be, standardise. Find out the best all-round pattern of each, and keep to it. Have as few sizes as possible. Arrange your parts so that they shall come in if extensions take place so that the work may not have to be redone. In his own practice the author has endeavoured to carry out these principles, and he has to a great extent succeeded, but it would be tedious to enter into the details. It is of little use for one or even many individuals to standardise unless there be co-operation. It will probably be said, all admit that uniformity of plant is desirable, and you are but labouring to prove that which is evident. How do you propose that this desirable end should be achieved? The author replies that there is but one way, and that is by settling upon certain standards that will be acceptable to the majority of those concerned, and this can only be done by thrashing out the subject by a committee thoroughly representative of all classes interested. This association is representative of a section of one section only—viz., the municipal section of users of plant—and it is not therefore competent to deal with the matter by itself. The Institution of Electrical Engineers, the mother of all British electrical societies and associations, is the proper organisation to which the matter should be referred, and it will doubtless be a matter of satisfaction to the members of the association to learn that our council has already approached the Institution with a view to this, and a committee has been appointed by them to thoroughly go into the question. The recommendations of the committee cannot fail to carry great weight, and if the matter be properly taken up uniformity will soon be secured, for it will be found that the firms not making standard plant could not compete with those that did, and users with fads would find them too expensive to indulge. It may be thought that such a system should be international, but it is to be feared that the difficulties of securing the desired end would be such as to make it impracticable, and it would result in the matter being indefinitely postponed.

In conclusion, the author trusts that the various points he has alluded to will be thoroughly discussed, and that some practical suggestions for the guidance of the committee referred to may be forthcoming.

DISCUSSION.

Mr. A. H. Gibbings (president) said this was what might be called a pioneer paper on the subject, and the thanks of the association were due to the author for bringing it up. A num-

mittee of the association had been formed to consider the matter subject.

Mr. R. A. Dawbarn (Brush Company) said he was glad that this question had been raised by the engineer of a municipal station and not by a manufacturer's representative. He hoped the discussion would produce some useful hints as to how to remedy the want of standardisation. One of the reasons why American and Continental manufacturers were making such great headway was that they had a good system of standardisation. A very serious drawback to English manufacturers was that it was impossible for them to make for stock. When plant was required, the engineer gave the order, and it was usually six or nine months before the plant was delivered. This would not happen if there was a regular standard. Plant might then be stocked and delivered on receipt of the order. Better work might also be done, as more time might be given to stock orders than is now given to orders which are being turned out as fast as possible. Mr. C. H. Wordingham mentioned some very old voltages which had been used. He took 100 volts as a sort of standard. There might be standard voltages of, say, 100, 200, to 500 volts, and engineers who wanted intermediate voltages might be told they could not have them. The meeting should give some expression of opinion on the subject of standard voltages before it broke up. The Brush Company were now making a great effort to standardise in some way. It was a very difficult thing to accomplish. Engineers sent in specifications for dynamos, motors, etc., of awkward voltages to suit some special type of engine which they might happen to have in their works. The wording of tenders should also be made so that the makers who sent in a tender for a 220-volt motor instead of 118 volts should not have their tender unconsidered and taken no notice of. Great efforts had been made to introduce a standard size for generating units, as there was only about one case in a hundred where intermediate sizes were really needed. Standards might be made in multiples of 100—viz., 400 kw., 500 kw., and 600 kw. There was no station to which one could point and say 100 kw. was too small, and 200 kw. was too large. Station engineers might help them in that matter by leaving their specifications open to manufacturers' standards. As regarded overload, he did not quite follow Mr. Wordingham's reason for making the plant consist of six machines.

Mr. Wordingham: Because it took 20 per cent. safe overload. If it took 30 per cent. they would only need four.

Mr. Dawbarn, resuming, said the output of a station varied from year to year. What it was at one Christmas might be totally different to the output the next Christmas. Stations in this country were started with a much too small unit of capacity. As regards plant, the simpler it was the better. Three-crank engines were introduced as a remedy against vibrations. In places where this was not felt they were unnecessary, and a single or double crank engine would give quite as good results, and was at the same time not so complicated. All manufacturers, he thought, owed Mr. Wordingham a debt of gratitude for his paper.

Mr. W. A. Chamen (Glasgow) said he sympathised with Mr. Wordingham in his efforts towards standardisation. The first point he wished to take was the voltage of lamps. Mr. Wordingham seemed to favour the 100-volt system, no doubt because this was the system in use in his own town. He himself would take 250 volts, and in this he was afraid he would upset some of Mr. Wordingham's tables. It was the best he could do at present. He could not get a higher or else he would have done so. This pressure was perhaps rather inconvenient for house lighting, but it worked as well as 100 volts for street lighting. Enclosed arcs were now becoming more and more prevalent, and this voltage was very suitable to these. In Glasgow at the present time their limit was 400 volts, but when this system was adopted they could reach 500 volts. His friends had all told him that he would only get scrap lamps for this voltage. That he didn't mind provided the lamps worked all right. He didn't think they had reached finality in incandescent lamps. The Board of Trade, though nominally only allowing 500 volts in the generating station, did not mind anything between 500 and 600 volts. Mr. Wordingham had missed out everything about concentric cables. There was a great deal of improvement to be made in meters. Thanks should be given to Mr. Wordingham for his paper.

Captain H. R. Sankey (of Messrs. Willans and Robinson) said that he thought it a good thing this recommendation should come from the opposite side. Engines were rather different to dynamos on the point of standardisation, inasmuch as they had to do with volts and amperes, but enginemakers had great difficulty with it because of the variety of engines which were required, some for lighting, some for power work, etc. It would be a very good thing if a standard could be made.

Mr. R. Hammond said he had not intended to speak on the paper. He was one of that class of engineers who were supposed to be responsible for the figures of cost, etc., in the various works. Consulting engineers were supposed to shine by doing something erratic, and by not going with the common herd. However, in this case he would act as an ordinary being, and, like the others, say he absolutely approved of this movement. When over in America in 1888 he went through the works of the Westinghouse Company, and was struck to see the lines of engines all ready to go out on receipt of orders. This was the way this company had built up so great a business, as it was possible to deliver plant almost immediately on receipt of an order. This was the result of standardisation. When the slack time came, plant could be made for stock orders ready for the busy season. The pressure was not, he thought, such an important point. In alternating plant the pressure used should be always the same. As to size of plant, that was a thing which could be settled. He disagreed with Mr. Wordingham in dividing up the initial plant into six units. He would only have one big unit. He thought that in the past sufficient attention had not been paid to the question of plant. If they began with 150-kw. generators, they must, of course, have another 150-kw. one as a duplicate, making 300 kw. altogether. As regarded periodicity, it was a case of every man for himself. The Brush Company had for years made their machines at periods of 100 per second. He always recommended the same periodicity himself. The Brush Company would not like it, however, if the committee altered it to 50 or 60.

Mr. C. J. Sutherland (Hanley) said there was one point in the paper he wished to notice, and that was with regard to running 120 kw. on 100-kw. machines. The engineers when the heavy winter loads came on would run the machines up to their full power, and have no margin for a reserve. He also thought a mistake occurred where the declared pressure was put at 102. That was, he thought, the working pressure.

Mr. J. A. Jeckell said that a short time ago he wanted to extend his switchboard and could not get glasses to fit the meters. They had all been altered, and the sizes which had been sold previously were unobtainable. The cases of the rheostats and meters were also different.

Mr. Faraday Proctor (Bristol) said Mr. Wordingham suggested that 2 h.p. was the smallest size which would be required in motors. He begged to differ from him in this. The author drew attention to an 88-kw. dynamo being driven by a 150-hp. engine. If you were going to run engines and motors together, they ought both to be standardised together. The author took multiples of 100 for standard voltages, and this was about the best standard. Mr. Byng, in a paper on lamps, recently said they should be rather higher than the specified voltage to allow for fluctuations in the current.

Mr. H. L. P. Boot (Tunbridge Wells) said, with regard to the standardisation of periodicity, an enormous outlay would be involved if this were applied to the plant in stations now, as everything would have to be altered. Standardisation should be started on a smaller scale, starting with lamps, etc.

Mr. G. F. Cottam asked who was going to pay the piper for changing over all the stations? Had they arrived at the stage of making everything uniform? If English manufacturers had put their foot down like those in America, he could have understood it. Mr. Wordingham had not quite carried out his formula. He thought that in Manchester even now there was some rope-driven plant. The author's standard size was too big for a number of smaller stations. There was likely to be a tramway boom soon, and tramway people might be consulted, and before the boom came on let them arrange a standard for trams.

Mr. A. H. Gibbings (president) said it was a clear necessity that something should be done in the matter. There seemed to be a misconception as to the line they were going on. The committee did not propose to standardise plant now in use, but that which would be put into new stations. There was no doubt that, having a standard, manufacturers would be enabled to have a large stock.

Mr. C. H. Wordingham, in replying, said Mr. Dawbarn had pointed out that it was impossible to make stock orders. In that he quite agreed with him. He had not thought it worth while to mention concentric cables, as in a few years they would, in his opinion, be extinct. Mr. Chamen went for him on this subject, but he was rather grateful than otherwise; in fact, he almost liked it. It was a question which must be settled by everyone concerned in the matter. With regard to Mr. Hammond's notion of having one big unit, what would he do when his one unit broke down? In 10 years' time single-phase alternating plant would be almost extinct. As to Mr. Sutherland's remarks, he should remember they had to deal with sane beings. No engineer would run his plant so close up as he suggested. Regarding the standardisation of the engine and motor together, in future no doubt these would sold as a generating set, and would be both of the some standard. There seemed to be rather a misconception amongst them. Of course the standardisation would only apply to new stations. He did not wish to suggest that there should be any hard-and-fast rule as to the sizes of engines and dynamos. He would conclude by thanking them for the kind way in which they had received his paper.

The following paper was then read:

Appropriation of Profits and Repayment of Loans.

BY BAILIE WM. MACLAY, CONVENER OF ELECTRICITY COMMITTEE, GLASGOW CORPORATION.

In every department of municipal work, however technical it may be, there always arises the question of finance. As the proverb has it, "Money makes the mare to go," and even an electricity committee must study ways and means. It would be a comparatively easy matter for a wealthy corporation to erect extensive buildings and put down an installation of the finest machinery and plant—it may be regardless of expense—but it is a different and a more difficult thing to generate current at a price that will commend its use to the majority of the community either as an illuminant or a motor power, or both. An old friend of mine was at one time manager of the home farm associated with one of the largest iron industries in this country. Many a time I wondered why he left the employment of that firm. I had it all explained to me one day by one of his contemporaries. Mr. Johnstone, he said, kept his farm in splendid order. Everything was done in

the very best style, but he could not make it pay, so he had to go. Fortunately for me, the subject of my paper does not compel me to deal with deficits—only with profits. As a rule profits can easily be disposed of. It is a fact, in the experience of most men, that profits are more easily distributed than secured. But when a corporation does come to hold something like a monopoly, it ought to make profits, or perhaps I should rather say, ought to have a surplus every year. Those surpluses having been secured, the question naturally arises what is to be done with them. In the city of Glasgow we have no difficulty with that. We believe in letting "Every herring hang by its own head." In other words, the Corporation allows each of our commercial departments to dispose of any surplus that may result from a successful year's business. We recognise the fact that not one of these departments exist to make profits—as is the case with a private commercial concern—but that rather it has been called into existence for the benefit of the community as a whole. This matter seems to be viewed rather differently in England, and had that not been the case, perhaps I should not have written this paper. Let us take Manchester as a typical example. At the end of their financial year they showed a surplus of £40,000 in the gas department which was transferred to city fund account, presumably for the relief of taxation. Now it may be said that "It is as broad as it is long," and what is taken out of the one pocket is simply put into the other, the community being no poorer by the transfer. I am inclined to dispute that. Take, by way of illustration, our gas department, whose business is one of the largest of its kind in the three kingdoms. Annually we carbonise something like 600,000 tons of coal, and we supply gas to all consumers in the city of Glasgow—the important burghs of Govan, Partick, etc., and nearly every district within a radius of seven or eight miles from the centre of the city. Now, let us suppose that every ratepayer uses our gas, but they all do not use this illuminant alike and in an exact proportion to their rental, which is the basis of municipal assessment. Some of our people use gas only as an illuminant. Others again turn it to account in stoves for heating purposes as well as for lighting, whilst a third class use it not only for light and heat but also as a motor power. Having no differential charge in Glasgow, the large consumer would therefore pay away far more, probably, than he received back in the form of reduced taxation, whilst a small consumer might get a rebate of taxation out of keeping with his gas consumption, and that at the expense of the larger consumer. This is neither fair nor equitable, and would not be tolerated in our city. We contend that what has been taken from a gas consumer in excess of the cost of production and distribution, should be given back to him at once and directly through the department in the form of a reduced charge in the immediate future. This meets all the wants of the case and inflicts a hardship on no one.

But this is not my principal nor my strongest argument in favour of the Glasgow system of appropriation of profits. We hold that it is a sound policy to place as few restrictions on business as possible, especially in these days of keen competition. We maintain that if any of our commercial departments, originated solely for the good of the people as a whole, is compelled to keep the price of anything above the cost of production and distribution, then a restriction, an artificial and arbitrary restriction, is placed on the business of that committee. Is it fair or just to that particular committee? Is it fair or encouraging to the engineer or superintendent who is largely responsible for the prosperity of the undertaking? I say that it is not, and that every committee should in this respect be unfettered. It is true that it is very creditable to the gas department of Manchester that they should be able to supply gas at a moderate price, and at the same time hand over £40,000 annually to the city fund. We, in Glasgow, think that it is at least as creditable to supply gas to the community at, perhaps, as low a price as obtains in the three kingdoms, although we should not give a farthing to the city fund for the relief of taxation. Further, our Electricity Committee have faith in the proposition, that by reducing the price of current they will increase the demand, and an increased demand will enable them to reduce the price still further until it reaches the irreducible minimum. The two things are closely associated, and, in fact, correlated. You cannot well have the one without the other. That leads us to the conclusion that every department, and especially the electrical department, ought to have a free hand in this respect in order to demonstrate to the public that it is doing its best to provide, and provide successfully, for the wants of the people, and the best evidence of this is to be found in a low charge for current rather than in a continuous large surplus to be appropriated by other departments at the end of each year. Last year, on a turnover of £30,000, our Electricity Committee had a profit of £18,000. When disposing of this surplus, we first of all set aside £2,770 as an extra depreciation on the John-street and Miller-street stations, where the plant and machinery were old and somewhat obsolete, having been acquired from a private firm when we received our provisional order. Next, we debited £1,500 against renewals on meters and £1,000 for probable renewals of ordinary plant and machinery in the Waterloo-street station. We further appropriated about £5,500 of our large surplus for ordinary depreciation on our buildings, plant and machinery, mains and cables, making in all £10,705. 10s. for depreciation and renewals in our stations. The balance of our surplus of £18,000, amounting to £7,293, we disposed of as follows: a sum of £4,300 was absorbed by interest on capital, £1,466 was placed to the credit of the sinking fund. This left a net balance of £1,527, which was carried forward to the credit of next year's account. This, gentlemen, is how we dispose of a surplus in Glasgow. Every penny of it was appropriated for the good of this department, and this department only, and we maintain that the citizens benefited quite as much as if the bulk of it had been devoted to the relief of our municipal taxation.

I now come to speak of the other branch of my subject—"the repayment of loans." It would take up too much of your valuable time were I to examine and compare the indebtedness of Glasgow with the obligations of other municipalities, or enlarge on their various systems of repayment. It may suffice that I treat of the indebtedness of our own municipality and of our sinking funds, allowing each of you to make his own comparisons and draw his own conclusions. In order to make my figures exact and complete, I shall deal with the year ending May 31, 1897, being the latest financial year of the Corporation of Glasgow. At that date the liabilities of our Corporation, including gas and water annuities, and the debt of the common good department, amounted to £8,748,652, and our assets to £11,596,384, thus showing a clear balance in favour of the municipality to the extent of £2,847,732.

But, having stated the amount of our indebtedness, the question naturally arises, How are these liabilities to be discharged? Let me say, before I proceed further, that all our money for departmental purposes is borrowed through the loans fund, at the head of which is an excellent financier. This is a useful institution, which unites and keeps in touch all the departments of the Corporation. Should any committee have more money than they can profitably use they lend it to the loans fund, whereupon the loans department either pays off debt or lends the amount to some other department of the corporation. In this way we never have to go outside to seek for investments. Temporary loans on revenue account must be repaid within a reasonable time, and out of the revenue of the year in which they were borrowed. If any one of our departments promotes new undertakings requiring further capital expenditure, then its borrowing powers must be increased by Act of Parliament, and the money secured from the investing public by an issue of stock or otherwise. In the case of a temporary loan, the lending committee is credited with the current rate of interest, whilst the borrowing committee is debited with the average rate payable on the loans. Our debts we liquidate in the customary way, by means of the sale of property and the sinking fund and the rates vary according to the nature and character of each respective undertaking. At May 31, 1897, our police department was still owing £1,549,254, but the sinking funds being all calculated on the maximum amount originally borrowed, this sum will be quickly reduced and finally disappear altogether. Under the heading of police department we include the following: public health and permanent pavior work, the sinking fund for which is at the rate of 5 per cent. The rate for sewage purification works is fixed at $1\frac{2}{3}$ per cent. For general police purposes, sewer construction, and street improvements purposes it is $2\frac{1}{2}$ per cent., whilst for rebuilding of bridges and payment of county road debts the rate stands at 2 per cent. In 48 or 49 years after to-day this large debt will be extinguished altogether. Many of us in Glasgow will not live to see this "consummation devoutly to be wished," but whilst the individual citizen dies the corporation lives on and flourishes in perennial youth. In our water-supply department, the balance of loan debt unpaid stood at £2,784,148 in 1897. At the departmental minimum rate of sinking fund, $1\frac{1}{2}$ per cent., this balance will be absolutely wiped out in 66 years hence. It is true that we are contracting new and large obligations, but we must leave something to be paid by posterity, as they will inherit from us perhaps the finest water supply in the kingdom.

I shall now say a word about the gas and electricity departments. Our Electricity Committee was a sub-committee of the Gas Committee until the November before last. It was then created a separate and independent committee unless in the matter finance. We shall therefore have to treat the indebtedness and the sinking funds of the two as one joint obligation. In 1897 the joint indebtedness might be taken to represent £1,127,495. These I have enumerated are the heaviest liabilities of the Corporation, and I think I need not go further into detail. The markets department, with its sinking fund and —in its case—surplus profits, should extinguish its present debt in 28 years, which is something like 3 per cent. per annum overhead. The parks and galleries departments and the municipal buildings have a minimum rate of 1 per cent. with accumulations for their sinking funds. The parks debt will be repaid in 49 years and the municipal buildings

n 56 years. The city improvements department has a oan debt of £1,246,256. The debt is reduced by sales of property and surplus income. The sinking fund does not come into operation till the last property is sold, and our tramways pay off their obligation of £516,556 by a sinking fund at the rate of 2 per cent., which if accumulated at 3 per cent. will pay off the debt in 30 years. I have thus given you the particulars of the manner in which we repay our loans. The system seems to have commended itself to our fellow-citizens, and our finance has been approved by capitalists all over the kingdom. Were evidence of this awanting, it must be found in the very low rate of interest we pay on our loans. On our last issue of stock it is only 2½ per cent., and on our temporary loans the average rate is as low as £1. 11s. 9d., whilst our promissory notes have been readily taken up by London financiers at even 1⅛ per cent. and 1 per cent. Gentlemen, our motto of old was "Let Glasgow flourish by the preaching of the Word." To-day Glasgow flourishes also by the low rate of interest on capital expenditure.

DISCUSSION.

Councillor G. Pearson (Bristol) said he did not agree with the author in the first part of his paper, but all electric committees would agree that the period for repayment should be as long as possible. Things were rather different in Glasgow from what they were in Bristol. The person on whose credit the money was borrowed should have some share in the profits. The electricity department should be able to compete with the gas companies all day, and not only in parts of the day. The way in which the ratepayers should be benefited should be by an improved system of lighting. There could not, as a rule, be much profit before three years after the station was started. The profit should be applied to decreasing the cost of lighting and increasing the number of lamps supplied. The next thing would be the reduction of the cost per unit to the consumer. He wondered how the Board of Trade would view the distribution of profits as shown in the paper. Instead of one reserve fund only, of 10 per cent., they had several little ones under different names, which might in time aggregate 20 per cent. If he found that Bailie Maclay could step through the Board of Trade regulations in this manner, he should not have any objection to doing the same himself. There was nothing more likely to injure the electrical venture than to have to make a call on the rates, and these funds would almost preclude the possibility of this. Once he had given the consumer his reduction, he would go in for public lighting.

Alderman Lloyd Higginbottom (Manchester) said he disagreed with the author as to the disposal of profits. He held that the ratepayers should have some share in the profits. The author took Glasgow as an example with its large gross profits, which were all devoted to the electricity department. In Manchester they allowed 10 per cent. on the life of machines. The renewal fund was used to replace machinery they had bought at the start, and before they knew how large units would be wanted. The way of doing it in Glasgow was against the Board of Trade regulations. Glasgow was evading the terms of the provisional order. With regard to the repayment of loans, Glasgow had done very well to get it at a little over 1 per cent. If it were possible to evade the regulations, he would be glad to do it himself, as he would rather borrow and extend repayment over 42 years than over 25.

Alderman Bruce (Sunderland) said he agreed with the last two speakers as to the allocation of profits. He was in the unfortunate position of not having yet made a profit. Any municipal authority should be prepared to face a loss on the first three years of the work. The first charge on the station should be for the sinking fund, depreciation, etc. After this the consumer should be benefited. They had recently introduced arc lighting into Sunderland, and it had proved a great success, and was also a good way of advertising the station. There was no mention of the gas sinking fund and their time for repayment If Glasgow could evade the regulations, unfortunately they could not.

Mr. R. Hammond said this was a subject for the chairmen of committees, but as he had a lot to do with the accounts, he would speak. He wished Mr. Wordingham had put into his paper something about the standardisation of rates of repayment of loans. He would like to know if a chairman was supposed to carry the Act in his head. Leeds, who had lately been buying up the electrical company, were to repay in 40 years their loan of £350,000. The Glasgow Corporation posed as the friend of the consumer, and so got electricity made as cheap as possible. He did not forget that the general ratepayer paid the money. In Glasgow they said they would give ratepayers everything, but they wanted that kept, and that kept, and so on, till by the time they were finished there was nothing for anyone else.

Dr. Smith (St. Pancras) said that on the first year at his station there was a loss, the next year it just paid, and the next there was a considerable profit. On the third year they gave something to the rates. The next year extensions were required, and these cost a little more than the sum given to the rates. There was a deficit that year of £800. They should not be in too much of a hurry to help to reduce the rates. A good renewal fund should be first laid by. The profits should be applied to purposes of public lighting. They had done this in St. Pancras. They started with the consumer, and were now in a fair way of getting the number of consumers they ought to have. Until the station was on a secure basis the rates should be let alone. He was sorry to see that no mention was made of the St. Pancras station, but any gentleman there was at liberty to inspect it during the week.

Mr. A. S. Barnard (Hull) said that Manchester had applied for and obtained 42 years in which to repay. He didn't know if the association could do anything in the matter, as it seemed very hard that all municipalities should not be treated alike.

Councillor Hesford said it was the most amusing thing he had heard, to propose to evade the Board of Trade regulation as to distribution of profit by reducing the cost of street-lighting. In such a case a member of a joint gas and electric committee would be awkwardly placed. When on the gas committee he would have to recommend gas for street-lighting, and when on the electric committee recommend electricity.

Mr. A. Wright (Brighton) said it was time some definite decision was come to. He used to imagine that these municipal ventures were to supply electricity to the ratepayers at as low a price as possible. In some places they could have 40 years in which to repay, they in the provinces had only 25 years. If 42 years were allowed for repayment, a sum should be put by for depreciation. They should have something put by for change of plant, lamps, etc. When this had been done they should supply the consumer at cost price. In some places the consumer was made indirectly to pay for the street-lighting, which was most unjust. Some return should be made to the ratepayers for the risks they ran. The best way to do this was by having a more efficient form of lighting. They should not hand over the money to the borough surveyor, who, in the case of Brighton, for instance, would take and build a new breakwater with it. Lowering the price of electricity did not necessarily mean a deficiency. They might not make a thing pay by selling it at 1s., but by selling it at 4d. a much greater number took it up, and a profit is thereby made.

Mr. H. L. P. Boot (Tunbridge Wells) said it was the object of the municipally-owned stations to benefit the consumer. If they did not get a reduction out of profits, they might as well go back to the days of the companies again, and do away with municipalities. It was the duty of municipalities to sell the electricity at the lowest price. It was a general opinion in some committees that a reserve fund was not needed. He agreed with the author in some points. It seemed to him that in Glasgow they did pretty much as they liked.

Bailie Maclay, in replying, said his object in presenting the paper was to draw the fire of their criticism, and he had done that very effectually. He had not said that Glasgow was a shining example, because it was not. He hoped, however, that it would show them something in the future. With regard to loss, they had never yet had a single occasion to draw on the rates. The ratepayers had some little benefit from the electricity department. They had in Glasgow reduced the rates from £25 per street arc lamp to £18. They were just going to apply for a loan of £1,000,000 for gas and electric lighting. This would be paid when it fell due, and when it fell due they would issue another loan. He did not agree with public lighting, and if they could have lighting for the year, with the light on all night, at £18 per lamp per year, it was not so very dear. No gas undertaking wrote off as much as they did for depreciation. In the North all the accounts were separate, and any item could be picked out by itself without any trouble at all. The English accounts were so mixed up that it was impossible to compare the North with the South. He thanked them for the interest which they had taken in his paper. Their Corporation, to show how they appreciated the association, had allowed them to come over 400 miles to represent them there.

Mr. Gibbings said they had all listened with great interest to the paper and the discussion on it, and he felt sure they would all give the Bailie a hearty vote of thanks.

An abstract of the following paper was next read:

Single versus Multiple Generating Stations.

BY JOHN F. C. SNELL, BOROUGH ELECTRICAL ENGINEER, SUNDERLAND.

This question is one by which doubtless many of us will be met, especially those engineers in charge of direct-current central stations, though the question will doubtless also affect to a less degree those supplying alternating current. There is no doubt that too little care has been taken in many cases to gauge the extent of the demand which will be made upon supply stations, and one finds small sites adopted in many cases, or small stations put down without, seemingly, any regard for future extensions or future uniformity of design. While, on the one hand, it is imperative for the well-being of these undertakings to keep down the capital cost per kilowatt installed, on the other hand, it is foolish and ill-advised to pay no heed to the future, and to design the station initially so that extensions may not be made systematically, and the result be a credit to the designer in the future, and, at the same time, economical to the municipality which he represents.

One cannot overlook the insignificance of many of our stations at the present day compared with, as the author thinks, the dimensions they must attain in the not remote future, and the question which each engineer will have to consider will be, shall the whole town plant be centralised upon one site (which in most cases would have to be extra-mural), or shall there be several supply stations at different points? The author commenced these notes before the question was raised at the late Parliamentary Committee and before it had begun its deliberations, and it is interesting to note that, while engineers gene-

rally admit the safety of extra high-pressure supply, many of the most eminent admit that multiple stations have great advantages. The whole question is determined by the following points: (1) the critical limit of horse-power installed from the point of economy; (2) economical generation; (3) efficiency of distribution; (4) load factor.

Critical Limit of Horse-Power.—This has been satisfactorily determined by Dr. Alexander Kennedy in the discussion on Mr. Ellington's paper on hydraulic power supply, read before the Institution of Civil Engineers in 1894. The professor there states that he has found this critical limit to lie somewhere between 3,000 h.p. and 5,000 h.p. installed (Mr. Ellington's limit being much lower), and once this limit is reached it is just as economical to build another station as to go on increasing the capacity of the first. This point being conceded, the questions of site, nuisance, and economical generation will be considered below. The author's opinion is that, given sites obtained with economy, and carefully chosen, that this principle of multiple stations is the right one, inasmuch as other factors, such as additional safety and reduced capital outlay on mains, and increased efficiency in distribution, are thereby obtainable.

Economical Generation.—It is impossible, of course, to lay down any standard on which a town supply can be based. But no doubt the ideal to be aimed at is a direct-current system, with its simplicity, availability for power purposes, possibility of storage (which we may hope will yet greatly improve), and its undoubted reliability; condensing plant with its added efficiency, reduced charge for water and boiler cleaning; and a convenient position for economically obtaining coal. It is impossible, except in rare cases, to obtain these advantages as it were naturally—*i.e.*, to find a site at once alongside of water and a railway siding. By far the greater number of towns will have to adopt auxiliary means for cooling circulating water if they must needs obtain the advantages of condensation, and it would therefore seem that in many cases it is unnecessary to build stations outside a town, the only factor against this being the increased cost of the sites in more central positions, but which may well be outbalanced by the cost of mains to various sub-centres, when one generating station is adopted. In the city of London no doubt the case is a specially peculiar one, but in the other large cities and towns there are plenty of available sites which would be easy to obtain, where the station may be practically erected on the mains it supplies. The question of a slight charge on the coal for cartage, or even the much more pronounced one of condensation, may be much outweighed by the inefficiency of the distribution. That a site situated by a river, for example, where surface condensation may be obtained, is one of the greatest blessings that a station can have will be admitted, but not so if a system has to be adopted which entails an inordinate price for trunk mains and repeated transformation.

Distribution.—It may be taken as an axiom, that simplicity of distribution is desirable, and even necessary, and we shall find that out more and more as time goes on, also that the lower the pressure adopted, consistent with economy, the safer and more reliable the supply. One does not want to rake up the old discussion of the *pros* and *cons.* of alternating and direct currents, but let these remarks apply to all stations of both classes; therefore, from these points of view alone, multiple stations with simple radiating feeders appear to provide the simplest system obtainable. It cannot be overlooked that the amount of conductors radiating from one huge extra-mural station would sometime become enormous, and expensive culverts would have to be constructed.

Capital Costs.—Multiple stations are not any dearer to construct than single generating stations, for if one analyses the costs of one of the London companies or municipal towns having multiple stations, and bears in mind the relative miles of street covered by their distributing mains, one will find very little difference in the cost of the two systems at this earlier stage, and one may venture to say that the difference as the load increases will be in favour of those stations which are fixed directly on the centre of gravity, as it were, of the system which they supply.

Load Factor.—There does not seem to be much in this point. If anything, there is a chance of a better load factor at several stations than with one large and distant one. Take a system which is supplying light and power, and supplying tramways, there can be no doubt that the system will have a better efficiency of distribution when several stations are erected, will be better able to deal with the requirements of the tramways and leakage, and better able to solve the problem of the decreasing space in the streets available for mains. The load factors of Glasgow and Liverpool, with multiple stations, or at Westminster, are as good as towns of equal importance where the whole supply is from one station, and the proportion of maximum load to plant installed much the same. So there is not much in that argument against multiple stations.

Nuisance.—Objections which may be raised to intra-mural stations are: (1) cartage of coal and ashes; (2) the absence of natural means of condensation of steam; (3) smoke nuisance; (4) vibration.

(1) The extra 8 or 9 per cent. payable on coal for carta[ge] may happen in the case of multiple stations) may be much outweighed by the decrease in efficiency of distribution the station is outside the town, added to which must [b]e interest on the capital cost which the extra mains entail.

(2) Condensation has been touched on before, and, [a]s been said, probably the majority of stations in future will to provide artificial means for dealing with the circulating if condensation of steam is to be adopted. Those stations have some natural source, such as a river or the sea, doubt have the advantage, and he would be unwise who omit to seize these opportunities if they are at all p[ossible]. The saving which may be obtained from the reduced sumption of steam, and consequently of coal, the absen[ce of] any charge for feed water, and the less cost of cleanin[g] boilers, are the disadvantages. Doubtless, therefore, the cases where the economics of this problem can be better m[et by] centralising the plant (probably in the future this may three-phase plant), where this great engineering advanta[ge of] condensation can be obtained, and the supply redistri[buted] from multiple sub-stations.

(3) Vibration, which has been raised as a deterrent adoption of stations inside certain towns, is one which, care in dealing with the foundations and formation on the station is erected, and by the adoption of three- engines, can be neglected. Atmospheric exhaust vibrati[on is] a matter which can be easily got over by exhaust silencer[s, or,] of course, by adopting condensing plant.

(4) The smoke nuisance is mentioned because often br[ought] forward as an argument for extra-mural stations. One confidently say that in these days there are few of us who care to admit that our stations would be complained of this point, and with careful stoking and management the nuisance is more visionary than real.

To briefly summarise, the actual problem we are confr[onted] with is that a station already exists, and we have to with both financial and engineering success, and our resp[ective] committees will not care about large alterations being mately made by the substitution of existing plant by systems. The most natural method, therefore, seems this—to prospect new areas by high-tension direct-cu[rrent] machinery, where possible, with sub-stations feeding into tension networks, the latter so designed that ultimately may become part of the general network into which the or more stations will ultimately feed, these taking the pl[ace of] the temporary sub-stations.

This paper contains nothing new, and is intended mer[ely to] be a basis on which the arguments for and against the prin[ciple] enunciated may be thrashed out, and I must apologise t[o the] members of the association for what may well be conside[red] plagiarism.

DISCUSSION.

Mr. Chamen (Glasgow) said the author mentioned from 3,00[0] to 5,000 h.p. as being the utmost capacity which any station obtain economically. He (the speaker) had put up on the diagram of the new station which they were building in Glas[gow] which would have, when finished, a capacity of 30,000 h.p.

The meeting here adjourned till Friday.

FRIDAY'S MEETING.

On the resumption of the proceedings on Friday, discussion on Mr. Snell's paper was continued.

Mr. Chamen, continuing, said he would not take up their by a technical description of the station. He wished to poi[nt out] that 3,000 h.p. or 5,000 h.p. was by no means the limit of a sta[tion]. A station in a densely-populated town like Glasgow had a density on the mains which was very different to that in S[...]port, for instance. It had been said that there was more tha[n one] station in Glasgow. There was only one large station, the o[thers] were small sub-stations. When the new scheme was compl[eted] these would also disappear. With regard to the smoke nuis[ance,] the Glasgow Corporation ran out of coal not long back, and wood fuel for their station. The consequence of this wa[s the] appearance in court of the assistant engineer, who was fined and costs or a fortnight. He agreed with Mr. Snell in str[iking] out in new directions outside the ordinary district. They di[d] their work by means of the direct feeder. In many large t[owns] before many years were over, they would have to treat generating stations as distributing centres.

Mr. Crossley (Manchester) said the paper seemed a so[rt of] Pomona's apple thrown among them. He did not, he said, a[ttach] so much importance to the smoke nuisance. That could be over by paying attention to the sizes of the chimneys and the the flues were made, etc. As to the size of engines and engines being more useful than large ones, and the point of load friction in smaller engines in proportion to the work they to perform, there was no doubt that there should be nothing l[arger] than 5,000 h.p. There were the serious results of a breakdow[n to] consider. They should be very careful of having any larger engine. With regard to the fixing of the engine, that dema[nded] a good deal of consideration, but it could only be settled by

ence to the conditions under which the station existed. In some cases, perhaps, it might be advisable to have larger engines.

Mr. C. H. Wordingham said that this was a subject of great importance. He did not think it possible to lay down any hard-and-fast rule as to single or multiple stations. It was highly desirable to have several secondary stations, but they should not have several engines, but should run the generators by means of motors. He thought a standard should be laid down for supply. He believed they would soon see a great development of three-phase current. These regulations made it perfectly easy to comply with the Board of Trade regulations. Mr. Snell had said there could be no saving above 5,000 h.p. He could not deny that it would be more economical to have one engine in one station, than five or six engines in two or three different stations.

Mr. A. B. Mountain (Huddersfield) said that when Mr. Wordingham had said his little say, it was not possible to add much more to it. It was no good comparing Glasgow with Huddersfield, as the towns were very much unlike. He thought that the whole of an alternating system should be kept under one roof.

Mr. Faraday Proctor (Bristol) asked if the strength of a station should not be taken in number of plants rather than in horse-power.

Mr. A. H. Gibbings (president) said their thanks were due to Mr. Snell for bringing the various points before them. He quite agreed that no hard-and-fast rule could be made as to whether one or more stations should be used, as in different towns the conditions were very different. The gas companies in many towns had two or three stations for making gas, and when they knew that they could not confine their stations so much as the gas companies, they could not hope to do without having more than one.

Mr. J. F. C. Snell, in replying, said his object in bringing the paper before them was to judge whether there should be one or many stations in a town. He was afraid he had referred too much to Prof. Kennedy in his paper. If they would refer to the *Proceedings* of the Civil Engineers for 1894, they would find that he had only referred to the London companies' stations. It was absurd that 5,000 h.p. should be taken as the limit of all stations. This was the limit in London, and was an argument in favour of not having all the plant under the same roof. He was glad Mr. Wordingham had approved of direct current. At the present moment this had the advantage of alternating current. He also thought that there was a great future before three-phase currents. When they reached 3,000 h.p., it was more economical than the direct distribution. It might be distributed to sub-stations and from them by direct supply. He could quite understand the smoke nuisance. Mr. Crossley was quite right in saying that too little attention was given to engines under one roof. The losses of small engines were made a great deal too much of. The present engines were much too small. Mr. Proctor raised the point as to the limit of size of engines. This he had answered in his explanation of Prof. Kennedy's remarks.

PHYSICAL SOCIETY.

At the ordinary meeting of this society on June 10, Mr. Shelford Bidwell, president, in the chair,

Dr. S. P. Thompson described and exhibited a model illustrating Max Meyer's theory of audition. Max Meyer abandons the audition theory of Helmholtz, and contends that analysis takes place in the ear otherwise than by resonance of the Corti organ. Imagine a jointed system, like a hand, to be oscillated from one end—*i.e.*, from the finger-tips. A small motion affects only the top joints, but a large motion affects the whole structure. Such a structure is the membrane of the inner ear. It widens towards one end, and is effectively damped by the contained liquid. Wave motions of different amplitudes run along it to different distances before they are extinguished; these distances are recorded by nerves, and are thereby communicated to the Corti organ. In the model, the compound wave to be analysed is cut out on the edge of a disc of zinc, so that, as the disc revolves, the motions are communicated to a framework. If the frame is thus moved through more than a certain distance a displacement occurs, which sets a second frame in motion, and so on to a third and fourth. The depth to which the motion penetrates is indicated by a series of incandescent lamps connected electrically to the frames.

Prof. Ayrton said it had for some time past occurred to him, when considering the way in which an expert telegraph clerk reads siphon recorder signals on a long cable, that it might be possible to analyse waves without the supposition of a resonating apparatus. The clerk interprets not so much the motions to one side or other of the zero line as the rate of change of velocity—*i.e.*, the acceleration of the siphon. This has been recognised in the design of those relays for long cables where the lever makes contact when the received current exceeds a certain value, and breaks contact when the current falls below a certain minimum. Messrs. Siemens had adopted a relay in which the lever was carried on the suspended coil of a D'Arsonval galvanometer by a pivot with a small amount of friction. If contact was made, the coil could, nevertheless, continue its motion in a given direction. If that direction altered, contact was immediately broken, and the lever passed over to the opposite stop, thereby reversing the local circuit. It was possible that, in the process of hearing, something akin to this took place, the ear behaving as a mechanism responsive, not by resonance to the complete waves, but by its sensitiveness to changes of direction of the received impulses.

Dr. S. P. Thompson thought that a mechanism similar to the relay described by Prof. Ayrton was contained in the telautograph of Elisha Gray; it was a "Prony mechanism." In the acoustical problem the ear was probably sensitive to abrupt changes of shape in the waves as well as to reversals. In the case of mistuned octaves, something is heard that suggests "revolving" in the ear, indicating a cyclic change. In this regard, it was necessary to take into account the phase relations as well as the relative intensities of the component tones.

Mr. E. H. Barton then read a paper on the **"Attenuation of Electric Waves along a Line of Negligible Leakage."** It forms a sequel to a paper communicated to the Physical Society, and printed in their *Proceedings* of December, 1897, and January, 1898. Shortly after the publication of the earlier results, Mr. Oliver Heaviside drew attention to Lord Rayleigh's high-frequency formula for the "effective resistance" of wires to alternating currents, and suggested that the formula might be approximately applicable to the case, but he thought the experimental value of the attenuation would be considerably higher than the one derived from calculations. Mr. Barton here repeats the work, with special precautions as to the mode of insulating the parallel copper wires through which the wave-train proceeds. The value of the attenuation constant deduced from these experiments in 0·000013. By applying Lord Rayleigh's formula for the effective resistance of the circuit, and using this value in Mr. Heaviside's expression for the attenuation, the calculated constant is 0·0000062. To account for the discrepancy, the author points out that the effective-resistance formula was originally developed for a wire placed at a considerable distance from other parts of the circuit, and for currents following the harmonic law. Whereas in the experiments the conditions are (1) wires 1·5mm. diameter, only 8cm. apart, and (2) the waves are propagated in the form of a damped train, with the large end leading; they are extinguished after 10 or 12 vibrations.

Mr. Oliver Heaviside (communicated) pointed out that, as there was human interest in error, it might be worth mentioning that at first it was supposed the previous experiments of Dr. Barton made the index of the attenuation factor to be six times that of the long-wave theory for simple periodic waves. And it was hard to account for so large a discrepancy. The discovery of an error in the figures reduced the result from six to two. The small depth of the surface layer of effective conduction and the distance apart of the wires seemed now to make it improbable that Dr. Barton's first reason (1) was adequate to account for the doubling of resistances. The second (2) was, of course, a substantial reason for increased resistance. A third one, Mr. Heaviside suggested, was the external resistance at the boundary of the waves. A combination of the second and third reasons, with a little of the first, might account for most of the extra attenuation observed, and if more was wanted one could "try the K. R. law."

Mr. Appleyard said it was rather to be regretted that in all the experiments the distance between the wires had been the same—*i.e.*, 8cm. By taking a few different values (1) might have been checked. Lord Rayleigh's formula for the effective resistance involved the square root of the magnetic permeability of the wires. The author had throughout used copper, a paramagnetic metal, and had assumed $\mu = 1$. It would be of advantage to try other metals.

Mr. Barton, in reply, said he would make further experiments with the two conductors at two different distances apart, and he would also try iron wires. With iron the thickness of the surface layer of the effective conductor was about one-thirteenth that of copper. Iron should therefore give a greater value of the attenuation than copper.

Mr. A. Griffiths then read a paper on **"Diffusive Convection,"** a phenomena analogous to caloric convection. The differences of density that produce convection currents are not due to changes of temperature, but to variations in the quantity of dissolved substance per unit volume. The author has devised an apparatus consisting of a vessel divided horizontally by a diaphragm, through which pass two vertical tubes of unequal lengths. A solution of copper sulphate maintained at constant strength is placed in the lower compartment. The upper compartment is filled with water. Diffusion takes place up the tubes. One tube is 4cm. long; the other is 4·05cm. The tops of the tubes are exactly at the same level. Up the longer tube and down the shorter diffusive convection occurs at the rate of 5cm. per year. This flow increases the quantity of copper sulphate transmitted by the long tube by about 2 per cent., and diminishes that transmitted by the shorter tube by about the same amount. Consequently, the resultant increase due to the motion is only a fraction of 1 per cent. To detect the flow, the author employs a second piece of apparatus, in which the upper ends of the tubes are separated by a capillary, containing coloured liquid. By this means the motion is considerably magnified.

Dr. S. P. Thompson asked whether, in a case where a large tube was used in determining the velocity, the viscosity of the liquid would not play a very much less part than with narrow tubes.

Mr. Griffiths explained that viscosity was not important until very small tubes were considered—*e.g.*, those of the order 0·001mm. diameter.

The **President** proposed votes of thanks to the authors, and to Dr. Max Meyer for lending the society his model. The meeting then adjourned until June 24.

Westminster.—Various extensions of mains are being carried out by the St. James's and Pall Mall Electric Light Company and the London Electric Supply Corporation.

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TO CORRESPONDENTS.

 Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

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THE ABUSE OF POWER-HOUSES.

The short paper by Mr. Preece read at a meetin municipal engineers last Saturday comes at an opp tune moment. In the matter of want of foresi there is much that could be said in every directi The phrase "only in its infancy," which fell so gl from the lips of members of municipal authori a few years ago, bore fruit, and now the m we preached then is becoming clear to those lacked foresight. What a moral has been taught Liverpool, Sheffield, and now Birmingham! Eac these municipalities have had to pay for their lac foresight. But this not the direction in which Preece uses the term "want of foresight," and emphasises his meaning in very definite terms. well remember the outcry at Mr. Preece's descr tion of the electric light as the poor man's lig His critics would have none of it. The light was luxury of the rich, and would never be used by commonalty. But Mr. Preece was right. The use the light is extending, and extending so rapidly t few of the central stations are really completed bef extensions are found desirable, and in a very sh time necessary. The anxiety of many resid engineers is very great, for their responsibility great and their stations are overloaded. It s much for their energy and carefulness that bre downs are not common instead of exceptio We may venture to ask here and now, What wo have been the position of the industry if th men had not grappled successfully with their di culties? It would have been in disrepute, progress would certainly have been delayed, eve not entirely prevented. Let us give praise wh praise is due, and when we consider the exceedi want of foresight shown as regards some of stations, the praise cannot be too great. Statio were put down in fear and trembling, and idea was to spend as little money as possible order to forestall failure. The committeemen w ready with the statement, "Oh, we had to it, and though it has failed, the loss will be much." In very few cases, indeed, can point to a thorough belief in the possibilities electric lighting, and when we go further, and that, in spite of all warning to the contrary, har a station has had the foresight to be erected so as cater for the supply of power as well as light, can see how unbelieving the ordinary committeem has been. The engineer has again and again be overruled, and has been compelled to instal a pl he knew and said was inadequate. Hence more than one case the plant first installed h within a year or two been thrown out for pl more suited to the requirements of the case. T engineer has suffered in pocket and in repute this state of things, but he is not to blame. T proper people to blame are the unbelieving co mitteemen, who absolutely refused to look up the work as probably leading to success, always looked upon it as leading to failure, tried to make sure of a good retreat when as about the failure by their constituents. It has b the dubiosity of committees that has led to the of unsuitable sites and to the prevention of

extension. We do not think much stress is to be laid upon the Legislature restricting operations to a defined area, inasmuch as the Legislature made exceptions to that rule, and, indeed, was not slow—that is, for a Legislature—in reconsidering the rule when the necessity for reconsideration was shown. Of course, Mr. Preece's remarks must be taken as holding good within certain limitations. There are cases where two central stations are to be preferred to one, and three to two, and so on. We trust that at this time Mr. Preece's views will have full weight, and that in future councillors will give due credit to the reports of their engineers, and have complete confidence in the success which must follow the undertaking of electric supply.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

JOINT COMMITTEE'S REPORT.

SIR,—In the revised report of the Joint Committee on Electrical Energy (Generating Stations and Supply) just issued, there appear two clauses which were not in the proof which was handed out just before Whitsuntide, but which are of such great importance that I venture to ask you to call attention to the fact in your next issue.

The clauses to which I refer are as follows:

"In connection with this question of purchase under Section 2 of the Act of 1888, evidence has been given to the effect that with a view to secure in London one and the same time for execution of the powers, the Board of Trade have in some cases imposed upon undertakers a less term than 42 years within which they are liable to be purchased."

"The committee suggest that if the full period of 42 years is not granted, and if a substantially shorter period is imposed by the Board of Trade, the terms of purchase should in each case be reconsidered."—Yours faithfully, SYDNEY MORSE.

4, Fenchurch-avenue, London, E.C.,
June 6, 1898.

ELECTRIC HISTORY.

SIR,—With reference to your "Note" headed as above in your last issue, the only thing solar about Mr. Hubbell's machine is the name, and this is how he arrives at it: "I suppose the sun or centre of our system to be possessed of the magnetic principles of attraction and repulsion, and exercising these influences at every point of an unbroken circumference around a common centre or axis; its face possessing equal capacity of power at any circumferential with any other parallel circumferential point to attract direct to and repel directly from this common axis or centre. I therefore construct a centre or solar magnet to embody within its known nature these aforesaid principles," etc.

Some spiteful people may suggest that there is more of the moon (luna, lunar, lunatic) about this than of the sun, but I haven't time to argue the point just now. I will only add that Hubbell was by no means the first to propose electric motors.—Yours, etc., J. J. FAHIE.

MUNICIPAL ELECTRICAL ASSOCIATION.

SIR,—With reference to the report of the discussion on Councillor Hesford's paper at the Municipal Electrical Association, which appeared in your issue of June 10, I beg to disclaim any credit (or otherwise) for the remarks put down under my name. You state, "This was the first meeting at which a paper had been read by a member of the Municipal Association." This is obviously incorrect. There are other points which it is scarcely worth while detailing in full, such as the fact that the second paragraph was included in my remarks and not in Mr. Wordingham's.

The more important point which I wish to draw attention to, however, is with reference to consulting engineers. The tone of my remarks as quoted by you would lead your readers to suppose that I were antagonistic to consulting engineers generally for central-station work, whereas on this occasion I took the opposite view. For instance, it is stated, "He thought that Councillor Hesford was rather hard on station engineers. No doubt they had their little weaknesses, but so also had consulting engineers." In the above the terms "station engineers" and "consulting engineers" should be transposed. I remarked that Councillor Hesford was rather hard on *consulting engineers*, and I pointed out that other engineers had similar weaknesses.

The other little inaccuracies are not of sufficient importance to require special attention being drawn to them.—Yours, etc., H. FARADAY PROCTOR.

Bristol, June 14, 1898.

ON THE ABUSE OF POWER-HOUSES.*

BY W. H. PREECE, C.B., F.R.S., PRESIDENT OF THE INSTITUTION OF CIVIL ENGINEERS.

There is a great tendency in the present day to multiply power-houses—or central stations, as they are more frequently called—unnecessarily. This arises from various causes: (1) from want of foresight in predicating the growth of electric industries; (2) economy in selecting land we have, rather than pay money for land more suitable by position but which we have not; (3) the restriction of legislation in confining operations to a defined area; (4) the growth of other industries side by side, especially tramways and railways worked by electric traction.

These causes have led to the original power-houses being designed too small, and on space too confined; and to the subsequent construction of other power-houses, further afield and more extended, and even to the necessity of going to positions outside the original area secured by provisional order. But worse than this, different industries have been promoted by rival and opposing interests. Trade competition and patent rights have led to the construction of power-houses side by side, until we see the absurdity of one installation being worked at night to supply energy for electric light and another installation generating energy during the day for traction purposes being built practically on the same site; whereas not only can the power be generated conveniently and economically by the same plant, but the two energies can mutually assist each other, so as to reduce considerably the work cost per unit generated. This is what the author means by the abuse of power-houses. The man who causes two blades of grass to grow where one only grew before is called a benefactor, but the local authority which deliberately allows two power-houses to be built where only one is needed is a disturber of the peace.

It is very well affirmed by experience that the greater the plant and the larger and more continuous the output the cheaper is the cost of generation per unit. It may be said, roughly, that if a given plant—say, 10,000 kw.—working at its maximum load on the average three hours a day, produces electrical energy at one penny a unit, it will do so at three farthings per unit if it works six hours a day, one halfpenny per unit if it works 12 hours per day, and less than one farthing per unit if it works 24 hours the day; hence, concentration of power is distinctly financially desirable if it has the effect of lengthening the daily maximum output of the plant. One large station, conveniently built on the waterside, where coal can be delivered alongside, by rail or sea, at its cheapest; where water is abundant and available for condensing; where ashes, clinkers, and dirt are easily barged away; where we have one control and one staff, is clearly the ideal power-house for economy. And it puts a stop to any cause of nuisance. The cartage of coal and rubbish does not impede traffic. Vapour clouds do not offend the eye, and

* A paper read before the Incorporated Association of Municipal and County Engineers at a district meeting held at Yarmouth, June 11, 1898.

apparent rain, in the form of condensed drops of water, does not damage one's garment or need the raising of umbrellas; vibration, noise, and smells cease to be causes of vexation and litigation; additional chimneys do not disfigure the view. The question of securing a site is very much simplified. Hence comfort and convenience attest the value of the concentration of power plant in one locality.

In these days of high electrical pressure, whether continuous or alternating, the position of the power-house is not a matter of serious import. In the early days of the new electrical industry it was a question of economy of distribution to place the working plant in the centre of the area to be served, but now it is of little consequence where it is placed within a limit of a few miles. The difficulty is a legal one, but even this has been considerably retrieved by the action of the recent Joint Committee of the Lords and Commons, who recommend that compulsory powers for purchase and for wayleaves for mains shall be allowed to those who find it necessary for public purposes to establish their power-house outside their own area of supply.

The whole tendency of recent legislation has been to favour local authorities and to facilitate their acquisition or induce their acceptance of those municipal duties which include the conduct of industries which affect the whole community, like the supply of water, of light, and of general locomotion. The success of the electric light industry in the hands of local authorities is beyond dispute, and some of our large cities are now taking up vigorously and with great spirit the working of their tramways by electric traction. The ultimate success must be the same. These corporations, with their provisional order and their electric light installations, have already the legal powers and the means to supply electrical energy. This is their right, and a valuable property it is to them. No one contests their right to do it, but there are corporations who have not yet acquired the working of the trams in their localities, but who have the right and the means to supply energy, and in these cases the right to supply energy to tramways is contested. If it were to succeed, and the tramway companies allowed in all cases to build and work their own power-houses, we should see the absurdity of two buildings existing where only one was needed, of two causes of nuisance perpetuated where none need exist, where the public would suffer from higher fares and the undertakers voluntarily accept the responsibility of generating their energy at a needless cost. The supply of energy to work the tramways would enable the undertakers to reduce the price per unit to the electric light users by probably 1d., while they could at the same time supply the tramway company, if such exist, as cheaply as the company can make it themselves. Moreover, when the time arrives for the local authority to take over the tramways they would not be saddled with two power-houses.

There are other advantages in combining an electric light and a tramway plant. There is but one question of site, and but one management. There is only one set of boilers and one steam-pipe system, for the loss of energy by radiation from steam-pipes is very large, and therefore of some consequence. There is, moreover, less reserve plant needed. The author thinks this abuse of power-houses is a subject that well deserves the serious consideration of the Association of Municipal and County Engineers.

VERBAND DEUTSCHER ELEKTROTECHNIKER.

FRANKFORT MEETING.

[BY OUR SPECIAL CORRESPONDENT.]

As announced previously in the *Electrical Engineer*, the meeting place of the Verband Deutscher Elektrotechniker selected for 1898 was Frankfort-on-the-Main. This place so chosen is a most appropriate one, as the electrical associations of Frankfort are historical. A number of important electrical manufacturers have established their works in the neighbourhood, so that there were numerous hosts ready to welcome the strangers to the town. Perhaps the greatest historical fact connecting the electrical industry to Frankfort was the exhibition held there in 1891, when the first long-distance transmission of power scheme was shown to the world. This celebrated Lauffen-Frankfort installation, by which power was carried over 100 miles, was the child from which innumerable undertakings have sprung, and it was also almost the first rotary-current installation. The fact that a number of

The Badge of the Verband for 1898.

electrical firms united to establish the necessary works for this transmission, was a good sign of the united interest they had in the results. The risk incurred have most amply repaid these enterprising firms, as the German and Swiss electrical engineers are now recognised as the best in the world for multiphase power transmission works. I know that our American cousins will kick at the above statement, and point to Niagara and Prof. Forbes, but the fact remains that many of the American dynamo designers were "made in Germany."


The Eschenheimer Tower, Frankfort.

Bearing these associations of the old free town of Frankfort in mind, I was somewhat prepared for the most cordial reception accorded to me on my arrival. Although there were a large number of distinguished engineers at the meeting from all parts of Germany and Austria, the Frankfort men were most conspicuous by their efforts to keep all happy. The meeting commenced

on Thursday, June 2, but as the business that day was confined to the council there was plenty of time for a general look round the town. I strayed to the works of Mr. C. Pollak, the far-famed accumulator designer, who has had so much experience in the commutating of alternate currents. A visit to these was on the programme for Friday, but I obtained a private view and much special information which will appear later on in my description of the works. It is to be specially noted that kept out of the public Press for the time being. After partaking of Mrs. Pollak's kind hospitality, the accumulator tramcars, also engineered by the company, took me back to the railway station at Frankfort. Of these trams I shall also have more to to say in a later letter, but may mention now that the first plates fixed in the cars about 13 months ago are still working without renewals, and that each set has been responsible for about 22,500 car miles. Some two tons weight of accumulators are used per car,

View from the Terrace of the Buildings in the Zoological Gardens, Frankfort, where the business meetings were held.

a large amount of the current required to form the accumulator plates is obtained from the single-phase alternate-current supply of the town. For this purpose commutators or rectifiers are used, and currents up to 600 amperes are successfully redressed. Additional current is generated in the works by direct-current dynamos, as the accumulator company is not allowed to take more than a certain power from the mains. I was not allowed to leave the works after my inspection and they are charged at constant potential at the end of each journey.

The general gathering of members and the wives or lady friends commenced at 8 p.m. in the evening in the large hall of the Saalbau. I had previously obtained my membership ticket in the same building, and found that for a total of 17s. all my inward wants and liberal carriage exercise thrown in were to be supplied for the next few days. Thus, at the reception on Thursday a most

The Central Railway Station at Frankfort, showing Arc Lamp Pillars for Four Arc Lamps.

was over, but was kindly invited to dinner at Mr. Pollak's private house, adjoining his experimental laboratory. In this laboratory I was shown some wonderful experiments on another method of redressing alternate currents without moving parts. These experiments are likely to take a practical form shortly, and will, if as successful on a large scale as on a small one, have a lasting influence on the progress of electrical engineering. For obvious reasons, a full description of the process is to be tasty cold collation was provided, as well as unlimited Pilsener. The real attraction of the evening gathering was the reunion of old friends, but exceedingly good music made the evening pass quickly. Mr. C. Pollak, Mr. G. J. Melms, and Mr. E. Hartmann seem to have borne the lion's share of the work of preparing the social items of the programme, and a daughter of Mr. Hartmann gave a eulogistic recitation on electrical matters in general. The recitation was very well delivered, and finished by a

cry for "more light." The young lady, who was dressed in a Greek costume of pure white, then raised a torch made of a number of incandescent lamps, which promptly lighted up. Amongst those I was specially glad to see again was Mr. Gisbert Kapp, the general secretary of the Verband. From him I gathered that the society has continued its work of drawing up rules and standards for the electrical trade in Germany, and that its efforts are fully recognised by the Government—in fact, in Germany there is no Government department corresponding to our Board of Trade, and the Verband Deutscher Elektrotechniker bids fair to prevent the need for such a Board being required to make regulations on electrical matters. Mr. Kapp was most pleased to hear news from his English friends.

After an interval a party of glee singers entertained us with a selection of songs, and the friendly greetings between members continued till long after 11. Mr. R. O. Heinrich, the gentleman representing the Weston measuring instruments in Germany, undertook to show me the best place to drink coffee in Frankfort, so on leaving we adjourned to the Café Bauer, where we found a large number of the members. The coffee was certainly wonderful, but the various liqueurs also obtainable were not neglected. Finally we returned to the Frankfurter Hof considerably the wrong side of midnight.

Notwithstanding the dissipation of the previous evening, a goodly number of members put in their appearance at the Zoological Gardens punctually to time, 9.30 o'clock, on Friday morning in order to take an active or quiescent part, as the case might be, in the subsequent proceedings. In fact, the hall alloted for the purposes of the meeting—which, by the way, was one of the several belonging to the garden property—became quickly full to overflowing, many even having to rest satisfied with standing room. Under these circumstances frequent desertions to the spacious refreshment-rooms adjoining were not to be wondered at, nor was it strange that members should have found a little welcome variation from purely business proceedings in paying the lions, monkeys, or bears, etc., an occasional visit as choice might dictate. Far from interrupting the course of business, these little excursions helped to sustain interest and put fresh vigour into the debates. The Germans, indeed, have a most happy knack of mingling business with pleasure, and this was evidenced at the meeting under consideration in a manner which could hardly be improved upon. But now let us return to business.

Owing to the absence of the president, the vice-president, Prof. Slaby (Geheimer., Regierungsrath), took the chair, addressing the meeting with a few appropriate remarks relative to the regrettable though unavoidable absence of their worthy chief. He also spoke in enthusiastic terms of the undisputed supremacy of Germany in the Continental world of electrical science; of the splendid work accomplished by the Verband in attaining to this position, and of future intention not only to maintain this enviable position, but to secure, in addition, a firmer footing in the world's markets. Continuing further, he referred to the magnificent reception which had been accorded to the Verband by Frankfort on the previous evening.

This opening speech was suitably responded to and endorsed with regard to the latter remarks by several prominent townsmen of Frankfort who were present. Prof. Dr. Petersen, president of the Physical Society at Frankfort, referred at some length to the progress of the town in matters electrical—the works recently carried out, etc.

Then followed the annual report, which was read by the general secretary, Mr. Gisbert Kapp. This proved eminently satisfactory, the register showing a membership of 2,112, and the accounts a balance of £3,050 on the right side.

It will be remembered that the special commission which was appointed at a previous annual meeting of the Verband to report upon the most practical method of determining the candle-power of incandescent lamps, and to suggest a basis for standardising the same, communicated the outcome of its labours to the last annual meeting. As a result of further enquiry, the commission was able last week to recommend its report for final adoption in *extenso*. This was unanimously agreed to, what was formerly suggested as a basis for calculation being thereby definitely recognised as the best method of accomplishing the desired end, which fact speaks well for the work of the commission.

It was further suggested as desirable that an international understanding between England, Germany, America, etc., for reducing the size and type of incandescent lamp sockets and holders to some common standard should be arrived at if possible.

Mr. Jul. H. West moved the appointment of a commission to adjust the normal sizes of screw contacts, fuses, and wires in conformity with the safety rules recently adopted. Modification of the dimensions which were at present recognised was necessary, he said, because the normal standards based upon the regulations issued in 1895 did not conform to the safety rules now in vogue. The proposition was agreed to, and a commission immediately appointed, which held its first sitting the same afternoon.

The day's business meeting terminated with the reading and discussion of several papers, after which an adjournment was made to the Palm Gardens for lunch.

(To be continued.)

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared, and should be written on one side of the paper only. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time.

Questions.

72. A building is electrically lighted from accumulators, which are charged during the daytime. The tenant decides to take current from the alternating-current mains of the local supply company. The building is wired throughout on the ordinary two-wire plan, with single lead-covered cables, which at places are drawn into iron pipes. Will any alterations have to be made supposing that the insulation and other tests are in accordance with the supply company's rules? The wires are mostly run in wood casing in the usual way, and are not buried in the plaster.—F. S. P.

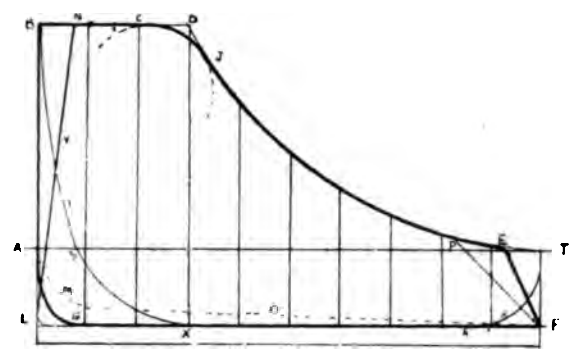
73. A large hall, 120ft. long by 60ft. broad and about 40ft. high, is to be lighted electrically. Compare the annual cost of lighting the same by incandescent and arc lamps from a direct-current supply at 6d. per Board of Trade unit?—S. K.

Answers.

Question No. 68.—Draw an indicator diagram for a defective engine and explain how the defects are shown in the diagram.

Best Answer to No. 68 *(awarded* 10s.*)*.—The accompanying model card illustrates several faults which sometimes occur in engines, and suggest the remedy. In the accompanying figure the various diagrams or cards have all been drawn to the same scale, and have been superposed on each other, and on an ideal or perfect card for the engine in question. It is hoped that as by this arrangement the difference between the good and bad cards will be easily noticed, their study will be the more interesting. The cards are supposed to be taken from engines of precisely similar design, and are condensing, the atmospheric line being shown by the line A T. The perfect card is represented by the thick outline, B J E F G A, and shows an ideal performance in the cylinder. First, to describe the cycle as shown by the perfect card. The indicator pencil rests at A, which is the point due to atmospheric pressure, and on full steam being admitted to the cylinder, the pencil immediately rises to B, and as the card rotates describes the line B C, which represents full steam. Supposing B to

be the point of opening and D the point of closing, then the port will be full open at a point, *z*, midway between B and D, and the valve consequently at the bottom of its stroke. At C the line begins to fall, showing that the valve begins to close, and at J the convex line becomes a concave, therefore J is the point where steam is fully cut off. The line J E is the curve of expanding steam in the cylinder. At E the line falls rapidly towards F, and is the point where the valve opens to exhaust, and at *h* it is full open. As *h* is the same distance from F as *z* is from B, it shows that the valve is at the top of its stroke. The port full open to the exhaust and the line F G represents the working vacuum line. At G the line rises towards A, showing that the valve to exhaust closes, and the curve G A represents the cushioning or compression. At A new steam is admitted, and the line A B represents the lead line.



Comparing the faulty engine diagrams with the good one:

(*a*) Diagram B J P F L.—We find that the exhaust opens at P—that is, sooner than the pencil arrives at E; also that it closes at L after the pencil has passed G. From this we gather that the *exhaust opens too soon and closes too late*, though the line L B shows good *lead*. There is no compression. From the foregoing we can see that the exhaust edge of the upper face of the valve is too short and requires a piece fixing to it.

(*b*) Diagram B J T R X Y.—Here we have the reverse of the foregoing, as the *exhaust opens too late and closes too soon*, as shown at the points T and X; also the lead line, X Y B, slanting upwards towards the steam corner, and cutting the atmospheric line to the right of A, shows that there is *too much lead*, that the *valve is too low*, and must be corrected by having a liner put under the foot of the eccentric rod.

(*c*) Diagram N J P F L.—A repetition of *a*, with an additional fault. There is too early an opening to exhaust at P; closes too late at L, which also shows absence of compression. From L the lead line follows L Y N instead of L A B. This shows that there is *no lead*, and that the *piston is on its return stroke before the port opens for steam*, if the valve has lap. This shows that the *valve is too high*, and a liner must be taken out to correct the fault.

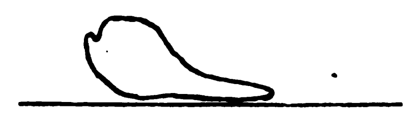
(*d*) Diagram B J P F X.—The valve to exhaust opens too soon at P, closes too soon at X, and from X Y B we see that there is too much lead. Everything is too soon. This indicates that the eccentric sheave is too much advanced, and requires putting back a little to correct the fault.

(*e*) Diagram N J T R L.—The valve to exhaust opens too late at T, closes too late at L, and there is no lead. Everything is too late, showing that the sheave is too far back and requires advancing.

Should the vacuum line, F L, rise towards A, as, for example, the line F O M, this would show that the vacuum grew less due to insufficient circulating water through the condenser, or to vapour being formed from condensed steam in the cylinder. Should a leak exist between the valve and cylinder faces, the expansion curve would fall outside of the curve J E, instead of on it, owing to the admission of high-pressure steam through the leak. This would show that the valve faces required attending to.

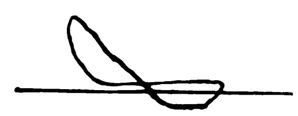
There are many other faults which indicator diagrams may disclose in the engines they are taken from, such as leaky pistons, glands and stuffing boxes, priming, etc., but the above examples will perhaps be sufficient to indicate the extremely useful record of otherwise obscure actions that the indicator diagram can give us.—F. S. P.

Answer to No. 68 (*awarded* 5*s.*).—The defects in the distribution of steam to a steam-engine are so numerous, that many diagrams would be required to fully show their effect on the indicator card. In enumerating a few of these, the following cover most of the ground, but it must be remembered that the bad setting of a valve producing a certain fault (in common valves) may be at the same time the cause for other faults, though harmful in a lesser degree. The defects may be classed generally under the heads of: (1) admission; (2) cut-off; (3) release; (4) compression and special cases of excessive back pressure, and faults in eccentric and condenser. Dealing with these, we have in late admission the steam pressure rising after the piston has moved forward thus:



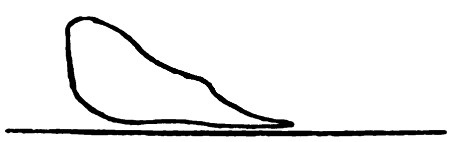
Late Admission.

With too early a cut-off the steam pressure falls below the atmosphere, and when exhaust opens the pressure rises again. This is most noticeable in the low-pressure cylinder of a compound engine, and is shown thus:



Early Cut-Off.

With a too early release a sudden drop of pressure is noticed in the expansion line thus:

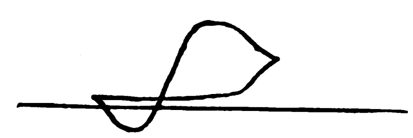


Early Release.

Where there is excessive compression, the steam pressure rises above the initial pressure, as is shown by the sudden drop of pressure on admission taking place:

Excessive Compression.

When the eccentric has slipped back on the shaft, we get a card thus:



showing all the movements too late.

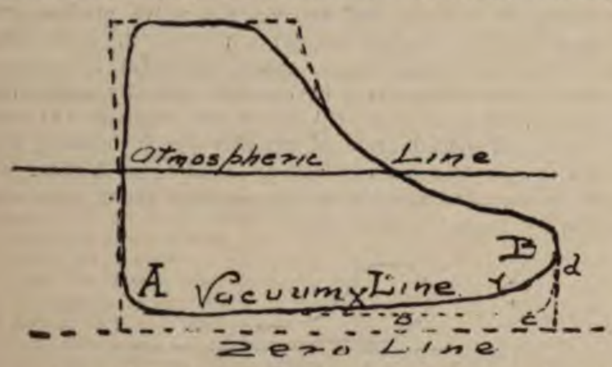
In considering the alterations to be done in the above cases, a good rule to remember is that when shifting the eccentric all the points in the diagram are shifted in the reverse direction, whilst if the position of the valve edges is altered we shift the points in the diagram in the same direction that the valve has been moved.—S. J. M.

Answer to No. 68 (*awarded* 5*s.*).—The following is a diagram from a condensing engine, from which the following defects may be noticed:

1. The slope of the admission line from the vertical shows that the valve has not been sufficiently open when the piston is at the end of its stroke—*i.e.*, the valve had insufficient lead. The less the amount of compression the greater will be the effect of insufficient lead. Another cause of this sloping admission line might be wire drawing in the steam passages, etc., but the fact that the full pressure on the piston is kept up until cut off shows that this cannot be the case.

2. There is not sufficient cushioning shown by the small rounded corner at A, indicating that the exhaust is closed only at the end of the stroke.

3. The slope of the line at B shows that the exhaust commences at or after the termination of the stroke. The falling line, X Y, indicates that the steam escapes with difficulty, and that the normal back pressure is reached late on the back stroke, as the valve has not been sufficiently



opened to allow the steam to pass freely through. The work lost is indicated by the area, *b c d*, included within the dotted lines.—J. F. M.

[N.B.—Will Mr. C. Coleman kindly send us his address, so that we may send him the prize he won recently?—Ed. *E. E.*]

BECKENHAM.

The following is the first part of Mr. J. A. Angell's report on electric lighting:

In accordance with the Council's instructions I beg to submit the following report on the proposed electric lighting of the district:

Provisional Order.

1. It will be within the knowledge of members of the Council that an electric light provisional order was obtained in 1890 and that in 1893 a report on the subject was presented by Mr. Kapp, M.I.C.E.

Electric Lighting Undertakings.

2. Until within recent years it was the usual practice of local authorities to favour the undertaking of electric lighting by private companies. Latterly, however, public opinion has changed so that, whilst formerly the majority of undertakings were companies, in the year 1896 only 59 companies existed, as compared with 74 municipal undertakings. Again, in 1890, out of 57 provisional orders applied for, one quarter only were granted to local authorities, whilst in 1896, 27 out of a total of 30 provisional orders were taken up by local authorities. During the present year over 30 local authorities have applied to the Board of Trade for powers. In all a total of 283 provisional orders have been granted, of which 202 were issued to local authorities and 81 to companies.

3. The loans raised by local authorities on the sanction of the Local Government Board for electric lighting have also steadily increased during recent years, thus: in 1890-1 the loans sanctioned amounted to £10,000; in 1891-2, £101,000; 1892-3, £115,000; 1893-4, £572,000; 1894-5, £560,000; and in 1895-6, £796,500. During 1896 loans were raised by 40 local authorities, the maximum period allowed by the Local Government Board for repayment being (with one exception) 25 years.

4. The total capital invested in electric light undertakings amounts to about £11,500,000 (as against £3,000,000 in 1891), of which £5,500,000 represents the cost of municipal undertakings and £6,000,000 those of companies, a not inconsiderable portion of this latter representing capital expended by metropolitan companies (see par. 54).

5. Profits have progressively increased year by year, more than keeping pace with the increasing number of undertakings. In 1881 the total profits are given as £8,500, in 1891 £60,000, and in 1897 £800,000 (financial statistics, par. 55).

6. Whilst some half-dozen provincial towns (York, Eastbourne, Liverpool, Hastings, Chesterfield, Cockermouth) were provided with electric lighting by companies as early as 1881-2 and certain parts of the Metropolis in 1885, it was not until 1892 that municipal lighting was first inaugurated, Bradford being the first town to recognise the advantage of a public undertaking (now one of the most successful in the country).

In 1893 municipal bodies generally became more alive to the fact [illegible]at, not only did these undertakings constitute sound enterprise [illegible] from a consumer's and ratepayer's point of view, but that a [illegible]oly was prejudicial to the present, and, in a far greater [illegible] to the future interests of both. Since 1893, consequently [illegible]al electric lighting has advanced so greatly that, should [illegible]ndencies continue, it would appear that erelong local autho- [illegible] almost monopolise the industry (par. 2). Indeed, perhaps [illegible] connection with electric lighting is more striking than [illegible] of municipal enterprise, and rightly so, inasmuch as [illegible] indicates that, with modern plant and due regard in design to probable demand, municipalisation must, given reasonable time for development, prove financially successful. Indeed, the very fact of supply being a monopoly (though a public one), and therefore outside competition, practically ensures its ultimate success. In any case a few years' deficits cannot for one moment weigh against the subsequent annual profits of generations.

During the past year, 1897, in many districts where generating stations have been established the local authority has been quite unable to cope with the demand for current. As examples, Edinburgh has within recent years doubled its supply; Brighton within five years has increased it eight times; Bradford, eight times in six years; Glasgow, five times in four years; the same rapid growth equally obtaining in metropolitan districts. The fact that the local authority has also been the gas authority in 29 instances has not deterred them from becoming the electric light undertakers, a spirited policy undoubtedly, but frequently justified by its success, as at Oldham, where not only did the gas profits remain undiminished but a considerable profit on electric lighting was realised in addition.

Municipalisation.

7. Amongst other more or less cogent reasons for municipalisation are that (1) the creation of a monopoly, certain to be profitable in the future if not at the outset, is prevented; (2) a heavy cost is involved in buying out a company prior to the termination of the statutory period—(under the Electric Lighting Act, 1888, Section 2, the local authority may, by compulsory purchase, acquire an electric lighting undertaking after the expiration of 42 years, or thereafter at subsequent intervals of 10 years at the then fair market value, without addition for compulsory sale, goodwill, or profits); (3) the capital cost is raised on easier terms by a local authority; (4) the necessary administrative machinery is already existent; (5) greater confidence is felt and greater public support obtained; (6) the local authority should control the design and system from its outset; (7) public street-lighting should be in the hands of the local authority; (8) interference with public roads and footways by companies is avoided. There is, perhaps, but little force in contention No. 3, inasmuch as a local authority must from the outset pay annual instalments of sinking fund and interest (equivalent to about 6 per cent. on the capital) out of revenue, or, in default, out of public rates. As regards contention No. 5, given equal conditions, municipal undertakings show better results financially than those of companies. Naturally public goodwill is enlisted on behalf of the former, whilst, on the other hand, ratepayers instinctively feel the necessity of protecting themselves against a mere trading concern whose only object is to realise profits, and who are uncontrolled by ordinary trade competition.

8. It can hardly be expected that undertakings of any great magnitude will realise a profit on the first few years' working (Brighton and Tunbridge Wells are exceptions, no call whatever being made on the rates), especially where repayment of capital (quite outside ordinary business requirements) has to be provided at the very outset. Experience, however, appears to indicate that where ordinary conditions prevail the profit-earning stage (which in a municipal undertaking involves a return of at least 6 per cent., all below that amount being regarded as loss) is arrived at or about the third year, though frequently at an earlier date (financial statistics, par. 55). Whilst admitting, therefore, that in the earlier years deficits are almost inherent to electric light schemes, as, indeed, at their outset, to all large undertakings, public or private, yet the prevention of a monopoly would, in itself, seem to be all-important, and, in the light of present experience (especially in relation to water and telephones), an imperative duty upon the present generation. Apart from the inconvenience due to the constant and uncontrolled cutting up and damaging of highways by companies, each without regard to the other or to public convenience, no one who has had official dealings with an Act-protected and monopoly-owning company can doubt the desirability of public control. The latest monopoly, telephones, than which no such inadequate, costly, and unsatisfactory system exists in Europe or America, is a fair illustration of results. As to the wisdom, therefore, of municipalisation, there appears to be no doubt. In any case, whilst the deficits of early years will probably represent a less burden on the rates than the subsequent cost of buying out a company (pars. 15, 16), ultimately, under proper management, all such undertakings cannot be otherwise than profitable.

9. That Parliament and the Board of Trade view with favour the introduction of electric light by local authorities rather than by companies is indicated by the special facilities afforded to the former under the Electric Lighting Acts, 1882-88, and by the restrictions placed on private enterprise.

10. As to whether a local authority shall of its own initiative enter upon an undertaking purely on its own merits, and prior to the advent of a company, is, of course, a matter for consideration, the determining factors being public feeling, character and needs of districts, and probability or otherwise of success within a reasonable period. When, however, as in the case of Beckenham, private enterprise threatens, matters are simplified, and there appears to be no doubt whatever that, in order to protect both present and future ratepayers' interests, the Council should put into operation its electric lighting powers. That no undue haste has been exhibited is evidenced by the fact that the provisional order has now been in the Council's possession for upwards of eight years. Municipalisation, as opposed to monopoly, is therefore advocated on the following broad grounds—viz., that the interests of (1) individuals and community alike are safeguarded, (2) future generations are protected, and that (3) the undertaking receives at its outset greater public support.

PRIVATE UNDERTAKINGS.

11. A private company's undertaking has, at its inception, one advantage over that of a local authority, in that, as a rule, an adequate scheme is framed at the outset. Usually a local authority is, much to its credit, parsimonious with public money, with a consequent tendency towards over-economy in capital expenditure, the result being that many municipal undertakings are practically crippled at their birth, and incapable of realising profit in the early or any other stage without subsequent and unduly costly extensions. The following extract from the statement made by Mr. R. P. Wilson, the electrical engineer retained by the Council, bears on the subject: "Before proceeding to the consideration of the various proposals now before your Council, I should like to point out that I am allowing in my estimates for the installation of such plant as will, in my judgment, be of permanent use in your station. It has been too often the case that local authorities have proceeded with such caution in the matter of electric lighting that, with a view to cutting down the initial expenditure, they have installed plant of far too small a capacity in the first instance. The result of this has been that it has been found necessary to add to the plant almost before the station has been opened for the supply of light. This has resulted from the fact that the estimates forecasting the probable demand have been founded on too cautious a basis. Furthermore, the result of this policy is that engines and dynamos which were thought to be of sufficient size for a start have been found to be almost useless, in point of size, after a year or two. This has happened so often that the moral is now obvious. It is well known to engineers that engines of small size are not nearly so economical from any point of view as are the larger sizes. In the first place, they cost much more in proportion to size, and, in the second place, they do not work so economically from the point of view of steam consumption; in other words, more coal is necessary to run two engines doing 20 h.p. each than to run one doing 40 h.p. There is, therefore, little to be said in favour of putting in small-sized engines in the first place, except that it very slightly decreases the initial expenditure, which initial saving has to be paid for heavily later on.

12. A private company is further advantageous in that it relieves the local authority of the risk of early losses. Whether, however, the business risks of a well conceived industrial concern, carried out under the favourable auspices of a local authority, with capital borrowed at, or less than, 3 per cent., are at all commensurate with the probable cost of avoiding them by the intervention of a private company—in other words, whether the remedy is not worse than the disease—is a question open to discussion.

13. As indicated in par. 7, objections to a private undertaking are both numerous and forcible. The capital of a private company is, moreover, considerably swollen by expenses from which a local authority is free—viz., expenses of promotion, underwriting, advertising, legal charges, etc.—amounting to not less than 10 per cent. in small companies. All this unprofitable (from a municipal standpoint) expenditure has, however, to be met by the local authority should the undertaking be purchased, and is, of course, avoided if municipalisation occur at the outset. Other reasons may, of course, exist for swollen, not to say watered, capital. Plant, buildings, apparatus, mains, etc., may be supplied by interested parties at much over their actual value; payments to contractors may be deferred, taken wholly or partly in shares, etc., and generally the conditions be such as could not for a moment obtain in the case of a local authority. Nevertheless, should the latter subsequently purchase the scheme on the basis of capital sunk, they may not only have to pay far beyond the actual value of the machinery, even when new and at its best, but be saddled with much that is old, obsolete, and useless for future use. To guard against this latter possibility, it is advisable that in any transfer of an order the local authority should have power to inspect and to disapprove of any plant, also that subsequent purchase should be based, not on capital sunk, but on revaluation by an independent expert. The above comments must not be taken as reflecting on company promotion generally, a form of business enterprise upon which the prosperity of the country so greatly depends, nor is it intended to suggest the impossibility of framing a scheme equitable and acceptable alike to company and to local authority. All that can be said is that, so far, no such scheme is forthcoming. Having regard to the adverse conditions of the Electric Lighting Acts in respect to private undertakings, and to the still more stringent conditions insisted upon by local authorities (as to transfer the moment a profit occurs, price of current, etc.), it might be supposed that capitalists would hold aloof from such concerns. On the contrary, however, so well do they rank, that they are deemed by the financial world to be favourable openings for capital, shareholders being satisfied that in all cases of transfer they will be bought out at very advantageous terms to themselves. Under ordinary circumstances, therefore, no difficulty whatever exists in raising the necessary capital, a fact not without significance to local authorities.

TRANSFER AND PURCHASE OF UNDERTAKING.

14. In only 15 cases have provisional orders obtained by a local authority been transferred to companies. Local authorities, as a general rule, are not anxious to part with their orders, though occasionally the protest comes from the ratepayers, as at Hackney, where, at a recent town's meeting, a resolution was carried by 500 votes to 3 (despite the favourable terms offered the Vestry for the disposal of their house refuse) protesting against the Vestry's proposal to transfer their provisional order.

15. Already eight private undertakings have been purchased by the local authority, and even where no actual negotiations have been entered into, the question of municipalisation is obtaining consideration more or less wherever companies exist. Owing to lack of experience, ill-designed plant, machinery too small and wasteful, injudicious expenditure generally, and the non-support of a then unappreciative public, a few pioneer stations of 10 or more years of age have proved more or less comparative financial failures. To-day, however, electric light practice being so well defined, and up-to-date stations (with machinery and plant amongst the finest and most efficient in the world), working under the most favourable auspices, the conditions of transfer would probably prove to be very onerous to the local authority.

16. For instance at Sheffield, after much litigation, the Corporation are about to purchase the electric light company's undertaking by the issue of £220 of 2½ per cent. stock for every £100 capital expended, plus £6,000 in cash, or, in other words, a payment of £273,838, as against an expenditure by the company of £124,472 only. At Liverpool, the amount paid by the Corporation to the company exceeded the actual capital sunk by £150,000. It is stated that at Birmingham negotiations for purchase of the company's undertaking are proceeding on the basis of a payment of 10 guineas for every £5 capital expended. At Bournemouth, negotiations for purchase by the Corporation have been, so far, abortive, on account of the prohibitive price demanded by the company, whose annual net profits amount to upwards of £2,000. In the Metropolis, the City of London Commissioners have recently protested against the action of the electric lighting company, who, whilst paying a 10 per cent. dividend, continue to charge no less than 8d. per unit, with the result that the formation of a municipal undertaking in opposition to that of the company is receiving consideration. At St. Luke's, the company charges 7d. per unit to consumers, as against the Vestry's charge of 6d. for the first two hours and 3½d. for subsequent hours, in the adjacent district of Shoreditch. At Marylebone the Vestry are now seeking powers (apparently with the approval of the Board of Trade) to compete for the supply of current with the existing company.

17. At Croydon a somewhat unique arrangement was made with the Thomson-Houston Electric Lighting Company, who contracted, not only for erecting the works, but also for carrying on the undertaking subsequently on the following terms—viz., the company to pay sinking fund, interest, working, and all other expenses, and in return to collect and receive for their own benefit the entire revenue (the charge per unit to consumers not to exceed 6d.), the Corporation reserving power to take over the works at any period on six months' notice, on the following terms:—That if the said period be determined within five years they shall pay the contractor as follows: if determined at the expiration of first year, £1,000; second year, £800; third year, £400; fourth year, £200. So successful has the undertaking proved that the Corporation have taken over the undertaking at the earliest possible moment by forfeiting the stipulated sum of £1,000. About £50,000 has already been expended on the undertaking, and considerable extensions are now in hand.

BECKENHAM.

18. Conceding that under certain circumstances and conditions as to repurchase, the transfer of a provisional order or the leasing of a prospective undertaking to a company might be expedient, the object of such transfer should be: (1) the avoidance of early trading risks; (2) subsequent municipalisation when deemed fit, and at reasonable cost; (3) moderate charges for current.

19. With these objects in view, the following offer actually made to the Beckenham Council by a well-known syndicate may be considered. The principal conditions are: (1) Charge for public lighting to be 7d. per unit for first hour, 2d. subsequently. (2) Charge for private lighting to be 7d. per unit for first hour, 3d. subsequently. (3) Purchase to be effected by the local authority at any period on six months' previous notice, by issuing to company corporation stock which will yield the company 5 per cent. on capital properly expended on the undertaking. The latter clause, perhaps, looks innocent, but practically involves payment to the company of £2,000 for every £1,000 expended. For instance, supposing the actual capital sunk to be £36,000—viz., the amount of the present estimate—sufficient stock must be issued to yield an annual interest of £1,800 (viz., 5 per cent. on £36,000), and as this stock would probably be issued at or about 2½ per cent., it follows that the company would secure about £70,000 thereof; in other words, the local authority would have to pay about twice the actual capital cost of the undertaking, and that without regard to the depreciated value of the plant, etc. The policy of transfer to a company of the rights of supply on anything like such terms as the above, cannot surely be advocated.

21. In concluding this part of the subject, I may quote W. H. Preece, Esq., C.B., F.R.S., chief of her Majesty's Telegraph Department, who stated some few years ago that electricity was no longer in its speculative or experimental stage, also that the industry represented a safe investment, and that, if municipalised, not only was the capital not swollen by promotion expenses, but that the ratepayers were not taxed to support a private concern. Mr. Preece, however, deprecated half-hearted measures as being likely to result in failure.

SPECIAL FEATURES OF DISTRICT.

22. In the matter of electric lighting, as in most other things, Beckenham presents features special to itself. Its large area, unusually scattered and widely separated houses with large front gardens, prevalent leasehold system, migratory habits of its residents and consequent diminished interest in local affairs, long summer and winter vacations, no demand for current for traction or motors, absence of any convenient central site for the generating stations, all represent disadvantages. On the other hand, the wide roads bordered with trees lend them-

selves effectively to street-lighting from the centre of the road; laying of cables, etc., is facilitated by gravel paths or margins; high-class residences are precisely those from which demand is likely to be active; absence of many shops no grave disadvantage, for although a fair proportion of shops to houses is preferable, shop supply in itself is brief and heavy, and to that extent unremunerative. Speaking generally, metropolitan suburbs, such as Beckenham, cannot be said to present such favourable conditions of success as provincial towns, partly owing to the less migratory habits of their inhabitants, and partly to the fact that local energy, enterprise, and initiative is more concentrated on local concerns in such self-contained centres.

SITE AND SYSTEM.

23. Having regard to the great difficulty of obtaining a more central site for the combined works, the land in Arthur-road (already the Council's property) naturally suggests itself as a suitable site. Its comparative isolation is no detriment, whilst its proximity to the railway affords facilities for delivery of coal, etc. Moreover, the area of land admits of subsequent extensions and the future aggregation of buildings—viz., electric light, dust destructor works, disinfecting chamber, mortuary, small fire station, depôt for carts etc.

24. In my previous report to the Council I stated of the three systems in vogue—viz. (1) low pressure up to 500 volts, (2) high-pressure continuous, and (3) high-pressure alternating—that "As regards the system to be adopted, in view of the large area and straggling character of the district, a high-pressure system alone is suitable, but whether high-pressure alternating or high-pressure continuous (Oxford system) is a matter for future consideration." Since that report the Council's electrical engineer has recommended the high-pressure alternating system above referred to. This system is now in course of adoption at Wimbledon (par. 59), where combined electric light and dust-disposal works are in progress. The electric current will there be generated at a pressure of 2,200 volts, and transformed at sub-stations to 200 volts for distribution to houses and public lamps. With reference to this system Mr. A. H. Preece, by whom the Wimbledon scheme is being designed, stated recently that: "The disadvantage of the alternating-current system is the necessity of having generating plant runing all day and night, as it was not possible to use a storage battery economically. But as the generating works will be placed adjacent to the sewage pumping station, and also in conjunction with dust destructors, this advantage will not be so great as usual, as steam will be available throughout the 24 hours."

25. It will be seen therefore that one of the chief disadvantages of the high-pressure alternating system is overcome in a combined system in which the day and late night current—viz.. all but the evening load—is generated by house refuse as a fuel. The fact that this system does not readily lend itself to motive purposes for machinery, etc., is of no great consequence in districts such as Wimbledon or Beckenham, where there are no factories, and electric traction, it is to be hoped, is remote.

DUST DESTRUCTION.

26. The sub-committee of this Council, after their recent visit to the combined power and destructor works at Manchester, Oldham, Shoreditch, and Leyton, practically the only districts (except perhaps St. Pancras and Ealing) where house refuse is utilised for the production of electric light, reported as follows: "Having visited three of the best known types of destructors—viz., those of Messrs. Manlove, Alliot, and Co., of Messrs. Horsfall, and of Messrs. Beaman and Deas (each destructor inspected being utilised for the generation of steam for electric light and other purposes), the committee are of opinion that combination is possible and presents economic advantages. From their personal observation and from information afforded by members of the various councils and by the responsible municipal officers, also borne out by the experiments and reports of experts, the committee consider that (1) destruction of refuse can be effected without creating a nuisance; (2) generation of steam from the refuse in the destructor furnace is practicable, and that such steam can be profitably utilised for driving electric light and other machinery; (3) capital cost of both dust destruction and electric light undertaking is reduced by combination."

27. The capital cost of providing a dust destructor would be from £2,000 to £2,500, and the annual cost of working, etc., about £600. Against this it is estimated that an annual saving of £150 would be effected by the use of a motor dustcart (capable of containing six cube yards of material), the chief, though not the sole, economy resting in the fewer daily journeys to and from the shoot or destructor. Allowing, therefore, for saving effected on cartage, the total increased cost of dust disposal by a destructor would amount to about £450 annually.

28. The disposal of house refuse by burning is, of course, apart from the question of electric lighting (except in so far as it relates to the economic effect of combination), and is recommended on its own hygienic and sanitary merits, the present mode of shooting foul refuse into holes or in brickfields being open to serious objection.

29. Although it is possible to determine experimentally the exact thermal equivalent of any given sample of refuse, the determination of its calorific value on a large scale is a much more difficult matter. Whilst 7lb. of water can be evaporated by 1lb. of coal, fairly reliable experiments prove that but from 3lb. to 5lb. of water can be evaporated from 1lb. of house refuse. Actual practice, however, on a large scale, shows less favourable results—viz., that but 1lb. of water can be evaporated by 1lb. of refuse. The approximate value of coal to refuse is, therefore, as 7 to 1. But little practical knowledge or experience, however, exists as to the actual value of refuse under the special conditions of a "combined" system. According to the *Surveyor*, several districts—viz., Gloucester, Hackney, Fulham, Swansea, Ashton-under-Lyne, Pembroke, Weston-super-Mare, and Llandudno—are about to enter upon combined schemes. In the case of Shoreditch, the results, though not yet published, appear to bear out those above indicated—viz., that seven tons of refuse approximate in steam value to one ton of coal. It is, however, stated that the refuse at Shoreditch is of an exceptionally favourable character, due to the presence of large quantities of wood and shavings, the refuse of the staple industry (cabinetmaking). One very favourable feature certainly exists—viz., that owing to the daily house-to-house collection the refuse is received at the works in a dry condition, not wet or damp as in districts where weekly collections prevail.

30. Taking, however, a less favourable view of the value of the Beckenham refuse, although supposed to be of a more than usually favourable character, and accepting 14 tons refuse (in lieu of seven) as the equivalent of one ton coal, the economic effect would be approximately as follows:

31. For the greater part of Stage I. coal, practically, could be dispensed with. As this stage progressed, however, and Stage II. become operative, the refuse would prove insufficient in quantity (its increase in bulk not keeping pace with the demand for current), and coal or coke would be requisite, the coal account then being reduced to the extent of about 500 tons per annum—viz., the assumed equivalent of 7,000 tons of refuse. The cost of current in the earlier stages of the combined scheme may, therefore, be reduced by ¾d. per unit—viz., the average cost of coal per unit generated in the case of 42 electric light stations. This economy, together with that due to the combined scheme by reason of (*a*) the provision of a common chimney shaft and boiler-house and (*b*) the reduced working expenses of either scheme in respect to stokers' wages, etc., should enable the Council to supply consumers at about 1d. per unit less than otherwise without decreasing the net revenue from the undertaking.

32. Of course the saving thus effected might be carried towards reducing the annual deficits of the earlier years, rather than to lower the charge to consumers. In my opinion, however, such a course is not desirable; the aim of the Council should be directed rather towards lowering prices as far as possible, bearing in mind that, whilst high charges deter, a reasonable sale encourages consumers to immediate demands for supply, and that popularisation of the light is the surest means of decreasing the number of lean and hastening the advent of fat years.

33. It may be suggested that the value of house refuse as a fuel, and the economic effects of a combined scheme generally, have been under-estimated. So little reliable data exists, however, as to the financial results of such schemes, that I have felt it desirable to err, if at all, in the direction of under rather than over stating possibilities.

34. Objection may be taken to a combined scheme on the grounds that refuse is an uncertain fuel, and may lead to fluctuating light; also that dust and dirt may impair the efficiency of the electric lighting plant. Whilst there is some force in both contentions, careful design, adequate separation, and good management will, no doubt, obviate substantial evil; at any rate, no difficulties are complained of at Shoreditch. If fuel is to be purchased, admittedly the best is cheapest. Where, however, fuel in the shape of house refuse is available, unless more potent objections than those already forthcoming are discovered, its use as an economical factor in the generation of electric light is, in my opinion, more than justifiable. In the few cases where dust destructors not originally intended as a means of generating electricity, and not, therefore, specially designed for the purpose, have been so utilised, the results have not been very satisfactory, St. Pancras being a case in point. Much of this ineffectiveness can doubtless, however, be avoided if due consideration be given in the original design to the ultimate subsidiary purpose of the destructor. Even thus, however, much of the constructional economy of a combined scheme would be lost. Combination, therefore, at the outset would be distinctly advantageous if not opposed to more important considerations of policy.

(To be continued.)

LEYTON ELECTRICITY WORKS.

The following is the annual report of Mr. H. C. Bishop, the electrical engineer, to the members of the Leyton Urban District Council on the working of the electricity department during the past year:

I have the honour to place before you my annual report for the 12 months ending March 31, 1898. During the year great progress has been made with the supply of current in the district. At the end of last year the length of streets in which mains were laid amounted to about eight miles, the whole of which was lighted by incandescent electric lamps. At the end of the year the total number of applications for current amounted to 128, divided as follows: offices, 6; shops 57; public-houses, 1, private houses, 49; public buildings, 7; schools (Board), 1; workrooms, 4; banks, 2; public lighting, 1. The station has been run without mishap, there having been no breakdowns. No faults in the mains have been recorded as causing any difficulty in the supply. There are 172 street lamps connected to the mains. The question of supplying arc lamps in the main roads has been considered on several occasions, and is still under consideration by the Highway

and Lighting Committee. The coal strike has caused some little inconvenience, which I have, so far, been able to get over by substituting coke (in the generator) for coal. The output of units sold is given below, together with the corresponding months of the year before, where possible :

	1896-97.	1897-98. Private.	Public.	Total.	Increase.
April	—	2,107	4,645	6,752	6,752
May	—	1,386	3,892	5,278	5,278
June	—	1,186	3,146	4,332	4 332
July	—	1,212	3 247	4,459	4,459
August	—	1,644	4,349	5,993	5,993
September	336	3,228	5.383	8,611	8,275
October	1,506	5,250	6,332	11,582	10,076
November	3,194	6,460	7,574	14,034	10,840
December	5,084	8,047	9,885	17,932	12,848
January	4,905	7,366	8,803	16,169	11,264
February	5,660	6,770	7,388	14,158	8 498
March	7,998	7,463	7,034	14,497	6,499
Totals	28,683	52,119	71,678	123,797	95,114

STATEMENT OF ACCOUNTS.—LOANS TO MARCH, 1898.

Amount sanctioned.	Amount borrowed. At 3%.	Total.	Amount repaid. Principal.	Interest.	Total.
£	£	£	£ s. d.	£ s. d.	£ s. d.
26,610	25,380	25.380	625 3 7	578 9 8	1,203 13 3
Paid. 1897	—	—	211 14 5	234 0 0	445 14 5
Total paid					£1,649 7 8

CAPITAL ACCOUNT FOR YEAR ENDING MARCH 31, 1898.

Expenditure.	£	s.	d.
Total expended to date on buildings, etc.	28,247	1	5½
Total	£28,247	1	5½
Receipts.	£	s.	d.
Total receipts—by amount raised by loans	25,180	0	0
Total	£25,180	0	0
Balance of capital	3,067	1	5½
Total	£28,247	1	5½

REVENUE ACCOUNT FOR YEAR ENDING MARCH 31, 1898.

Expenditure.		£ s. d.
Fuel	£265 11 10	
Oil, waste, etc.	48 2 7½	
Wages	636 8 0½	
Repairs and maintenance	18 10 5½	
		968 12 11½
Works costs—salaries	180 18 4	
Management	99 18 5½	
		280 16 9½
Management costs—sales department		522 13 7
Total sales department—public lighting		86 5 4
Total stores in hand		112 3 0
		1,970 11 8
Balance to net account		466 10 1
		£2,437 1 9

Receipts.	£	s.	d.
Sale of current by meter	1,003	17	0
Sale of current public light	618	0	2
Meter rents	20	19	5
Receipt for work done on consumers' premises	632	2	2
Premiums	50	0	0
Stores in hand	112	3	0
	£2,437	1	9

NET REVENUE ACCOUNT.

Expenditure.	£	s.	d.
Interest on loan	578	9	8
Instalment on loan	625	3	7
	£1,203	13	3
Receipts.	£	s.	d.
Balance brought down	466	10	1
General district loan	737	3	2
	£1,203	13	3

COSTS PER UNIT.

Units sold		123,797
Fuel	0·5114d.	
Oil, waste, etc.	0·0933d.	
Maintenance	0·0359d.	
Wages	1·2321d.	
Works costs		1·8727d.
Management costs, etc.		0·5446d.
Total costs		2·4173d.

GENERAL INFORMATION.

Price per unit	5d.—3d.
Power and heat	3d.
Average price obtained—public lighting	2·07d.
Private lighting	4·60d.
For both	3·335d.
Total lamps connected to March 31, 1898	6,788
Number of street arcs	1
,, incandescent street lamps	172
Combined normal capacity of station—Dynamo	140 kw.
Battery	60 kw.
Total	200 kw.
Maximum load observed	127 kw.
,, ,, in amperes	390
Number of motors on circuits	5

COMPARISONS WITH OTHER STATIONS OF SIMILAR OUTPUTS.

Name.	Units sold.	Coal.	Oil, etc.	Wages	Repairs.	Management.	Total costs.
Ayr	124 924	·92	·20	1·15	·37	·97	3·61
Belfast	149,721	1 33	·19	·87	·53	1·09	4·01
Blackburn	157,000	·39	·18	·58	·11	1·34	2 60
Cheltenham	103,715	·98	·16	1·80	·39	·84	4·17
Dewsbury	150,878	·65	·23	·70	·25	1·47	3·30
Lancaster	106,125	·75	·23	·79	·15	·67	2·59
Southampton	131,843	1·16	·14	·66	·31	1·40	3·67
Sunderland	146.440	·50	·21	·98	·31	1·26	3·26
Taunton	126,840	1·33	·21	·71	·25	·99	3·49
Crystal Palace.	118,316	1·88	·25	1·82	1·66	3·12	8 73
Wandsworth	116,821	1·52	·16	1·11	·13	1·28	4·20
Northampton	114,676	1·06	·19	·74	·33	1·62	3·94
Reading	123,702	1·59	·18	1·34	·28	2·01	5·40
Richmond	138,916	1·08	·17	·61	·47	1·43	3·76
Leyton	123,797	·51	·09	1·23	·02	·54	2·41

You will see that Blackburn is the only place with a lower fuel account, and they are able to buy coal very much cheaper. Leyton has the lowest account for oil, waste, stores, etc. Eleven places are better than Leyton in wages account. We are rapidly getting this item down. Leyton has the lowest account for repairs and maintenance. Leyton has the lowest account for total management expenses. On total costs Leyton comes out the best. These results are very satisfactory, and show without doubt that the best system for the locality has been adopted. Comparing Leyton with the metropolitan stations (irrespective of size), where the conditions of cost of material, labour, etc., is very much alike, I find that no station has better fuel costs ; St. James's is the same, but the output is over three million units compared with Leyton's 123,797. Stores, oil, etc. : I find two stations better than we are—viz., St. James's and House-to-House. Three are the same as Leyton. Wages are better in all cases than Leyton, which is accounted for by the enormous difference in the output. Repairs and maintenance: Leyton is the best of all. Management: Leyton is beaten by two—viz., Charing Cross and Clerkenwell. Total costs: Leyton is beaten by only three—viz., Charing Cross, output over two million units ; St. James's, output over three millions ; and Westminster, output over four millions.

LEGAL INTELLIGENCE.

THE NEW MOTIVE POWER SYNDICATE.—TESTING GUITTARI'S PATENT.

Mr. Justice Bigham and a common jury had before them on Thursday and Friday, the 9th and 10th inst., in the Queen's Bench Division, an action brought by Sir Samuel Canning and Mr. Tom E. Gatehouse, consulting engineers, against the New Motive Power Syndicate, Limited, in which it was sought to recover 75 guineas, balance of account for tests, and a report upon Guittari's patent mixture for generating steam in boilers, and which ultimately resulted in a verdict for plaintiffs for the full amount. Defendants counter-claimed for damages alleged to have occurred to their boilers.

The counsel were: for plaintiffs, Mr. McCall, Q.C., Mr. Macaskie, and Mr. Howard Spenceley (instructed by Mr. J. E. Lickfold); and for defendants, Mr. Tindal Atkinson, Q.C., and Mr. A. B. Shaw (instructed by Messrs. Robinson and Stannard).

Mr. McCall in opening the case, stated that the plaintiffs were requested by defendants, who were interested in a certain patent, to test and report upon it. They did so, and now said that they were entitled to the sum claimed, which was the balance due to them. The main question to be decided was, whether or not plaintiffs had carried out the work they were employed to do. The substance of the patent was that by a mixture of carbonic acid gas and Dutch liquid with water in a boiler, Mr. Guittari claimed that the motive power would be increased, and steam would be generated more rapidly, besides which there would be an enormous saving of fuel. Defendants, who were interested in the invention, were anxious to obtain a report from a firm of leading engineers like the plaintiffs, with the ultimate object of placing it before the public. Therefore, on July 23 last year, Mr. Bale, one of the directors of the syndicate, wrote to Sir Samuel Canning on the subject of tests, and the fee for that and the report thereon was fixed at 150 guineas, half of which was paid at the time the arrangement was entered into. The tests took place on August 2 and 4 last year at the defendants' works, when an engine was

supplied with steam from two boilers all constructed by Messrs. Davey, Paxman, and Co. On August 2 one boiler was supplied with Guittari's patent, and on the 4th the other with pure water. The results were taken, and would be put before the Court. The substance of the tests was that Mr. Gatehouse and the other gentlemen present with him came to the conclusion that the results obtained from Guittari's mixture were no better than those obtained from plain water, and plaintiffs reported accordingly. Mr. Bale objected to the way the tests had been carried out, and then refused to accept the report or to pay the money due.

Mr. Gatehouse, A.M.I.C.E., M.I.M.E., editor of the *Electrical Review*, etc.; Mr. W. H. Booth, member American Soc. C.E., a former inspector of the Manchester Steam Users' Association; Sir Samuel Canning, M.I.C.E.; Mr. J. Christie, engineer to the Brixton electric lighting station, and a certificated chief-engineer of the mercantile marine; Mr. Webster, for some time chief draughtsman and assistant to Mr. Bryan Donkin; and Mr. W. H. Massey, engineer to her Majesty the Queen, who had also made tests, were then examined at considerable length, and tabulated statements showing the results of the tests were put into court.

Mr. Tindal Atkinson, in addressing the jury for the defendants, said Guittari's patent consisted of a secret mixture which made the water extremely volatile, so that it gave off steam with a much less consumption of fuel than would be required by plain water. Plaintiffs were duly consulted as to proposed experiments, which should have consisted of a series of practical and exhaustive trials before the practical utility of the process was arrived at. Upon a previous report made by the plaintiffs to another gentleman, a syndicate was formed, and £1,500 was subscribed by them for the purpose of carrying into effect and rendering the process a popular success. Before they asked the public to subscribe, they were very anxious to be satisfied beyond all possibility of doubt of its actual value. They were entitled to have the very best information through the means of exhaustive trials, which Sir Samuel Canning had assured them would occupy at least 10 days. Instead of that, only two days were occupied in the trials, which were unfair in every respect, and hence the present action.

Mr. A. J. Bale, one of the directors in the defendant syndicate, was then called, and he bore out the statement of Mr. Tindal Atkinson. The plaintiffs agreed, he said, to make the trials in such a manner as to test the points included in a previous trial of Guittari's patented process made by the syndicate's consulting engineer, and they did not do so. Moreover, the stoker provided by plaintiffs was not competent, and the firing was inefficiently done.

In cross-examination, **Witness** said he made a protest against the way in which the whole thing was done. He admitted that he saw nothing wrong in the stoking by Guittari personally. He did not take the trouble to see whether the proper weight of coal was supplied during the tests. Mr. Guittari was now on the Continent, and he declined to come to assist the syndicate.

Mr. McCall, in replying upon the evidence, said that what the syndicate desired was a good report, and they could not get it. They wanted one which would have enabled them to pass off to the public the invention which they had bought from Guittari. Finding they could not obtain it, they immediately found fault, and objected to what they had practically ordered and had honestly been given them.

In summing up, his **Lordship** said the question the jury had to decide in this case was whether the plaintiffs, who were suing for certain money promised for certain services, did their work in a proper and conscientious manner. If they did, they were entitled to be paid the balance; while if they did not they would not be entitled to it, but, on the other hand, would be bound to refund the 75 guineas which had already been handed to them. Now the jury had better consider what in this case the plaintiffs wanted, and whether they liked it when they got it. The defendants were the New Motive Power Syndicate, Limited, and had apparently bought the process of Mr. Guittari, whom they had not seen in court during the hearing of the case. It was described as a process by which, if one mixed with water a mysterious compound, and then put it in a boiler, much better results could be obtained than with water only. A syndicate, which he would call No. 1 syndicate, bought the process, and raised amongst themselves £4,000, with the object of making certain tests to see whether the mixture was really worth what was claimed of it. That £4,000 seemed to have been spent. Then it was thought wise to sell the process, and it was proposed that somebody else would come in and find more money; consequently, syndicate No. 2 was formed, the object from the very beginning being that the proper thing to do was to sell it to the public—that was to say, to form a public company. Before they could hope to do that, however, they must get from a good firm of engineers, who possessed a good name, a favourable report, which would have been subsequently printed in a prospectus. Defendants wanted that favourable report from a good firm, which he believed the plaintiffs to be, and for a favourable report they were willing to pay a certain price. There had been one report in the past, made to a member of syndicate No. 1, and the attention of the jury ought to be called to it, for it might be of some importance. It was made in December, 1896, by Sir Samuel Canning and Mr. Gatehouse, who, after dealing with the process, wrote the following: "At the same time, we think from the result of our trials that there is sufficient promise in the Guittari method to warrant a further expenditure to allow of a thoroughly practical and exhaustive series of experiments with an engine and boiler of reasonable horse-power." Bearing that in mind, counsel for the defence had indicated that the tests which formed the subject of this action were not sufficient. Well, the jury could put such value upon that as they thought proper. Following the course of events, it appeared that after they received the first report from Sir Samuel Canning, they approached him and his partner again, and further tests were arranged, which were supposed to be under as nearly the same conditions as possible, otherwise the whole thing failed. The first of the tests took place on August 2, and was substantially under Guittari's control. It was suggested by the plaintiffs that as soon as the result of the test with Guittari's mixture, Guittari himself stoking, was seen by Mr. Humes and Mr. Bale, who represented the defendants, they saw at once that they were not likely to get a report which would be of any marketable value to them. The only report which would have any commercial value to them was a favourable one. The Guittari test having been made, it did not appear that any objection was taken by defendants, except that it was not long enough, the objection being based upon what Sir Samuel Canning wrote in December, 1896, to an entirely different party, as to "exhaustive tests"; and certainly that objection was not made until plaintiffs asked for the balance of the fee agreed upon. With regard to the report which plaintiffs prepared, his Lordship said he could not assist the jury much as to that. He had it, but they had not seen it themselves. It was a very long report. Plaintiffs sent it to defendants in September, the month following the tests, and defendants at once said to them: "Take it away, we won't look at it, and we certainly won't pay you for it." Mr. McCall, plaintiffs' counsel, had suggested that the reason defendants refused to have it and pay for it was that they knew very well it was not favourable; and it might be that Mr. McCall's suggestion was right, and that the real reason was that it was not the sort of report the syndicate required. If the jury were of opinion that plaintiffs did their work in a proper and skilful way they need not be afraid to give them a verdict entitling them to the balance of their contract money. If, on the other hand, the jury came to the conclusion that they were neglectful, and did not go about their work as properly skilled men ought to have gone, by all means say so, and let them be made to give back to defendants the half of the fee which they had already paid, together with the sum which was claimed for damage done to the boilers, which was said to have occurred through the excessive use of the blower. That damage was laid at £25, which, to his Lordship's mind, seemed extraordinary. However, if the jury agreed to that figure let them by all means allow it.

The jury considered for two or three minutes, when the **Foreman** said they found a verdict for the plaintiffs for £78. 15s., and also on the counter-claim.

Judgment was entered accordingly, with costs.

COMPANIES' MEETINGS AND REPORTS.

CALLENDER'S CABLE AND CONSTRUCTION COMPANY, LIMITED.

The second annual general meeting of this Company was held on the 15th inst. at the offices of the company, Mr. Henry Drake (the chairman of the board of directors) presiding.

The **Chairman** moved the adoption of the report and accounts, as published in our last issue.

Lieut.-Colonel Elliot seconded the motion, which was unanimously agreed to.

Mr. W. O. Callender (the retiring director) was re-elected, and Messrs. J. Worley and Son were re-elected auditors at the increased remuneration of £150 per annum.

The **Managing Director** (Mr. T. O. Callender) said that an immense amount of work had been done during the year 1897, but that was as nothing compared to what they were doing this year. The difficulty was, not to get orders, but to execute them; in fact, many orders had to be refused. He endorsed the necessity of increasing the capital of the Company, prophesying that in two or three years' time the business of the Company would have doubled itself. At least 90 per cent. of their business was with leading corporations, such as Liverpool, Manchester, Birmingham, Nottingham, Glasgow, and Edinburgh.

A vote of thanks to the directors and staff concluded the proceedings.

At an extraordinary general meeting subsequently held it was decided to increase the capital of the Company to £200,000 by the creation of 20,000 new shares of £5 each.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY, LIMITED.

The thirty-fifth ordinary general meeting was held on the 9th inst. at Winchester House, Mr. W. S. Andrews presiding.

The **Chairman** moved the adoption of the report and the payment of the dividend published in our last issue.

Lord Richard H. Browne seconded the motion, which was carried unanimously.

HARROW ELECTRIC LIGHT AND POWER COMPANY.

In our issue of the 3rd inst. we gave the report of the directors of this Company. We have since received the accounts of the Company for the year ending Dec. 31, 1897, which show the total capital expended up to date to be £28,331. 14s. 7d. The revenue account and general balance-sheet are given herewith:

REVENUE ACCOUNT.

Dr. Generation of Electricity.	£	s.	d.	£	s.	d.
Generation of electricity and maintenance of station under contract with Messrs. Crompton and Co.				867	11	7
Rents, Rates, and Taxes.						
Rents payable	41	0	0			
Rates and taxes	105	15	1			
				146	15	1
Management Expenses.						
Salary of secretary	87	10	0			
Salary of collector	25	0	0			
Stationery and printing	27	17	6			
Audit fees	18	10	0			
Directors' fees	50	0	0			
Sundry disbursements	21	7	8			
				230	5	2
Law and parliamentary charges				18	16	10
One-fourth written off cost of working contract				8	11	1
Amount written off preliminary expenses				169	2	0
Depreciation in respect of leasehold property				25	0	0
Special Charges.						
Insurances	35	9	2			
Repairs to property	63	14	2			
Discounts allowed to sundry customers	45	15	6			
				144	18	10
Balance carried to net revenue account				310	19	0
				£1,921	19	7

Cr.	£	s.	d.
Sale of current as under :			
At 9d. per B.T.U., including lamps	2	2	4
At 8d. ,,	1,619	3	4
At 7d. ,,	2	4	4
At 5d. ,, (motors)	19	1	8
	1,642	11	8
Rental of meters on consumers' premises	45	1	10
Installation rents and guarantees	42	9	9
Rents receivable	148	5	3
Transfer fee	0	2	6
Sundry receipts for work done	0	10	0
Commission received on sale of lamps and sundries	42	18	7
	£1,921	19	7

Dr. GENERAL BALANCE-SHEET.	£	s.	d.
Capital account—amount expended	25,240	0	0
Amount due to bankers	2,433	0	9
Sundry tradesmen and others, due on construction of buildings, plant, and machinery	961	14	10
Sundry creditors on open accounts	668	7	3
Depreciation fund account	60	0	0
Net revenue account	1	8	9
	£29,364	11	7

Cr.	£	s.	d.
Capital account—amount received	28,331	14	7
Sundry debtors for current supplied, meter and installation rents	963	18	4
Other debtors	68	18	8
	£29,364	11	7

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Tunbridge Wells.—The Corporation invite tenders for the wiring of the new baths. Specifications, etc., at the Borough Surveyor's Office. Tenders by 27th inst.

Edinburgh.—The Magistrates and Council invite tenders for the supply of copper strip for electric conductors, for particulars of which refer to our advertisement columns. Tenders by 30th inst.

Belfast.—Tenders are invited by the Belfast Harbour Commissioners for the extension of their electric lighting station, Abercorn Basin. Specification, etc., at the office of the harbour engineer, Mr. G. F. L. Giles. Tenders by July 4.

York.—The Corporation invite tenders for the erection of an electric lighting station. Specifications, etc., may be obtained from Mr. A. Creer, the city engineer, on payment of £1. 1s., to be returned to bona fide tenderers. Tenders by June 25.

Bethnal Green.—The Guardians invite tenders for supplying the necessary plant and installing the electric light at their new infirmary, Palestine-place, for particulars of which refer to our advertising columns. Tenders by June 28.

Wimbledon.—The District Council invite tenders for the installation of the electric light mains and fittings in the new depôt buildings in Queen's-road, Wimbledon, for particulars of which refer to our advertisement columns. Tenders by 27th inst.

Barnet.—The Lighting Committee of the Urban District Council invite estimates for the lighting of the district by electricity from firms willing to undertake such installation, for particulars of which refer to our advertising columns. Letters by June 24.

Southampton.—The Corporation invite tenders for the supply and erection of cast-iron and wrought-steel lamp columns, arc and incandescent lamps, automatic switches, and fittings, for particulars of which refer to our advertisement columns. Tenders by 20th inst.

Madras.—The Secretary of State for India in Council announces that the time allowed for the receipt of tenders by the Chief Engineer for Irrigation, Madras, for the utilisation of water power of the Periyar Lake has been extended from Oct. 31, 1897, to July 1, 1898.

Bournemouth.—The Corporation invite tenders for cables, arc lamps, incandescent lamps, wiring, switchboards, fittings; steam dynamo, etc. Specification, etc., can be obtained of the borough engineer, Mr. F. W. Lacey, M.I.C.E., provided £1. 1s. has been previously deposited at his office. Tenders by June 20.

West Hartlepool.—The Town Council of West Hartlepool invite competitive plans, designs, and tenders for the erection of refuse destructor, boilers, etc., adjoining the electric light station, Burn-road. Conditions, etc., can be obtained upon application to Mr. J. W. Brown, borough engineer. Tenders by 4 p.m. on July 27.

Cape Colony.—The Town Council of East London, Cape Colony, is prepared to receive tenders for the erection of buildings and the supply of electric lighting machinery, electric tramcars, plant, rails, etc., and for their maintenance for six months from completion. Full particulars will be found in our advertisement columns. Tenders by June 28.

Bootle (Lancs.).—Tenders are invited by the Corporation for the erection of an electric light station on their land in Pine-grove. Specifications, etc., may be obtained at the office of Mr. J. A. Crowther, borough engineer, on and after 17th inst., on payment of £2. 2s., which will be returned on receipt of a bona fide tender, with quantities fully priced out. Tenders by noon on 28th inst.

London, N.E.—Tenders are invited by the Bethnal Green Board of Guardians for supplying the necessary plant and installing the electric light at their new infirmary, Palestine place. Specifications, etc., can be obtained from the architects Messrs. Giles, Gough, and Trollope, 28, Craven-street, Charing Cross, W.C., on payment of £5. 5s., to be returned on receipt of a bona fide tender. Tenders by 10 a.m. on 28th inst.

Cardiff.—Tenders are invited by the Corporation for the construction, supply, delivery, and fixing of two water-tube boilers with superheaters, each to evaporate about 6,500lb. of water per hour, and one 300-kw. direct-driven steam alternator. Specifications, etc., may be obtained from Mr. Neville Appelbee, borough electrical engineer, Cardiff, upon deposit of £1. 1s., which will be refunded on receipt of a bona fide tender. Tenders by 9 a.m. on 28th inst.

London, S.W.—The London County Council invite tenders for supply of engines, dynamos, accumulators, switchboards, the feeders, distributors, and service mains, and all accessories, to be fixed complete in buildings at the Crossness outfall works, near Erith, Kent. Specifications, etc., may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W., upon payment of £1, to be returned to bona fide tenderers. Tenders by June 21.

London, S.W.—Tenders are invited by the London County Council for works in connection with the construction, delivery, and erection complete of two sets of three-cylinder compound pumping engines and accessories in a new engine-house now being built at the Barking outfall works, near Beckton, North Woolwich. Specifications, etc., may be obtained from the Engineer's Department, County Hall, Spring-gardens, S.W., upon payment of £3, to be returned to bona fide tenderers. Tenders by 28th inst.

London, S.W.—The London County Council invite tenders for providing and fixing cables, wires conductors, casing, pendants, brackets, watertight and other fittings, columns, lanterns, lamps, switches and switchboards, distributing boards, fuses, cut-outs, etc., which may be necessary for the lighting by electricity of the Crossness pumping station and works near Erith, Kent. Specifications, etc., may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W., upon payment of £1, which will be returned to bona fide tenderers. Tenders by June 21.

Edinburgh.—Tenders are invited by the Magistrates and Council for the supply, delivery, and erection at Henderson-row power station of steam-engines and other machinery for the cable tramway; also for the supply, delivery, and erection at Shrubhill and Tollcross power stations of rope drives and tension machinery, etc., for the work required in connection with the conversion of the tramways to the cable system of traction. Conditions, etc., may be obtained on payment of a deposit of £2. 2s., which will be returned on receipt of a bona fide tender, to Mr. W. N. Colam, C.E., or Mr. John Cooper, burgh engineer, engineers to the Corporation, 1, Parliament-square, Edinburgh. Tenders by 22nd inst. at 10 a.m.

Victoria (Australia).—Tenders are invited by the Council of the city of Hawthorn for the supply and erection, or for the supply only, of: (Section A) buildings only; (B) boilers, water-heater, pumps; (C) engines, dynamos, switchboard, mains, sub-mains, transformers, meters, arc lamps, insulators, testing instruments; (D) supply of poles and their erection; running of the plant for three years. Specifications and forms of tender can be obtained at the office of the Agent-General for Victoria, Lieut.-General Sir Andrew Clarke, G.C.C.M., Victoria Office 15, Victoria-street, Westminster, London, S.W., on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Tender for Electric Lighting," and addressed to the Mayor of Hawthorn, Victoria, Australia, on June 24, at 5 p.m.

RESULTS OF TENDERS.

Plymouth.—The Council have accepted the tender of Messrs. Goddard, Massey, and Warner for the erection of a chimney at the electric lighting works for £2,528.

Hammersmith.—The Electric Lighting Committee of the Vestry have recommended the Vestry to accept the tenders of Messrs. Ferranti for the extension of the rectifiers at £640, and for the switching apparatus at £154.

Aberdeen.—The Docks and Pilotage Committee have accepted the offer of Messrs. Lucy and Co., Oxford, to supply and erect the arc lamps and lamp-posts for lighting the quays and dock entrances by electricity for £2,110.

Stockton.—The Corporation have authorised the Gas Committee to accept the tender of the Brush Electrical Engineering Company, Limited, for a complete equipment for the borough, subject to details of the various requirements being approved by it and the manager.

BUSINESS NOTES.

Harrogate.—The Town Council have decided to light the Spa Grounds with electricity on a most liberal scale.

Newport.—The County Council will apply for sanction to the borrowing of £6,150 for electric lighting purposes.

Beckenham.—Mr. Angell's report, published elsewhere, is to be discussed by the Council at their next week's meeting.

Wakefield.—The Corporation's new electric lighting plant in Calder Vale-road was formally opened on the 15th inst.

West India and Panama Telegraph Company.—The receipts for the half-month ended May 31 were £4,012, against £2,448.

Cape Tramways.—The receipts for May of the Cape Electric Tramways were: Cape Town, £8,400; Port Elizabeth, £2,525.

Aberystwyth.—A report upon the complete lighting of the promenade is to be submitted at the next meeting of the Council.

Taunton.—A further increase in the demand for electric light is reported, the total connections made during the past month being equivalent to 623 8-c.p. lamps.

Chelsea.—The Chelsea Electricity Supply Company, Limited, announce that they have reduced their price for power and heating supplied at 200 volts to 3d. per unit.

Stourbridge.—The Urban Council have decided to support the order granted by the Light Railway Commissioners in relation to the Dudley and district light railways.

Southport.—The minutes of the Electricity Committee show a profit of £642 on the year's working, as against a loss of £471 last year, an increase in the right direction of £1,113.

Johnstone.—Representatives of the British Electric Traction Company are to meet the Town Council relative to a proposal to connect Johnstone with the proposed tramway to Glasgow.

Electric and General Investment Company.—The transfer books and register of members will be closed from the 13th to the 28th inst., inclusive, for the purpose of preparing the dividend warrants.

Shrewsbury.—The Board of Trade have issued copies of the new provisional order which they have just forwarded to the Corporation of Shrewsbury authorising them to supply electricity throughout the area of their borough.

Worcester.—The Council have ratified the agreement transferring to the National Electric Free Wiring Company the rights and obligations of the Electric Free Wiring Syndicate, Limited, under their agreement with the Council.

West Bromwich.—The Bill confirming the West Bromwich electric lighting provisional order was on Friday last found to comply with the standing orders of the Upper House, and was sent by the examiner for second reading.

Bray.—The Township Commissioners have decided to reduce the price of electric current from 6d. to 3½d. per unit after 1½ hours' lighting of maximum load. Notice of motion was given for the next meeting that the price be reduced to 4d. all round.

Blackpool.—We hear that, in consequence of a memorial signed by a number of ratepayers, the mayor will shortly call a ratepayers' meeting on the question of spending £40 000 on extensions to the electricity works, and also to discuss the overhead system.

Extension of Premises.—Messrs. Palmer and Watson, electric lighting and power engineers and contractors, intend opening a showroom on the ground floor at 100, Charing Cross-road as soon as the necessary alterations are completed, where they will exhibit samples of electrical fittings and appliances.

Change of Address.—Messrs. Pritchetts and Gold, electrical engineers and contractors, have removed from 31, Soho-square to 15, Hart-street, Bloomsbury, W.C.—The offices of the Brockie-Pell Arc Lamp Company have been removed from 97, Queen Victoria-street, E.C., to 21, 23, and 25, Tabernacle-street, E.C.

Liverpool.—The Local Government Board object to Clause 30 giving the Corporation power to borrow £600,000, £200,000 of which was for electric lighting purposes, on the ground that the Local Government Board could, without further parliamentary powers, sanction borrowing for electric lighting purposes.

Sale.—The minutes of a meeting of the Electric Lighting Committee, adopted by the Urban Council at their last monthly meeting, stated that it had been intimated that the Manchester *Corporation could make* arrangements for supplying electric light to Sale either by way of Stretford or Chorlton-cum-Hardy, and that the price would not exceed 3d. per unit.

Bermondsey.—At the last meeting of the Vestry Mr. Cox, chairman of the Electric Lighting Committee, reported that the Board of Trade had granted the Vestry a provisional order, subject to the approval of Parliament. He asked that the committee should be empowered to engage counsel to support the order before the parliamentary committee if it was opposed.

Fulham.—The Vestry have received a letter from a Mr. A. Digby with reference to the supply of electricity to the Granville Theatre, Fulham, and asking permission to lay a pipe either in Jerdan or Vanston place to take the current, which they proposed generating themselves, to their building, and have referred the same to the Electric Lighting Committee for their consideration.

Edmonton.—At the last meeting of the Guardians Mr. S. J. Ross, electrical engineer, wrote stating that he was willing to prepare detailed plans, specifications, and generally to supervise the carrying out of an electric installation at the workhouse for 5 per cent. on his estimate of the cost—namely, £2,500. The matter was referred to committee, with power to engage Mr. Ross's services.

Worthing.—The Town Council have appointed Messrs. Burstall and Monkhouse as consulting engineers for electric lighting purposes on terms to be arranged with them by the Electric Lighting Committee. The contractors will be required to work the undertaking at a stipulated rental for a period of five or seven years, when the works are to be handed over to the Council in proper working order.

Reward.—We have been asked by Messrs. E. P. Allam and Co., electrical engineers, of 14, Hatton-garden, E.C., to mention that a few days ago their premises were broken into, and an Evershed generator, No. 125, and a Nalder Bros. ohmmeter, No. 6,418, were stolen. A suitable reward is offered to anyone giving information which will lead to the recovery of the instruments and the apprehension of the culprit.

Marylebone.—The agenda for yesterday's meeting of the Vestry contained the motion: "That it be referred to the Baths and Wash-houses Committee to consider and report as to the desirability of fixing a dynamo in the establishment for supplying electric light in place of purchasing from the Metropolitan Electric Supply Company, believing such a course will effect a considerable saving in expenditure."

New Lighthouse.—The Northern Lighthouse Commissioners' steamer "Pharos" sailed from Granton on Saturday last, having on board the following commissioners: Sheriffs Comrie Thomson, Cheyne, Vary Campbell, Johnston, and Dundas, and Mr. Murdoch (secretary) and Mr. Stevenson (engineer). The purpose was that of fixing on a site for the erection of a new lighthouse at Barnness, on the Haddington coast.

Rotherhithe.—The Vestry have agreed that upon the London Electric Supply Corporation running their main to the town hall free of expense to the Vestry, the Vestry agree to take the current on the usual terms, and light the town hall by electricity. The Vestry have accepted the tender of Messrs. Henry Knight and Son, of Tottenham, for the erection of dust destructor buildings at a cost of £3,933. 10s. 6d.

Sheffield.—The Tramways Committee, having considered the report of Mr. F. Nell, the expert, which confirms in all respects the reports presented to this committee by the water engineer and the electrical engineer, have agreed that as at present advised it is economically impracticable to utilise the compensation water at the disposal of the Water Committee for generating electricity for electrical tramway traction.

Leith.—The Council have authorised the electrical engineer to advise parties as to the wiring of their premises with a view to their taking in the Corporation electric light supply, but on condition that the fees received by him be put into a fee fund in the Council's hands, out of which the Council might at any time they think fit allow Mr. Bryson any extra remuneration. The conference referring to the purchase of the tramways has been adjourned until July 5.

Knaresborough.—At the last meeting of the District Council is was said that, with reference to the proposed light railway, they might not have considered the fact that if the promoters of the light railway carried out their scheme they would probably apply for power to light Knaresborough by electricity. If they did that, Knaresborough would lose £7,000 or £8,000 worth of gas. The Rural District Council would insist that the wires should be placed underground.

Court of Common Council.—At a meeting of the Court of Common Council last week it was stated that the City of London Electric Lighting Company has reduced their charges for electric current by 1d. per unit. A motion to refer to the Streets Committee the consideration of approaching the company with a view to purchasing so much of that company's undertaking and plant as is situated within the City, together with the company's electric light generating station in Southwark, was deferred until the next meeting.

Personal.—Mr. George C. Sillar, M.I.C.E., who for nearly 17 years has been connected with the Brush Electrical Engineering Company, Limited, in various capacities, has been appointed general manager of the Otis Elevator Company, Limited, of 4, Queen Victoria-street, London, E.C.—Mr. R. V. Macrory, Limavady, formerly with Messrs. Siemens and Co., has been appointed to take charge of the electric generating station at Derry, in room of Mr. John Christie, who is leaving to enter a new engagement at Glasgow.

Australian Contracts. — The machinery for the lighting of the city of Goulbourn (N.S.W.) is being built by Messrs. Johnson and Phillips, of Old Charlton, Kent, the order having been handed to them by their sole representative in Australia, Mr. W. W. Crawford, consulting engineer, Imperial-chambers, Sydney, and Brookman's-buildings, Adelaide, who is at present on a visit to London. This firm have also in hand the order for plant for lighting Port Adelaide, South Australia.

Glasgow.—The minutes of the Watching and Lighting Committee state that in the event of the Corporation resolving to erect traction poles for the tramways in High-street, from Glasgow Cross to Parliamentary-road, those poles should be adapted for lighting purposes, and that the expense of such lighting be borne by the lighting department. Thirty-seven electric lights would be required. The annual cost for electric energy at the present rate would be £666; the cost of lighting at present with gas might be taken at £191.

Brierley Hill.—At the monthly meeting of the District Council an application by the British Thomson-Houston Company, Limited, for permission to lay underground electric cables was granted, subject to the cables being laid in such a position as not to interfere with the footpaths or road channels. It was decided to support the British Electric Traction Company's application to the Board of Trade for the confirmation of the order granted to them by the Light Railway Commissioners for the making of a light railway for the district of Cradley Heath, in the event of a public enquiry being held by the Board of Trade in reference to the said order.

Clerkenwell.—At the last Vestry meeting the Clerk read a letter from the Marylebone Vestry, stating that the Board of Trade had granted provisional orders to the Vestries of Bermondsey and St. Marylebone for the supply of electricity in their respective districts, and notice had been given of a motion, at the instigation of the electric light companies, to reject the Bill on the ground that local authorities should not be permitted to enter into competition with private companies. The letter asked that the Vestry would urge upon their member in Parliament to support the Bill for confirmation of the orders which it was anticipated would soon be before Parliament. This was agreed to.

Darlaston.—At the monthly meeting of the District Council it was decided that the Midland Electric Corporation for Power Distribution, Limiied, having entered into a satisfactory agreement with the Council, consent be given to the grant of the proposed provisional order. In reply to the Chairman, the Clerk said most satisfactory terms had been arrived at. A letter was received from the British Electric Traction Company, stating they were about to apply for parliamentary powers to adopt the overhead system on the South Staffordshire and other tramways, and asking for the support of the Council. The letter was referred to the General Purposes Committee.

Kirkcaldy.—Prof. Kennedy's report on the proposed introduction of the electric light, both for illumination and traction purposes, shows the proposed route of the tramway to be 6½ miles. The report was discussed at the Town Council meeting on the 14th inst. The Provost intimated that a private company who had the matter in hand was desirous of allowing the Council to take up the scheme, failing which they would take up the matter and float the scheme. The cost, he considered, would be nothing less than £100,000. In view of the limited time at the disposal of the promoters to enable them to apply for a Bill, it was agreed to hold a special meeting to consider the whole matter, and give a final decision in July.

Sydney (N.S.W.).—Sydney has about 50 miles of city and suburban tramways, with over 100 steam-motors and over 108 passenger-cars. Most of these lines are really railway lines, some are on the St. Francisco cable principle, while a short section is an overhead electric trolley. All these tramways are Government property and are run by the Railway Commissioners. The steam trams are now to be converted into electrical ones. Some five years ago an accumulator wagon was built in Sydney at a cost of about £3,000, which was generating electricity by the mere turning of its own wheels, so that the further it went the more electricity was used. The trials were pronounced a success, but the system has not been introduced up to now.

Poplar.—At the last meeting of the District Board the following resolution was agreed to: "That the Guardians of Poplar Union be informed that the Board has resolved to put in force the provisional order, obtained by the Board in 1893, for the purpose of supplying the Poplar district with electricity for lighting and other purposes; that the Board has recently appointed a resident electrical engineer to prepare and carry out a scheme under the order, and will, in due course, be in a position to supply electricity to buildings and premises in the district; and that the Board is prepared to supply the Guardians with the current at a reasonable charge. That a copy of this resolution be forwarded to the Local Government Board."

Canterbury.—The Town Council have adopted the electrical engineer's report, containing the following recommendations: (*a*) that the band of the chimney shaft be in brick, not stuccoed, and the top built in stone instead of blue brick; (*b*) that the sum mentioned by the contractors for connecting up to consumers' houses for 30s. per house be accepted; (*c*) that the rules of wiring be printed, and that a circular be printed inviting intending consumers to have their houses connected up during the time the cables are being laid; (*d*) that the charges be as follows: private lighting, 6d. per unit; power and heat, etc., 3d. per unit; (*e*) that the arc lamps be fitted with incandescent lamps, with separate switches, at a cost of about £5. 0s. 6d. per lamp.

Birmingham.—At the meeting of the City Council on the 14th inst. the Lord Mayor submitted the recommendation of the General Purposes Committee, previously referred to by us, as to the purchase by the Council of the undertaking of the Birmingham Electric Supply Company, Limited, at £420,000, and authorising the committee to take the necessary steps for the promotion of a Bill in Parliament to authorise the purchase. The recommendation of the committee was, as already stated, that they should pay £10. 10s. per share for the £5 shares of the company and take over the undertaking as a going concern with all its assets and liabilities as from Jan. 1, 1898. The recommendation of the committee was agreed to, the voting being 53 for, 0 against, 5 neutral.

Lynn.—The Town Council have adopted the following resolution of the Electric Lighting Committee; "The committee further conferred with Prof. Robinson as to the site for the proposed electric lighting central-station works, and as to proceeding with the scheme. And upon his stating that the site at the waterworks was a most advantageous one, that the cost of the works would not be increased if that site was adopted, and that gas-producing plant would be more economical at that site than the steam plant, and upon his confirming the statement in his report as to the financial success of the undertaking, it was unanimously resolved that it be recommended that the waterworks site for the works be adopted, and that gas-producing plant, instead of steam plant, be used at that site."

Stockton.—At the Local Government Board enquiry, referred to in our last issue, evidence was given to show that of the £30,000 not more than £22,000 would be expended at the outset. The site would be on spare ground close to the gasholder at the top of Richmond-street, and Mr. Ford, the gas manager, who has been with the Corporation 30 years, would take charge of both sections, with the assistance of an electrical expert. Mr. Ford stated that if the electric light was not adopted in the town it was probable in the near future, no further extension being possible on the present site, that the gasworks would have to be removed at a cost of from £100,000 to £150,000. As it was, with the additions to the gasworks last year and the electric light, they would be able to meet the requirements of the town for the next 10 or 15 years.

Monmouth.—At the monthly meeting of the Town Council the report of the Drainage and Electric Light Committee was discussed at great length. The £20,000 borrowed for the carrying out of the combined scheme of drainage and electric light appeared to have been already practically expended, while the work was not nearly completed. Some statement explaining the expenditure was asked for, and it was explained that the engineer, Mr. Lailey, had not yet rendered his report. The committee were therefore unable to give the figures. They were also at a deadlock for money, as the Local Government Board would not sanction the additional loan of £10,000 until they got Mr. Lailey's report explanatory to the extraordinary difference between his original estimate and the actual cost of the work. It was resolved to write to Mr. Lailey again on the subject.

British Thomson-Houston Electrical Company.—At the annual meeting of the British Thomson-Houston Electrical Company, held on the 10th inst., Mr. E. E. Lazarus, the chairman, in moving the adoption of the report, said increasing business had led them to extend their premises largely. They were executing traction contracts in Oldham, Ashton, Sheffield, Dudley, Stourbridge, Middlesbrough, the cities of Dublin and Cork, and for the Central London Railway. The profit for the year was £32,961, out of which they proposed to pay a dividend of 10 per cent. on the A and B shares. As usual with a new industry, they had found a good many competitors who had infringed their patents, and having spent about £100,000 in acquiring these patents, the directors thought it advisable to spend a little money in defending them, and he thought they would have to take an aggressive attitude in this respect. The report was adopted.

Glossop.—At a special meeting of the Town Council held on the 11th inst., a scheme for lighting the borough by electricity was discussed. The scheme adopted by the sub-committee comprises an electric station and works on a site adjacent to the Glossop Ironfoundry, from which centre the electric light would be supplied practically throughout the borough. The street lighting along the line of route would be electric, and the existing lamp pillars would be used in most of the streets. The cost of working, maintenance, rent of site, and the redemption and interest of the capital would be about £1,975 per annum, and the income would be, per 4,000 lamps, about £2,000, which would give a clear margin of £25 profit, after loan, principal, and interest had been paid. The capital estimated to be expended is about £15,000, which will include mains to Hadfield sufficient to supply 1,500 lamps to that part of the borough. The further debate was adjourned till the 29th inst.

Wednesbury.—The Town Council have adopted the following resolution: "That the Wednesbury Corporation enter into an agreement with the Midland Electric Corporation to withdraw their opposition to the application of the Midland, etc., Corporation upon the following terms—viz. (*a*) that the Midland, etc., Corporation supply electricity to the Corporation for lighting and power purposes within the area agreed upon with Mr. Addenbrooke (engineer) and the borough surveyor upon the same terms and conditions (if any) as may be hereafter agreed upon with the local authorities of West Bromwich, Oldbury, and Smethwick; (*b*) that the Midland, etc, Corporation will not oppose, but will support, the application of the Wednesbury Corporation for an electric lighting order at any future date; (*c*) the Midland, etc., Corporation are not to begin operations within the area of the

borough of Wednesbury until a provisional order has been obtained by the Wednesbury Corporation."

Appointments Vacant.—The Electric Committee of the Belfast Town Council require two fully qualified men as engineers-in-charge at £2. 5s. per week each. Applications, stating age, past and present employment, with copies of testimonials, endorsed "Engineer-in-Charge," to be lodged in the office of Sir Samuel Black, town clerk, by 21st inst. Applicants must be competent to take charge of a low-tension continuous-current station with batteries. Canvassing will be a disqualification.—The Town Council of Rochdale require an engineering assistant in the surveyor's office. Salary, £120 per annum. Candidates must be good and expeditious draughtsmen and surveyors, and have experience in mechanical work. Applications, stating age, experience, and qualifications, and accompanied by not more than three recent testimonials, endorsed "Assistant," to be delivered at the office of Mr. S. S. Platt, M.I.C.E., borough surveyor, Town Hall, Rochdale, by 22nd inst.

St. George's (Hanover-square).—The agenda for yesterday's meeting of the Vestry contained a motion to appoint a special committee to approach the electric light corporations in order to ascertain upon what terms they will light the parish or any portion thereof as may be agreed upon by electricity. Also that an application from Prof. Kennedy, on behalf of the Westminster Electric Supply Corporation, Limited, for the pipes from the condensing engines at their works in Eccleston-place to discharge into the canal on the south side as well as on the north side, as per plan submitted, be granted, the work to be carried out to the satisfaction of the surveyor, and the corporation to enter into an agreement to remove the pipes at any time should the Vestry require such removal on the ground of inconvenience or nuisance or other sufficient cause. A notice from the Westminster Electric Supply Corporation, Limited, of their intention to lay various electric light distributing mains was agreed to.

Leamington.—The Town Council have passed a resolution approving of the insertion of the following clause in the Leamington electric lighting order: "The undertakers shall not exercise any of the powers conferred by this order until they have paid to the Midland Electric Light and Power Company, Limited—hereinafter referred to as the company—such sum in respect of the lands, buildings, works, materials, and plant used by the company for the supply of electricity within the area of supply as may be agreed upon between the undertakers and the company, or, in default of agreement, may be determined by the Board of Trade, who, in such determination, shall have regard to the fact that under a deed dated Aug. 8, 1887, and entered into between the company and the undertakers, the company have for 10 years supplied electricity within the area of supply with the assent and countenance of the undertakers, and are entitled to some consideration in respect of their work, but they shall not have regard to any past or future profits of the company."

Lymington.—A special committee of the Town Council has conferred with the managing director of Edmundsons' Electricity Corporation, Limited, relative to a proposal to establish electric works at Lymington, and the proposed provisional order which the company are desirous of obtaining, and have reported that if obtained it would be entirely optional with the Council as regarded their lighting the public streets by electricity. The company's proposal is to form a local company with a capital of £10,000, half of which is to be subscribed locally, and the other half by the promoters. With respect to the formal agreement, which it was decided the Council should seal, so that the sanction of the Board of Trade might be obtained for the provisional order, the committee recommended that it be not sealed, but that Messrs. Edmundson be informed that the Council would not oppose the application for a provisional order if the terms of such order be approved by them, and provided that the company undertook to establish and complete the works at Lymington in two years. The report was adopted at the last meeting of the Town Council.

West London Tramways.—The Select Committee of the House of Commons over which Sir J. Kennaway presides is still engaged in considering the scheme of the London United Tramways Company for the adoption of electricity (on the trolley system) on its existing lines, and for the construction of new lines from Acton to Hanwell, from Hanwell to Brentford, and from Kew to Hounslow. At the last sitting Mr. Moore addressed the committee for the frontagers in the Ealing district. His petition bore 78 names, and he said that out of a total of 465 frontagers, 374 objected. These people had taken their present residences in order that they might be in a district half rural and half urban, and if the new tramway were constructed they would have to go elsewhere. They would receive no compensation, as would be the case if the injury were inflicted by a railway. Tramways interfered with the amenities of suburban residence. They brought trippers into a residential district, the old order and quiet disappeared, and the jerry builder made his appearance. The opinion of the Ealing District Council was against the scheme, because of the unsightly appearance of the trolley tramways, and also because they thought that the district was admirably served with railway accommodation.

Chatham.—The line recommended by the Light Railway Commissioners, as the result of the recent enquiry, will commence on the Maidstone-road and run down into Railway-street, joining a line which commences at the bottom of Ordnance-place, near by the Waghorn Memorial. The line will then proceed down Railway-street, along the Military-road, past St. Mary's Church and the Royal Marine Barracks, to the main and lower gates of Chatham Dockyard. At the corner of Military-road the line diverges by the Corporation offices, and forms a branch for Luton. It passes along the brook into Chatham High-street, opposite Union-street, and then on through the railway arch into the Luton-road to The Hen and Chickens. At the foot of Westcourt-street, Old Brompton, the line branches off up into High-street, turns into the upper part of Wood-street, and proceeds across the great lines into the High-street of New Brompton, and on past the railway station to Bachelor's Cottage in the Gillingham-road. Another New Brompton branch turns off through James-street and Richmond-road, into Pier-road to the bottom of Church-street, while there is also a branch by St. Mark's Church, up Canterbury-street to Jezreel's College, abutting on the London and Dover road. It is intended to connect this branch by a line running down Chatham-hill with the Luton-road branch by a junction at the railway arch. For this line the consent of the Commissioners has yet to be obtained.

Hastings.—An enquiry was held on Tuesday and Wednesday last week into the proposed electric tramways, the Commissioners present being the Earl of Jersey, P.C., G.C.M.G. (chairman), Colonel Boughey, R.E., C.S.I., and Mr. Allen Steward (secretary). There was considerable and, as it proved, successful opposition. The counsel present were: Mr. Vesey Knox, M.P., and Mr. Willis, supporting the application of the promoters of the scheme; Mr. Lewis Coward, for the Hastings Corporation; Mr. J. F. P. Rawlinson, Q.C., who opposed the application on behalf of the United Opposition Committee; Mr. H. C. Richards, M.P., who opposed on behalf of the trustees of the Eversfield Estate; Mr. Hellerd, who opposed on behalf of her Majesty's Office of Woods and Forests; and Mr. Freeman, Q.C., barrister, who opposed on behalf of the London and Brighton Railway Company. Mr. F. A. Langham appeared on behalf of the Bexhill District Council. Mr. Lewis Coward was instructed by the town clerk, Mr. Rawlinson by Mr. F. A. Langham and Mr. W. Carless, J.P., and Mr. Richards by Mr. F. W. Coles. About noon on the second day the Chairman announced that they had come to the conclusion not to grant the application. No doubt there was a majority—though not a very large one—in the Corporation in favour of trams, but, on the other hand, there were very strong objections and the peculiar circumstances of the town to be considered. It was no use going on with the enquiry, as the Commissioners were not prepared to try and force a scheme on the town that was not generally acceptable.

Coventry.—Mr. G. W. Willcocks, M.I.C.E., Local Government Board inspector, held an enquiry on the 14th inst. into the Corporation's application to borrow £33,000 for the purposes of extending the Corporation's electric light undertaking. The Town Clerk (Mr. L. Beard) stated that the electric light was first supplied to the public on Jan. 1, 1896, through two miles of mains, and the outlay on capital was in proportion greater than the plant installed; but the buildings were erected so as to permit of an extended supply. In the first year the working expenses were cleared, then the Corporation had to apply for a further loan of £13,000, of which £4,000 was for mains and extensions, and £9,000 for new generating plant, new mains, and requisite extensions. The plant was increased to 350 kw. power, and $3\frac{1}{2}$ miles of supply mains had been provided. The outlay on capital sanctioned and expended was £33,000. They had 9,600 lamps connected, and applications for 500 more had been received. Hence further extensions were obvious, unless applications for the light were refused, and the success of the undertaking thereby endangered. Several towns had been visited by the Electric Lighting Committee to acquire the latest knowledge, and it was proposed to erect arc lights in several thoroughfares, so that ordinary ratepayers who had not installations at their houses would get some return for their money. The committee would be able to supply accumulators for motors, and erect 30 ornamental posts and 10 brackets for street-lighting. It was on the recommendations of Mr. Hammond, their electrical adviser at the outset of the undertaking, that these extensions were undertaken.

London-Birmingham Telephone.—The Post Office authorities have, says the *Daily Mail*, laid about 40 miles of the large telephone and telegraph trunk line cable which is to extend from London to Birmingham. The laying of this cable is by far the largest piece of work the authorities have undertaken since they had control of the telegraphs. The cable, which is being manufactured by the British Insulated Wire Company at their works at Prescot, has a total diameter of $2\frac{5}{8}$in., and the weight of each mile of cable is about 22 tons. It is made up of 76 separately insulated wires, each mile of which weighs 150lb. The manner in which the cable is constructed is interesting. Each conductor is separately enclosed in a tube of paper, so that it is entirely surrounded with air. The object of this is to get as much air round the conductors as possible without increasing the size of the cable. Air has a lower capacity than any known substance, and low capacity on a cable is equivalent to small absorption of current. This means that speaking is possible over a greater distance than under any other circumstances, and it was not until a cable was invented on this principle that it became possible to speak over any considerable distance by means of underground wires. The ordinary overhead wires are, of course, always surrounded by air, and this is why speaking is possible over such great distances, but long lines and many wires, "cross talk," and the danger of breakage render this system very troublesome and expensive. On the new cable the conductors are made up in pairs, the wires stranded together round one another, and the whole covered with a heavy sheathing of lead. At intervals of five miles pillars are erected, and at these points dry air is to be forced through the spaces into the cables, so that if the lead sheathing should become punctured the presence of the hole will be instantly discovered.

Wolverhampton.—The Lighting Committee's report, which was approved without alteration by the Town Council, states

that they have had under consideration for some time past the question of offering special terms for energy consumed for motor and heating purposes with a view of inducing an increased business in this direction. The committee propose, therefore, after July 1, 1898, to make the following charges for energy used for the above purposes—viz., 2d. per unit on a maximum demand for two hours per day, and 1d. per unit for all energy consumed in excess thereof. These terms are the lowest yet introduced into this country. The price above quoted is for a 50-hour week, 1¼d. per unit, or about 1d. (1·06d.) per brake horse-power hour. The maximum charge for a brake horse-power cannot exceed 1·7d. per hour, assuming the use of a 1-b.h.p. motor for not more than an average of two hours per day. To further facilitate and increase the business of their undertaking, the committee propose to obtain the sanction of the Local Government Board to a loan to enable them to purchase and hire out motors to motive power consumers, and to enable them to provide the initial capital for wiring and fitting up consumers' premises for lighting purposes. With regard to the motors, they would be hired out on the simple hire system, as well as the hire-purchase system, whilst for wiring consumers' premises a charge would be made either by way of annual rent, or by a charge not exceeding 1d. per unit of energy consumed. The charge for lighting is 6d. for the first two hours per day during winter months, and one hour per day during summer, and 3d. per unit for all in excess. A sum of £32,660. 9s. 6d. has been borrowed. The expenditure in the capital account during the year has been £3,162. 2s. 8d., the largest item being £1,042. 4s. 10d for meters, and the next largest £873. 0s. 1d. for mains. The total expenditure to March 31 last had been £41.781. 15s. 8d. The receipts for the same period were £32,660. 9s. 6d. The balance carried to the net revenue account was £2,833. 18s. 9d. Alderman Mander spoke of the reduction of the deficit, and said that by this time next year they would probably be absolutely on the right side. In 1897, 224,709 units were sold, which was an increase of 14 per cent. on the previous year. But this year they had sold 291,233 units, or an increase of 22 per cent. The number of lamps was in 1896, 8,941; in 1897, 11,307, an increase of 21 per cent.; and in 1898, 14,151, an increase of 20 per cent. Their gross profit this year was £2,833. 14s. 9d., or 6¼ per cent., the net profit being 1 per cent.

Kensington.—At a meeting of the Vestry on June 15 permission was given to the House-to-House Electric Light Supply Company to erect a trial arc lamp in Kensington-road, opposite 1, Leonard-place, subject to no part of the expense in connection with the trial being borne by the Vestry. The Surveyor submitted a report as to excavating the sand from the land recently acquired in Wood-lane, and for the laying out and utilisation of such land as a depôt, from which we extract the following: "The committee are aware that since the change in contracting for the removal of house refuse from Chelsea Wharf, when a price per ton was substituted for a price per load, it has not been found advisable and economical to use the furnace on that wharf for burning the light refuse for which purpose it was erected, as it will be apparent that paying (as at present) 1s. 5d. for getting rid of a ton of light refuse is a very different thing to paying (as formerly) 1s. 11d. for the disposal of a load. As the present contract is settled for some years, I would recommend that this furnace be removed and re-erected on the Wood-lane land, where an economical use could be found for it in generating steam for pumping and hauling purposes, and also for lighting the depôt by electricity. With regard to all the future possibilities and uses of this depôt, I think it premature to attempt to deal *en bloc* with them at the present time, but application should be made forthwith to the London and North-Western Railway Company for siding points as shown on plan in order that railway trucks may be run into the depôt as soon as possible. One further suggestion at the present time I would place before the committee—viz., as to taking the view of the Vestry as to erecting works for generating electricity for lighting the north-western part of the parish. True it is that the Notting Hill Electric Light Company took over this district in 1895, with an obligation to lay mains in certain streets within two years, but I am quite certain that it will be a very long while before any company will go in for lighting this relatively poor portion of the parish—even the above-named company has not yet fulfilled its obligations to lay mains in the few specially selected and picked streets in the district. When, moreover, it is borne in mind that no attempt is being made to electrically light the public streets of Kensington—one of the best districts in the Metropolis—I experience, as your surveyor, some feeling of regret that the Vestry did not adopt the advice contained in my report of 1889 (see annual report, p. 25) and go in for their own provisional order, and thus have become pioneers in the movement, much to their present profit. With their past experience to guide them, I think it would be well for the Vestry to consider the question of lighting the lamps in some of the principal streets in the north-west part of the parish by electricity to be generated on the Wood-lane land, and conveyed under the railway into the parish. I have made a rough calculation as to 5¼ miles of the leading streets in the north-west district, and I estimate that the sum of £14,000 would cover the cost of buildings, generating plant, mains, and connections to lamps, and assuming there are 190 lamps in the 5¼ miles of streets, costing £2 per annum per lamp for gas, this would yield £380 per annum, or about 2¾ per cent. interest on the outlay without counting upon any private house supply whatever, although it would be fair to assume some demand would arise for private consumption, especially if some scheme of free wiring was entered upon by the Vestry. This question can be gone into thoroughly whenever the Vestry so desire, but for the moment, in order that the parish may immediately get some profitable return for the money sunk in the purchase of this land, it is imperative that I should forthwith be placed in a proper position for excavating the sand and gravel and filling up with road sweepings, and as over half a million cubic yards will have to be moved, it will be true economy on the part of the Vestry to take a broad view of the work, and employ all proper means in its execution." Notices and plans of the House-to-House Electric Light Supply Company, relative to extensions of their mains, were approved of.

PROVISIONAL PATENTS, 1898.

JUNE 6.

12617. **Improvements in the means or apparatus for controlling and regulating electric motors.** Charles Ashley Carus-Wilson, Hanover Lodge, Kensington Park, London.

12636. **Improvements in electric switches.** John George Dixon, 70, Palace-chambers, Westminster, London. (Complete specification.)

12667. **An improved device for fitting reflectors, shades, globes, or the like to electric incandescent and other lamps.** Curt Bartenstein, 45, Southampton-buildings, Chancery-lane, London.

12670. **Improvements in the production or generation of electrical currents.** Josef Popper, 55, Chancery-lane, London.

12680. **Improvements relating to electric alternating-current cable systems.** Franz Clouth, 166, Fleet-street, London. (Complete specification.)

JUNE 7.

12699. **Improvements in or relating to electric transformers.** John Jacob Bellman and Charles Tomlinson Rittenhouse, 111, Hatton-garden, London. (Complete specification.)

12731. **Improvements relating to electric telegraphs.** Alexander Muirhead, 323, High Holborn, London.

12754. **Improvements in apparatus for the generation and electrolytic application of electric currents.** Francis Edward Elmore, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (John Oliver Surtee Elmore, India.)

12765. **Improvements in or relating to the electrolysis of liquids and apparatus therefor.** William Phillips Thompson, 322, High Holborn, London. (Maurice Hazard-Flamand, France.)

12774. **Improvements in electric railways.** George Frederick Redfern, 4, South-street, Finsbury, London. (Benjamin J. Falk, United States.)

JUNE 8.

12784. **Improvements in electrical rheostats and resistances.** Louis John Steele, 14, Clarendon-road, Holland Park, London.

12815. **Improvements relating to electrical motors.** Robert Cattley Jackson, 3, St. Nicholas-buildings, Newcastle-on-Tyne.

12829. **A new or improved apparatus for electrically signalling on railways.** Robert Muschamp, 33, Chancery-lane, London. (Complete specification.)

12839. **Improvements in electric glow lamp fittings.** Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.)

12840. **Improvements in electric glow lamps.** Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.)

12841. **Improvements in contact rings for electric glow lamps.** Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.)

12855. **An electrical indicating apparatus for automatically denoting the position of ships' and other doors and for like purposes.** George Hill, 171, Queen Victoria-street, London.

12860. **Improvements in telegraphy by means of electric light.** Karl Zickler, 6, Bank-street, Manchester.

12866. **Improvements in electrical circuit controllers.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Nikola Tesla, United States.) (Complete specification)

JUNE 9.

12877. **Improvements in electric arc lamps.** Peter Spies and Samson Roberts, 85, Elliscombe-road, Charlton, Kent.

12890. **Improvements in the method of and means employed for connecting the guard wires of electric cables.** Ralph Bostock and Frank Arthur Cheetham, Penny Bank-chambers, Halifax.

12893. **Improvements in safety devices for electrical circuits.** Louis John Steele, 14, Clarendon-road, Holland Park, London.

12897. **Pliable support for electric incandescence lamps or other light articles.** John Dugaill, Fire House, Failsworth, near Manchester.

12925. An improved device for holding and supporting telephone "receivers," and for automatically operating the switch lever. Alexander Back, 191, Fleet-street, London.

12926. Improvements in or relating to electric arc lamps. Alfred Julius Boult, 111, Hatton-garden, London. (Moriz Baumer, Germany.)

12929. Improvements in or connected with telephones. Frederick William Golby, 36, Chancery-lane, London. Richard Christian Stempel, Germany.)

12968. A new or improved magnetic controlling device. Henry Edmunds, 47, Lincoln's-inn-fields, London.

JUNE 10.

13010. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Richard Fleming, United States.) (Complete specification.)

13011. Improvements in clutches for electric arc lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Henry C. Spinney, United States.) (Complete specification.)

13012. Improvements in caps for enclosed electric arc lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles E. Harthan, United States.) (Complete specification.)

13021. A combined portable manual-power dynamo and accumulator. William John Le Couteur, 104, Wool-exchange, London.

13037. Improvements in electric glow lamps. The Spiral Globe, Limited, and Bertram Charles Edward Parker, 53, Chancery-lane, London.

JUNE 11.

13080. Imp oved signal or alarm for tramcars, yachts, electric launches, and like purposes. Abraham Henry Wormald, Bank-buildings, George-street, Sheffield.

13113. Improvements in connection with holders for incandescent lamps and other articles. Frederic Hughes, 23, Coleman-street, London. (Complete specification.)

13116. Improvements in conductors for incandescent electric lamps. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Carl Auer von Welsbach, Austria.)

13121. Improvements in electrical accumulators. Henry William Cobb, 17, Crunden-road, South Croydon.

13137. A new or improved apparatus or tool-holder for carrying carbons or electrodes for use in electric welding, brazing, and the like purposes. George William de Tunzelmann, 27, Martin's-lane, Cannon-street, London.

13144. Improvements in apparatus for electrically controlling engines, electromotors, and other machinery. William Horatio Harfield, 4, South-street, Finsbury, London.

SPECIFICATIONS PUBLISHED.

1897.

6773. Connections of telephonic and telegraphic instruments to conducting lines. Maiche.

9457. Electrical transformers. Berry.

12443. Electric accumulators. Werner and de Kilduchevsky.

12665. Combined generation and application of electricity supply and the manufacture of salt. Tee.

13236. Electric incandescent lamp. Bolton.

13599. Self-acting mule with electrical driving gear. Bretschneider and Lauth.

14397. Generation and utilisation of hydrogen gas and electricity for motive power, lighting, and heating purposes. Wattles.

15298. Electric arc lamps. Bardon.

15879. Plates for secondary batteries. Barber-Starkey.

16488. Cores for electrical machines. Westinghouse. Date applied for under International Convention, Jan. 20, 1897.

16489. Fastening means for core plates of electrical machines. Nolan. (Date applied for under International Convention, Jan. 20, 1897.)

17540. Electric light fittings. Lea.

18284. Method of making high electrical resistances. Fawcett.

18510. Electrical current distributing fuse and switchboards. Watson.

26102. Process for the production of pliable and elastic bodies by electrolysis. Krüger.

1898.

125. Controlling electric motors and switches therefor. Bowen.

3925. Electric safety fuses and lamp connections. Gover and Moffat.

4398. Electric railways on the sectional conductor systems. Murphy.

6235. Electrical insulators and method of making the same. Boch.

6989. Electrical measuring instruments. Weston.

7566. Systems of electrical distribution. Bliss.

7577. Electrical batteries. Stubblefield.

TRAFFIC RECEIPTS.

Liverpool Overhead Railway.—The traffic receipts for the week ended June 12 were £1,482, as compared with £1,857 in same week of 1897, being a decrease of £375.

Birmingham Tramways.—The traffic receipts for the week ending June 11 were £3,828. 18s. 8d., as compared with £4,281. 18s. 8d. for same week in 1897, being a decrease of £453. 0s. 0d.

Dover Tramways.—The traffic receipts for the week ending June 11 were £157. 4s. 8d. The total receipts for the year 1898 are £2,698. 15s. 9d. The mileage open at present is 3 miles.

Bristol Tramways.—The traffic returns for the week ending June 10 were £2,899. 0s. 1d., compared with £3,365. 1s. 5d. for same period of last year, being a decrease of £466. 1s. 4d.

South Staffordshire Tramways.—The traffic returns for the week ending June 10 were £556. 14s. 7d., as compared with £928. 2s. 6d. in same week of 1897. The aggregate receipts for the year are £13,872. 10s. 1d., as against £14,094. 12s. 5d. in the same period of the previous year.

City and South London Railway.—The returns for the week ended June 12 were £931, compared with £880 for same week of 1897, being an increase of £51. The total receipts for the half year amount to £24,558, compared with £24,215 for the same period last year, being an increase of £343.

Dublin S.D. Tramways.—The traffic receipts for the week ending June 10 were £648. 5s. 3d., as compared with £920. 8s. 0d. in the corresponding week in the previous year, being a decrease of £272. 2s. 9d. The number of passengers carried was 97,778 in 1898 and 123,715 in 1897. The aggregate returns up to date are £10,963. 10s. 1d., as compared with £11,548. 5s. 7d. last year, being a decrease of £584. 15s. 6d. The mileage open is the same as last year—viz., 8 miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	[illegible]
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	15½-15¾
—— 6 p.c. Cm. Pf., 30,001-40,000 (iss. at £2. 10s. pm., all pd.)	4	7-8
Brush Company, Ordinary	2	1¾-2
—— Non. Cum., 6 per cent. Pref.	2	2¼-2½
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	105-108
Callender's Cable Company, Debentures	100	128-133
—— Ordinary	5	10-11
Central London Railway, Ordinary	10	9¾-10¼
—— "	6	5¾-6¼
—— Pref. Half-Shares	1	1⅛-1¼
—— " "	5	4¾-4¾
Charing Cross and Strand	5	12-13
—— 4½ per cent. Cum. Pref.	5	4-4½
Chelsea Electricity Company	5	8-9
—— 4½ per cent. Debentures	100	113-117
City of London, Ordinary	10	26-27
—— Prov. Cert. 90,001-100,000	5	18-19
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	132-134
City and South London Railway, Consolidated Ordinary	100	69-71
—— Ordinary	2	1½-1¾
—— 4 per cent. Debenture Stock	100	126-128
—— 5 per cent. Pref. Shares	10	15-16
—— " " " '96	10	15½-16½
County of London and Brush Provincial Co., Ordinary	10	13-14
—— " " "	4	6½-7½
—— 6 per cent. Cum. Pref.	10	14½-15½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
—— 5 per cent. Debentures	—	90-95
Crystal Palace District, Ordinary 5 per cent. Stock	100	136-139
—— Preference 5 per cent. Stock	100	143-145
Edison and Swan United Ordinary	5	3½-3¾
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	103-105
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	3	3¾-4¼
Electric Construction, Limited	2	2½-3½
—— 7 per cent. Cumulative Pref.	2	3½-3¾
—— 4 per cent. Perp. 1st Mort. Deb.	100	106-108
Elmore's Copper Depositing	1	[illegible]
Elmore's Wire Company	2	[illegible]
W. T. Henley's Telegraph Works, Ordinary	10	21½-22½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-113
House-to-House Company, Ordinary	5	3¾-4¾
—— 7 per cent. Preference	5	10½-11½
India Rubber and Gutta Percha Works	10	21-22
—— 4½ per cent. Debentures	100	103-106
Kensington and Knightsbridge Ordinary	5	15-16
—— 6 per cent. Pref.	5	8-8½
London Electric Supply, Ordinary	5	3½-4½
Metropolitan Electric Supply, Limited, Ordinary	10	12-13
—— 4½ per cent. First Mortgage Debenture Stock	100	117-120
National Telephone, Ordinary	5	5½-6½
—— 6 per cent. Cum. First Pref.	10	16-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	5½-6½
—— 3½ per cent. Deb. Stock, Red.	100	103-106
Notting Hill Company	10	17½-18½
Oriental, Limited, £1 shares	1	1¼-1½
—— £5 Shares	5	7½-8
—— £4½ shares	4	6½-7
Oriental Telephone and Electric Company	1½	4-5
Royal Electrical Company of Montreal	—	143-145
—— 4½ per cent. First Shares Mortgage Debentures	100	100-103
South London Electric Supply, Ordinary	2	2-2½
St. James's and Pall Mall, Limited, Ordinary	5	16-17
—— 7 per cent. Pref.	5	9-10
—— 4 per cent. Deb. Stock, Red.	100	107-110
Telegraph Construction and Maintenance	12	35-36
—— 5 per cent. Bonds	100	103-106
Waterloo and City Railway, Ordinary	100	124-127
Westminster Electric Supply, Ordinary	5	15-16
Yorkshire House-to-House	5	4½-5½

NOTES.

The Regent-street Fire.—The disadvantages of overhead telephone wires are clearly shown by the trouble caused at the recent fire in Regent-street. A great number of circuits were broken, owing to the fall of a structure on the top of the building gutted. Underground wires would not have suffered. We are glad to be able to congratulate the National Telephone Company on the rapidity with which they are carrying out the repairs.

Opening Ceremonies.—The electricity works in England are rapidly on the increase, as witnessed by the numerous invitations to attend opening ceremonies. Thus, to-day we have to be at Morley on the invitation of the chairman of the Electric Light Committee, Mr. Hammond, and the contractors. Next Thursday the Winchester Electric Light and Power Company will open their works, which will entail another pleasant trip to the country.

Americans at the Paris Exposition.—We understand that, as the result of efforts exerted by the special American commission sent to Paris to look over the ground and furnish advice regarding the American display there, the American electrical machinery manufacturers are to have the opportunity to furnish the Paris Exposition with electrical machinery to the value of £200,000. This new contract will be awarded notwithstanding the fact that the United States have not as yet voted any sum for the national exhibit, or even appointed a commission.

Signs of Progress.—In consequence of representations from Mr. Austin, the President of the Board of Trade has promised to make enquiries concerning the alleged overcrowding on the City and South London Electric Railway. At the same time steps will be taken to ascertain whether there is any foundation for the complaint that insufficient means of ingress and exit are provided for passengers at the King William-street and Stockwell stations on the said line. This tends to show the increasing patronage given to this line, and a more frequent service will most likely have to be adopted at certain periods of the day.

An Electric Wedding.—The Americans cannot resist the Barnum influence in their exhibitions. So at the electrical exhibition in New York an electric wedding has been used as a means of advertisement. The unfortunate bride and bridegroom were married for the good of the show (we trust for their own good also) in the Moore Chapel. The vacuum tubes designed by Mr. Macfarlane Moore provided the light; the organ was driven electrically, and phonographs sang the hymns. Electric carriages were, of course, provided for the couple in question. An electric execution should be the next attraction, with a Spanish spy as the victim.

The Committee on the London United Tramway Company's Bill.—On Monday last the Chairman of the committee announced they had decided that the preamble of the Bill was proved with regard to tramways Nos. 6 and 7 (the Boston-road and the Kew Bridge to Hounslow sections), but did not impose upon the promoters any condition as to simultaneous construction. The committee were of opinion that the preamble was not proved with regard to tramway No. 8 (Ealing), and were further of opinion that a sufficient case had not been made out for over-riding the principle laid down by Parliament, requiring the consent of the local authority, and, therefore, Clause 27 (repealing the veto) must come out of the Bill. The committee were strongly of opinion that the congested state of London made the speedy adoption of electric traction on tramways necessary, and they earnestly trusted that arrangements might be made between the London County Council and the promoters by which the benefits of one system or another of electric traction might be secured to the public at the earliest possible date. With the view of enabling the promoters and the London County Council to discuss the matter so far as it related to the lines within the county of London, the consideration of clauses was deferred.

Company Opposition.—The Bill to confirm the electric lighting provisional orders which have been granted by the Board of Trade to the Vestries of Bermondsey and St. Marylebone having been referred to a Select Committee, objection has been taken, on behalf of the Vestries, to the right of the companies to appear before the committee in opposition to the orders being confirmed. The question of the *locus standi* of the companies will therefore be decided by the Court of Referees. The companies who have lodged petitions against this Bill, and whose *locus standi* is now called in question, are the London Electric Supply Corporation, the Marylebone Electric Supply Company, the County of London and Brush Provincial Electric Lighting Company, the Chelsea Electric Supply Company, and the St. James's and Pall Mall Electric Lighting Company.

Canadian Electrical Association.—The following is a list of papers to be read at the convention of the Canadian Electrical Association, to be held at the Windsor Hotel, Montreal, on the 28th, 29th, and 30th inst.: "How to Overcome Some of the Difficulties Encountered by Central-Station Men," A. A. Wright, Renfrew, Ont.; "The Unconscious Ownership of an Important Key" (a plea for the introduction of goods traffic on our suburban tramways), "The Quimby Electric Screw Pump," W. T. Bonner, Montreal; "Experiences of an Inspector," Dr. J. K. Johnstone, inspector of electric light, Toronto; "The Electric Current in the Rainy River Gold Mines," W. W. Hopkins, B.Sc., C.E., etc.; "The Importance of Proper Methods of Illumination," F. A. Bowman, M.A., B.E., New Glasgow, N.S.; "Economics in the Boiler-Room," James Milne, Toronto. P. G. Gossler, Montreal, is also expected to read a paper. The social features include trip around Mount Royal by special Park and Island cars, afterwards ascending incline railway to the look-out point on the mountain to view the city when illuminated; a visit to Bell Telephone Company's new building, and to the Street Railway Company's power-house; the power-house and works of the Lachine Rapids Hydraulic and Land Company will also be visited. On the last day the members will visit the McGill University, the Royal Electric Company's lighting station and factory, and then by special train will visit the works of the Chambly Manufacturing Company at Chambly.

Telegraph Tournament.—The *American Electrician* says the Morse National Telegraph Tournament, which was held at the New York Electrical Exhibition on May 14, was excellently conducted by Mr. Fred Catlin, manager; Mr. T. J. Smith, master of ceremonies; and Mr. A. E. Sink, timer, not a hitch occurring in the programme. The prizes amounted to £270. The championship sending contest was won by Mr. W. M. Gibson, who sent 254 words in five minutes with but one error, Mr. F. L. Catlin winning the second prize on 253½ words with one error. Both these returns break all previous records, which stood at 248 words, or 252 words including a record not generally recognised on account of its imperfect Morse signals. In the code-sending class the first prize was won by Mr. G. W. Coakling (345 words in five minutes), and the second prize by Mr. W. M. Gibson (330 words), the former breaking previous records. In the ladies' sending class Miss J. McManus and Miss Emma R. Vanselow won the prizes, the former on 239 words with eight errors

(superior Morse), and the latter with 241 words and eight errors (good Morse). In the 230-word sending class the prizes were won by Mr. Charles F. Edney (233 words, excellent Morse) and Mr. F. M. McClintic (242 words, good Morse). The prizes in the 240-word class were won by Mr. J. D. Hinnant (252 words) and F. M. McClintic (243 words). Almost 100 contestants participated in the tournament. Phonetic records in duplicate were made in the championship and code classes, which can not only be reproduced at any time in the future but multiplied at will.

Society of Arts.—The council have awarded the society's silver medal to the following readers of papers during the session 1897-98: to Prof. James Douglas, for his paper on the "Progress of Metallurgy and Metal Mining in America during the last Half Century"; to Samuel Rideal, D.Sc., for his paper on "The Purification of Sewage by Bacteria"; to Captain B. F. S. Baden-Powell, for his paper on "Kites: their Theory and Practice"; to Prof. J. A. Ewing, F.R.S., for his paper on "Linde's Method of Producing Extreme Cold and Liquefying Air"; to Prof. Silvanus P. Thompson, F.R.S., for his paper on "Telegraphy across Space"; to Miss Clive-Bayley, for her paper on "The Revival of Hand-Loom Weaving"; to J. K. Starley, for his paper on "The Evolution of the Cycle"; to Herbert Mills Birdwood, C.S.I., M.A., LL.D., for his paper on "The Plague in Bombay"; to Henry Luttman-Johnson, I.C.S., for his paper on "The Earthquake in Assam"; to Sir Alfred Comyns Lyall, G.C.I.E., K.C.B., D.C.L., for his paper on "Chartered Companies and Colonisation"; to Nevile Lubbock, for his paper on "The West Indies and Sugar Bounties"; to J. Hungerford Pollen, for his paper on "Renaissance Woodwork in England"; and to Sir E. Maunde Thompson, K.C.B., for his paper on "English Art in Illuminated MSS." The thanks of the council were also voted to the following members of the council: to R. Brudenell Carter, F.R.C.S., for his paper on "Children's Sight"; to Captain W. de W. Abney, C.B., F.R.S., for his paper on "Photography and Colour Printing"; and to Lewis Foreman Day, for his paper on "The Making of a Stained-Glass Window."

Electroid Gas.—We get from a West Coast local paper the following details of the new "electroid" gas as installed on a pier at a seaside health resort. We are told that "the trade name of electroid gas has been adopted because the light hold a middle place between the electric arc light and the incandescent system. In colour it differs alike from the bluish cast of the former and the yellowish hue of the latter, being a pure white. It is claimed for electroid gas that it is a perfectly steady light, exceedingly brilliant, and of great diffusive powers. One of the great features of this system is the almost infinite number of purposes to which it is readily applicable. The apparatus, which is very small and easily movable, is just the thing for shooting boxes, fairs, galas, and out-of-the-way hamlets and villages. It is all this, and something more. Larger districts and towns can be supplied with electroid gas at the shortest notice either from a larger apparatus or from a number of smaller ones. On the West-End Pier the lights from 150 lamps have been kept going by the aid of a mechanism small enough to be contained in one of the kiosks at the side of the pier deck. A special feature of the new gas is the simplicity of the mode of production. The generation of the gas is purely automatic, even the larger sizes requiring merely half-an-hour's attention a day for charging and drawing off the waste, both of which operations may be done without so much as soiling the hands." Reading between the lines we have little hesitation in saying that the West-End Pier in question is lighted by acetylene gas, and that the enterprising inventors of the electroid gas have invented nothing but the name. Still, if they can get paid for the use of the name, so much the better for them. The disadvantages of acetylene are kept well in the background.

The Working of the Light Railways Act.—In the House of Commons last week Mr. Hazell asked the President of the Board of Trade whether the Board was favourably considering and approving the orders of the Light Railway Commissioners for the construction of tramways in purely urban districts under the Light Railways Act of 1896, which was intended for the relief of agricultural districts; whether the fact had been considered that the powers of purchase by local authorities under this Act were not nearly so favourable to the public as the powers of purchase under the Tramways Act of 1870; whether, in particular, his attention had been called to a scheme promoted by the Metropolitan Tramways and Omnibus Company, Limited, for the construction of electric tramways in the purely urban districts of North London, and in connection with the North Metropolitan tramway system under the Light Railways Act of 1896; and whether the Light Railways Commissioners proposed to sanction such a scheme. Mr. Ritchie, in reply, said that there was nothing in the Act to prevent consideration by the Board of Trade of light railway schemes for urban districts, and that the Light Railway Commission had ample authority in deciding as to powers of purchase. The Commission had the particular scheme referred to under consideration; but he was not in a position to say what steps they proposed to take. We are glad to see by the above answer that the powers of the Light Railway Commissioners are not to be restricted. In tramway questions the cry against monopolies has done a vast amount of harm, as many municipal bodies evidently by their action consider no tramway facilities should be granted in their districts. They starve the existing lines by the enforcement of the Tramway Act, and take no steps themselves to provide travelling facilities for the people. We should like to see the Quaker's advice to his son paraphrased as follows, and drummed into the heads of our county and town councils: "Get electric trams, municipally owned if you can, but by all means get them."

English Tramways.—Mr. E. F. Vesey Knox, M.P., has contributed a series of articles to the *Daily Mail* on what he calls the national calamity of our deficiencies in electric tramway work. As regards London, he says that at present the position is this: The County Council (1) will not allow any existing company to make any extensions; (2) will not allow any existing line to be electrically equipped; (3) will not allow any new companies to make lines either under the Tramway Act or the Light Railway Act; and (4) cannot make any new lines for itself, for it finds itself everywhere blocked by the opposition of the local authorities. The local authorities are actuated by precisely the same feelings which actuate the two parties on the Council. The Moderate vestrymen think the roads would be much nicer to drive on if there were no tramways at all. The Progressive vestrymen have heard so much about the vast profits which tramway undertakings may yield to the rates that they will not "give up their roads" to anyone without the vestry being well paid for it. London is, he says, only an extreme case. The same sort of opposition is met everywhere. The Progressives are mainly anxious to keep the streets free from "monopolists." They forget that the main object of roads is as means of communication; that the electric car is the cheapest and quickest means of communication; that unless electric lines are laid, the only people who can get quick communication by the roads are those who can afford cabs or carriages.

This is correct in the main, but when Mr. Vesey Knox pointed out our manufacturers' faults, he got into trouble through want of knowledge, as a correspondent shows in correction of the statement that the equipment for the Waterloo and City Railway is coming from America. The boilers were manufactured at Colchester, the engines at Birmingham, and the dynamos, motors, and switch-gear at Woolwich, the only part of the equipment coming from America being the cars. He also calls attention to the fact that the City and South London Railway, the Liverpool Overhead Railway, the Douglas and Laxey Railway, the Snaefell Mountain Railway, the Stockholm and Djursholm Railway, and the Blackpool and Fleetwood Tramway were all equipped with English plant.

Royal Meteorological Society.— The monthly meeting of this society was held on Wednesday afternoon, the 15th inst., at the rooms of the Royal Astronomical Society, Burlington House, Mr. F. C. Bayard, LL.M., president, in the chair. A paper by Mr. R. C. Mossman, F.R.S.E., was read on the "Frequency of Non-Instrumental Meteorological Phenomena in London with Different Winds from 1763-1897." In previous papers the author has discussed the secular and seasonal variation of various phenomena, and he now gives the results of an analysis of the direction of the surface winds observed during the occurrence of snow, hail, gales, thunderstorms, lightning, fog, and aurora. Snow is of most frequent occurrence with north and east winds, and least common with south-west winds. Hail showers occur most often with west, north-west, and north winds. Gales are most frequent with west and south winds. The greatest number of both summer and winter thunderstorms occurs with west winds, although the values in summer are high with east, south-east, and west winds. The greatest number of fogs are recorded on calm days, closely followed by days on which the wind blew from the east. A paper by Mr. A. L. Rotch was also read on "The Exploration of the Free Air by Means of Kites at Blue Hill Observatory, Mass., U.S.A." After giving a brief account of the use of kites for scientific purposes from 1749 to the present time, the author described the various forms of kites which have been employed at Blue Hill Observatory—viz., the Eddy or Malay tailless kite; the Hargrave cellular or box kite; and the Lamson ærocurve kite. The highest flight was on Oct. 15, 1897, when by means of four kites having a combined lifting surface of 150 square feet, the meteorograph at the end of 20,100ft. of wire was raised vertically 11,080ft. above the hill. About 200 records from kites have been obtained in the free air at heights from 100ft. to 11,000ft. in all kinds of weather. Mr. Rotch maintains that the kite can be made of the greatest importance for meteorological investigation. At the recent meeting of the International Aeronautical Committee at Strassburg it was recommended that all central observatories should employ kites as being of prime importance for the advancement of meteorological knowledge.

New Gases.—A further communication of great interest, says the *Times*, on the occurrence of hitherto unsuspected elements in the atmosphere was made to the Royal Society on Thursday last week by Prof. Ramsay and Mr. Travers. Since the discovery of argon it has always been a question whether the gas isolated by Lord Rayleigh and Prof. Ramsay was in reality a single uniform substance, a point which was very difficult to settle owing to the impossibility of applying any ordinary chemical test. Moreover, as the molecular weight of helium—which shares with argon the peculiarity of being an entirely inert element—is four, whilst that of argon is almost 40, it appeared probable that an element of intermediate molecular weight remained to be discovered. Prof. Ramsay and Mr. Travers have therefore prepared a large quantity of "argon" from atmospheric nitrogen, separating this latter gas by means of magnesium, and having liquefied it by cooling with liquid air, they have then fractionally distilled the product. The first portion, consisting of less than 100 cubic centimetres, distilled off from the liquid obtained by condensing 18 litres of argon, was found to have a density of about 13 instead of 20, which is that of argon; and its spectrum differed from that of the known gases, a yellow line, less refrangible than those characteristic of helium and crypton, being especially prominent. On continuing the distillation, after nearly the whole of the liquid argon had evaporated, a solid was obtained, which only slowly volatilised. The gas into which this solid was converted was found to be of practically the same density as argon, but its spectrum was altogether different and peculiar, consisting for the most part of bands, not of lines. It is proposed to call the lighter element Neon, and that derived from the solid Metargon. These observations, as well as those on crypton communicated to the society last week, must obviously be regarded as but indications of the presence in various minute proportions of a variety of new substances, probably all elements, in the atmosphere. Further development of the investigations will be awaited with interest. The success which has thus far been obtained is striking proof of the great value of the new engine of research which liquid air affords, especially as diffusion experiments had failed to afford any evidence of the presence of such substances in our air.

Trial of Motor-Vans. — The Royal Agricultural Society has been holding at Birmingham trials of heavy motor-driven vehicles over heavy roads, details of which we extract from the *Times*: Due to a series of accidents, the only competitor left in the one-ton class was the covered van sent by the Daimler Motor Company. This vehicle did extremely well. It is propelled by a Daimler motor, and light oil or petrole is used. There are four speeds of driving. The engine runs at 700 revolutions a minute, and as the driving wheels, which have rubber tyres, are 3ft. 3in. in diameter, the engine is naturally geared down even at the highest speeds. The engine is on the Otto cycle. The van is very neat in appearance and well adapted for carrying light goods. Turning to the three-ton class, the Steam Carriage and Wagon Company's vehicle is the same as was entered, though at a lighter load, for the recent Liverpool trials. It is a four-wheeled open lorry, with a driving cab in front. It is steam-propelled, having an ordinary two-cylinder compound engine and a coal-fired water-tube boiler of the Thornycroft type. No provision is made for change of speed. The Leyland van is also steam-driven, having a pair of vertical inverted engines and a vertical fire-tube boiler, which is fired by liquid fuel. It has three changes of speed, driving first by spur gearing and then by chain-gear on to the road wheels. On the first day—Monday (the 13th inst.)—a short run of about 13½ miles was successfully made by the Daimler, Leyland, and Chiswick vans. On Tuesday the crucial trial took place over an approximately 50-mile course through a very hilly country. The results of the trials were encouraging. The Daimler van took its load of one ton over the stiff Warwickshire hills without mishap or hindrance throughout the day and at high speed. Could the pungent vapour from the exhaust be done away with, there would be no objection to the use of such vehicles on public roads. The Leyland van—the same which broke down through wheel troubles at the Liverpool trials—also carried its load well, mounting the steep hill out of Atherstone, which we estimated at 1 in 12 in parts, without a check. The Chiswick van was not

quite so successful at this point, and was some time before it reached the summit. Later on it was stopped when mounting another steep hill. This vehicle was overloaded for the exceptionally trying roads. The trials were under the direction of Mr. F. S. Courtney, the consulting engineer to the Royal Agricultural Society. Prof. Unwin, Mr. Bryan Donkin, and Mr. F. W. Webb were the judges. Their report will be issued shortly.

The Telephone Enquiry.—Sir James Fergusson's evidence before the Select Committee last week was most pertinent on the vexed question as to what the Government promised in 1892. It will be remembered that the Bill authorising the Government to take over the trunk wires from the National Telephone Company was signed by Sir James Fergusson the very day the Government resigned office. Sir James explained that this Bill was sent to a Select Committee, under the chairmanship of Mr. Shaw-Lefevre, and was subsequently passed into law. The details given by previous witnesses as to the agreement entered into between the Post Office and the National Company, by which this Bill was given effect to, were, in the main, correct. The Chancellor of the Exchequer was fully aware of the terms of this agreement, and had even discussed it with the chairman of the company. It was not correct to say that he had signed the document without due consideration, as he had explained the details of the agreement in a speech he delivered in the House of Commons on March 22, 1892. The Chairman of the Select Committee pointed out that the heads of the agreement were only signed on the day the Government quitted office, and asked whether they were fully known to the Government. Witness, in reply, said that his honour was at stake in the matter, but he could assure the committee that nothing was signed and nothing was said which had not been fully considered and publicly announced months previously. The suggestion that he had entered into a secret understanding with Mr. Forbes, who represented the company on this occasion, was absolutely incorrect. All he had done was to state that no doubt the Post Office would be disposed to favourably consider any application the company might make for the enlargement of the telephonic areas. He made no definite promise, and left the matter entirely in the hands of the postal authorities for the time being. The Chairman said that he was very anxious to clear up this matter. Up to the present the Post Office had evidently felt bound by Sir James Fergusson's promise, and had very materially altered the telephone areas as fixed in 1892. He wished to make quite certain that the verbal assurance did not go any further than he had said. Sir James Fergusson, in reply, assured the committee that the spirit of his promise went no further, but the letter of it might have done so. He believed his exact words were, "You may be quite sure the Post Office will come to reasonable terms about the areas." There was no record of this assurance, and, therefore, future Postmaster-Generals would not be able to consult it before deciding on an application of the company. But, as a matter of fact, the policy of one Government was, in the departments, always adopted by the next. He did not remember whether the Chancellor of the Exchequer was aware of this verbal assurance or not. It was with the idea in his mind that the Post Office would probably take over the telephone service that he had signed the 1892 agreement. At no time during the negotiations with the company had any promise, verbal or otherwise, been given that competition should be discouraged. Pressed on this point by Mr. Bartley, he said that he would not be quite sure, but that was his impression. Certainly he had said nothing which would cause any subsequent Postmaster-General to commit a breach of faith by granting licenses or permitting additional telephone services. He had, he remembered, discussed the matter with Mr. Forbes, who asked for an assurance that competition should be discouraged, but he had told him that it was quite impossible to enter into any such undertaking, as neither the Government nor the House of Commons would ever consider such a proposal for a moment.

The Conversazione.—The largest gathering on record of members and associates of the Institution of Electrical Engineers took place last Thursday week at the Natural History Museum. The pleasure of seeing fellow-members had become somewhat dulled by the frequent business meetings held during the past two months, but on this occasion the attraction was the presence of the ladies. Those who were unfortunate enough not to have a lady to bring consoled themselves by getting introductions from those who had escorts. These unattached atoms were, however, spared the herculean task of getting refreshments for the fair ones. This task towards the end of the evening became an impossibility, and the lack of suitable catering and waiting was the only hitch in the otherwise perfect arrangements. The large entrance hall and the stairs and corridors alone made most pleasant promenades, and in spite of the numbers no part was unpleasantly crowded. Amongst those present we saw the following noted personages: Mr. J. W. Swan, F.R.S. (president), Prof. W. G. Adams, F.R.S., Mr. G. L. Addenbrooke, Mr. J. F. Albright, Mr. L. Andrews, Prof. W. E. Ayrton, F.R.S., Sir B. Baker, K.C.M.G., F.R.S., Mr. Shelford Bidwell, F.R.S., Sir A. R. Binnie, Mr. M. Blumbach, Mr. S. L. Brunton, Prof. Capper, Prof. C. A. Carus-Wilson, His Excellency the Chinese Minister, Mr. Latimer Clark, F.R.S., Mr. Dugald Clerk, Prof. F. Clowes, F.R.S., Mr. S. Cowper Coles, Captain E. W. Creak, R.N., F.R.S., Mr. R. E. Crompton, Sir William Crookes, F.R.S., Sir A. Durston, K.C.B., Mr. H. Edmunds, Prof. Egaroff, Mr. S. Evershed, Mr. C. E. Fagan, Mr. W. P. J. Fawcus, General Festing, C.B., F.R.S., Prof. G. F. Fitzgerald, F.R.S., Sir W. H. Flower, K.C.B., F.R.S., Prof. George Forbes, F.R.S., Prof. G. Carey Foster, F.R.S., Sir E. Frankland, K.C.B., F.R.S., Mr. E. Garcke, Dr. W. Garnett, Dr. J. H. Gladstone, F.R.S., Mr. W. T. Goolden, M. Gyeorguiewsky, Prof. F. L. V. Harcourt, F.R.S., General Sir R. Harrison, K.C.B. (inspector-general of fortifications), Admiral Lord John Hay, Prof. O. Henrici, F.R.S., Dr. E. Hopkinson, Prof. W. H. Hudson, Prof. D. E. Hughes, F.R.S., Mr. Holman Hunt, Lord Kelvin, G.C.V.O., F.R.S., Prof. A. B. W. Kennedy, F.R.S., Lord Loch, G.C.B., Sir Philip Magnus, Mr. W. G. McMillan (secretary), Sir Henry Mance, C.I.E., Major-General J. Mann, R.E., Master of the Saddlers' Company, Master of the Salters' Company, Mr. H. S. Maxim, Mr. H. W. Miller, Sir S. Montague, Mr. W. M. Mordey, Mr. S. Morse, Mr. Kenric B. Murray, Sir Hugh Owen, K.C.B., Major Flood Page, Sir W. Peace, K.C.M.G., Dr. W. H. Perkin, F.R.S., Prof. J. Perry, F.R.S., Mr. J. Denison Pender, Mr. W. H. Preece, C.B., F.R.S. (president Institution of Civil Engineers), Sir A. Ramsay, Dr. W. Ramsay, F.R.S., Mr. J. S. Raworth, the Rev. A. Robertson, Sir E. M. Shaw, K.C.B., Mr. Dane Sinclair, Prof. R. H. Smith, Madame Antoinette Sterling, Mr. James Swinburne, Mr. Cameron Swan, Sir D. Tennant, Prof. S. P. Thompson, F.R.S., Dr. T. E. Thorpe, the Rev. Dr. Wace, Prof. R. M. Walmesley, Mr. F. H. Webb, General C. E. Webber, C.B., Mr. R. W. Weekes, Mr. Henry Wilde, F.R.S. (hon. member), Sir E. L. Williams, Mr. J. Wimshurst, F.R.S., Mr. Edward Woods, Sir H. Trueman Wood, Mr. C. H. Wordingham.

THE WAKEFIELD ELECTRICITY WORKS.

The city of Wakefield is the latest recruit to the ranks of the 69 municipal authorities who already control their own electric light works, and we here offer our hearty congratulations to its citizens.

The ceremony of opening the works, at which we were present through the invitation of the chairman of the Electric Lighting Committee (Councillor Wigham) and the

MR. A. W. STANFIELD, MAYOR OF WAKEFIELD.

consulting engineer of the works (Mr. Robert Hammond, M.I.E.E.), took place on the Wednesday of last week, and a very interesting function it proved to be. The proceedings were timed for four o'clock, but we arrived at Calder Vale, where the electricity works are situated, before that hour, and took the opportunity afforded us to make a tour of inspection of the works under the guidance of Mr. J. K. Brydges, the resident electrical engineer. Order and cleanliness prevailed on every hand as befitted the occasion, and by the time our inspection was completed a goodly

MR. F. H. WIGHAM, RESIDENT ENGINEER.

number of guests were present, and the contractor's representatives were having a busy time of it initiating the lay mind into the mysteries of the working of their plant. So also was Mr. Hammond, who had his coat off to it, conspicuous in immaculate white shirt and with finger in waistcoat, gliding here, there, and everywhere with critical eye, having everything put to rights in anticipation of what was to follow.

The hour for the ceremony was now at hand, and when the members of the Corporation and invited guests who had strayed into the various rooms of the works for the purpose of a preliminary inspection had been gathered together, Mr. Hammond, in accordance with the programme, proceeded to explain in detail the why and the wherefore of the plant in the works to the assembly, beginning at the boiler-house and ending in the engine-room. He went about his task in a manner such as only one who has been responsible for the carrying out of the works can do, his remarks being occasionally tinged with a humour highly entertaining, as with pardonable pride he

MR. C. J. HUDSON, TOWN CLERK, WAKEFIELD.

touched upon the uses of one interesting piece of mechanism or another in connection with the undertaking.

It was now the turn of Councillor Wigham to engage the attention of the assembly, and all were quickly gathered around the crimson-covered daïs, upon which the Mayor and the other elected speakers had taken their stand. Councillor Wigham began by explaining step by step the events which had led up to the completion of the electric lighting scheme. He went on to say that in November, 1893, a committee was appointed to take steps to obtain a provisional order

MR. ROBERT HAMMOND, CONSULTING ENGINEER TO THE WAKEFIELD CORPORATION.

but nothing of any great moment was done until in 1895 a deputation went round to different parts of the kingdom inspecting electric light works, and the Council were ultimately recommended to adopt the electric light. Mr. Hammond, consulting engineer, was next called upon to advise the Corporation as to the most suitable means of carrying out the undertaking. A Local Government Board enquiry was subsequently held, and sanction for the borrowing of £25,000 was given in March, 1896. After alluding to the difficulty experienced in the sinking

of the chimney shaft, the speaker said that it was in October, 1897, that Alderman Sherwood, the then chairman of the Electric Lighting Committee, had the satisfaction of going to the top of the chimney and laying the last brick—a remark which was received with much merriment. A dispute with the engineer was responsible for the delay of nearly 12 months, but now, when they looked around them and saw matters so far advanced, and took into consideration the trials they had had to go through, he thought that Messrs. Fowler, the contractors for the engines and alternators, had done well. Having paid a tribute to that firm for the efficiency of the engines, he called upon the Mayor (A. W. Stanfield, Esq.), who during the past year had been the chief magistrate of Wakefield, on another auspicious occasion—viz., the celebration of the jubilee of the city—and congratulated him upon having the privilege of opening such an undertaking in the same year as the city's jubilee was celebrated.

The MAYOR, in declaring the works formally open for the regular supply of electricity to the city, expressed the pleasure it gave him to be present and witness the completion of the lighting labours of the Corporation to establish the electric light for the city of Wakefield. He ventured to think that the committee and all concerned were amply repaid that day for their exertions, and this was an occasion upon which they might all congratulate themselves, because from that day they had the privilege of taking into their houses one of the marvels of modern science—the electric light. He thought the Corporation in adopting the electric light had taken a step in the right direction, and he could not speak in terms of too strong recommendation of such light, and urged them to take the electric light into their houses at once, especially into the rooms in which they lived. His Worship then declared the works open amid loud applause, and the engines were set in motion at his command.

A hearty vote of thanks having been accorded to the Mayor for performing the opening ceremony, on the motion of Councillor WIGHAM, seconded by Councillor FALLAS (the deputy-chairman of the Electric Lighting Committee), the assembly were invited by the contractors to partake of light refreshment in a room adjoining the engine-room. It was a sultry day, and one may be sure the invitation was very welcome and obeyed with alacrity, and the forethought of the contractors was highly appreciated, as indicated by the manner in which the sandwiches, etc., disappeared. Everybody now took the opportunity to become acquainted with everybody else, and, after the inner man had been refreshed, the toast list in the order given in the programme was gone through, the chairman of the committee, of course, acting as chairman in this instance.

Mr. H. WHITE (president of the Wakefield Tradesmen's Association), in proposing the toast of the day, "Success to the Undertaking," thanked Councillor Wigham and the committee, on behalf of the association, for kindly inviting him to be present, and the association appreciated the invitation because they felt that the Corporation realised that their work and interests were identical, and the association, like the Corporation, believed in the promotion of anything conducive to the welfare of the city. The committee had just reason to feel pleased that their work had been completed. The city of Wakefield had long needed reformation in lighting, and the electric light was a long-felt want. He felt sure that if the Corporation could only see their way to reduce the price, the number of consumers would be increased. At Bradford the lamps were supplied gratis, and at Blackpool the meter rents were abolished. Many times it had been suggested that the Wakefield people should approach the gas company and ask them to reduce the rents of the meters. He hoped that Wakefield would not be behind other corporations in making concessions. He had great pleasure in submitting the toast (with which he coupled the name of Councillor Wigham), and hoped the electric light would have a successful future. The toast was heartily drunk.

Councillor WIGHAM, in rising to respond, was greeted with hearty applause. He remarked, with regard to the price—viz., 6d. per unit—that he did not think that for a beginning was at all unreasonable. He did not think there was a tradesman in that room who was in the habit of getting discount who would say that he could not get it from the Corporation if he only took a sufficient supply to justify that discount. The Corporation, he felt sure, would do anything they could to make the scheme a conspicuous success. The Corporation desired to do the best for the public generally, and there was not the slightest doubt that if the demand justified a decrease of the price they would decrease it immediately.

Councillor FALLAS, in giving "The Consulting Engineer and the Contractors," remarked that as regarded Mr. Hammond personally—well, they had seen him, and that was a great thing, and, further, they had heard him. They were quite satisfied in their own minds that they had the right man in the right place. They were all indebted to him for the good way in which he had served them from the beginning of the work to the completion of it. Alluding to the contractors, they had acted justly with the contracts, and had met the committee in every way they could. He felt sure they had had the best men that could be found. They had done their work in a creditable manner, and to the entire satisfaction of the Electric Lighting Committee.

Mr. HAMMOND, responding to the toast, thanked them for the hearty manner in which the toast had been honoured, and went on to say that out of the 45 works in course of construction in this country 40 were in the hands of local authorities, and only five belonged to companies, while out of 13 millions at present invested in this particular line of business seven millions were in companies, particularly the big London ones, while the remainder was controlled by local authorities. The price per unit could not possibly be low at the commencement of new works, inasmuch as the demand was not known. The price was regulated by the number of consumers.

Mr. W. DANIEL responded on behalf of Messrs. Fowler, Mr. SHEARD for Messrs. Spurr-Inman, and Mr. KEEP for Messrs. Manlove, Alliott, and Co.

Mr. J. L. LEE having made a few well-chosen remarks, the proceedings, which had been most enjoyable throughout, terminated.

Coming now to the works themselves, the Wakefield electric lighting provisional order was granted in the year 1894, and soon afterwards the Corporation appointed Mr. Robert Hammond, M.I.E.E., of Westminster, to act as their consulting electrical engineer, and their powers were carried into effect soon after Mr. Hammond's favourable report upon the prospects of electricity supply in the city. In the year 1895 the contracts for the works were placed in the hands of Messrs. John Fowler and Co., Limited, of Leeds, for the boilers, engines, alternators, and switch-gear; the British Insulated Wire Company, of Prescot, for the underground mains; the Brush Electrical Engineering Company, Limited, for the arc lamps; the Westinghouse Electric Company, Limited, of London, for the meters; and Mr. Thomas Smith, of Rodley, for the travelling crane.

BUILDINGS.

The works are situated at Calder Vale adjoining the railway. The buildings, which include, in addition to those of the electricity works, an engine-house for the sewage works and refuse destructor, were designed by the city surveyor, Mr. Richard Porter. In February, 1896, trial holes were made on the proposed site for the foundations both of the walls for the engine-house and for the chimney, which serves for the boilers of the electricity works and the refuse destructor and the sewage pumps. Considerable difficulty was experienced in the excavation of the foundations of the chimney, which are 33ft. by 33ft. and 35ft. deep. An enormous quantity of water had to be pumped in order to keep the foundations dry, and although the digging was commenced in August, 1896, the blue shale, on which the foundations rest, was not reached until five months afterwards, on Jan. 15, 1897. Mr. Alderman Sherwood, the then chairman of the Electric Lighting Committee, inserted the last brick on the top of the chimney on Oct. 19, 1897. The buildings in the meantime were proceeded with. The accompanying view (Fig. 1) shows the substantial, though plain, nature of the structure. The whole of the engine-house is lined inside with glazed bricks, and a dado 4ft. 6in. high in two shades, of brown with a moulded projecting course surmounting it;

above this and to the roof the walls are faced with cream-coloured glazed bricks, pilasters are provided at regular intervals to support the travelling crane beam rail, under which there are four courses corbelled out, forming a series of bays. The ends of the engine-house have at present temporary wood ends, in order that any extensions may be made in both directions, and it may be here mentioned that tenders are now obtained for the extension of the east end for the purpose of erecting the engine-house for the sewage pumps, and these buildings will very shortly be commenced. The engine-house is 85ft. long and 42ft. wide, and has a clear space from the floor to the tie-rod of the roof of 30ft. The boiler-house is on the north side of the engine-house, being 77ft. long and 51ft. wide, with an outbuilding 21ft. by 11ft. for the feed pump and stoker engine. The boiler-house has room for four boilers (two are already fixed) and economiser apparatus. To the south of the engine-house there are the well-lighted offices, which will be used for the several departments, and also for the Electric Lighting Committee when they visit the station. The test-room, which is 16ft. by 18ft., adjoins the office, is entered from the engine-house, and is to be used for the testing of cables and adjusting meters, etc. The switch-room extends over the office and test-room on the first floor, a balcony 30ft. long, fitted up with a balcony, affording a complete view of the engines and machinery by the engineer in charge. The water for condensing purposes has been brought by means of pipes from the River Calder, 700 yards away, at a capital cost of £2,400. The Corporation have also laid (included in this cost) another set of pipes from the works to the river, in order to return the condensed water; a portion of this water is used for the feed water for the boiler. When the engines are working in full, the Corporation will thereby save £190 per annum by using this water instead of taking it from the public mains.

FIG. 1.—General View of the Electricity Works and Refuse Destructor, Wakefield.

Refuse Destructor.

The tender of Messrs. Manlove, Alliott, and Co., Nottingham, was in July, 1896, accepted for the construction and erection of a four-cell refuse destructor, house, and two Babcock and Wilcox boilers. The construction was commenced on July 20, 1897, and was completed in February of this year. It has for some time been working in a temporary manner, but it has now been put in full working order, and will supply steam at the required pressure to work the engines of the electricity plant as far as possible. Mr. Keep, representing Messrs. Manlove and Alliott, of Nottingham, explained at the opening ceremony that with the refuse alone, without an atom of coal, steam of 120lb. pressure could be raised and kept up, each boiler being 90 h p., so that they could develop between 100 h.p. and 200 h.p. by refuse alone. The refuse was carried into the furnaces by iron carriages without further handling. One man could charge the four cells inside of five minutes. The clinker fell through into the bottom, whence, after parting with its heat, it was withdrawn. The rubbish was not sorted, everything such as pots and pans and broken crockery being tipped into the furnaces and destroyed, and that without creating any nuisance.

Boiler-House.

The boiler-house at present contains two Lancashire boilers, 30ft. long, built up in six shell plates ¾in. thick, and a diameter of 8ft., manufactured by Messrs. Spurr, Inman, and Co., of Wakefield. Each boiler is capable of evaporating 7,000lb. of water per hour when working at 125lb. per square inch, with the feed water at a temperature of 60deg. They are constructed to work up to 140lb. per square inch if necessary. Each boiler has two flues, and is fitted with McNeil's patent manhole. The boiler fittings are of Hopkinson's make. The boilers are fitted with mechanical stokers by Bennis and Co. Two Worthington feed pumps are in use, each capable of pumping 30 gallons per minute at a piston speed of 50ft. per minute. Messrs. Holden and Brooke have supplied the injector, which is designed to work against the maximum pressure of 140lb. per square inch, and is capable of lifting and delivering 1,500 gallons per hour at 125lb. pressure. The economiser is by Messrs. Green and Son, and is able to deal continuously with 2,000lb. of water per hour. The boiler-house is provided with the necessary steel barrows and weighing machines.

Engine-House.

The principal feature here is, of course, the slow-speed flywheel steam alternators. Under the contract the plant to be erected will comprise three sets of steam alternators of 130 kw. each = 390 kw., and one set of day-load plant = 34 kw., or a total capacity of 424 kw. At present, two sets of steam alternators are in operation together with the day-load plant, while the third steam alternator is at present going through the maker's shops. The engines (Fig. 2) of the large plants are horizontal com-

pound type, capable of working condensing or non-condensing, the alternator being fixed on the crankshaft, and running at a speed of 112 revolutions per minute. Working condensing, they give a maximum output of 130 kw., with a pressure in the steam chest of 125lb. They are fitted with governors which have proved to be very efficient in ensuring steady running and paralleling, and under the specification the variation of speed when the load is suddenly switched on or off should not exceed 5 per cent., and from no load to full load—*i.e.* 2½ per cent.—up and down from the mean. The type of governor which Messrs. Fowler have employed is that of their latest design—viz., the "Marshall" vertical governor—driven by chain band, by means of which a variation as low as 1 per cent. up and down from the mean can be obtained. The automatic gear fitted on both cylinders is quick and simple in its action, and takes little power, the movement being limited to the raising and lowering of a die in a link. The pistons are of an improved type recently invented by one of the itself, so that the clearance is reduced to the smallest possible dimensions; with this is combined the latest form of cut-off gear, with separate steam and exhaust valves, the movement secured by the arrangement being exceedingly small and very rapid, and, therefore, allowing of application to high speeds. The valves are arranged in the following manner: The steam is controlled by the expansion valve working on the back of the main valve. This main valve is driven from a wrist plate connected to the side of the cylinder. This also drives the exhaust, as in the ordinary Corliss practice. The expansion valve is driven from a double-curved slotted wrist plate on the opposite side of the cylinder, the travel of the valve being varied by the raising or lowering of the die in the curved slot as controlled by the governor. The wrist plate takes its movement from the eccentric, to which it is coupled direct. One jet condenser and air-pump is arranged for each engine, the pump being fixed below the floor and worked off an extension of the low-pressure piston rod.

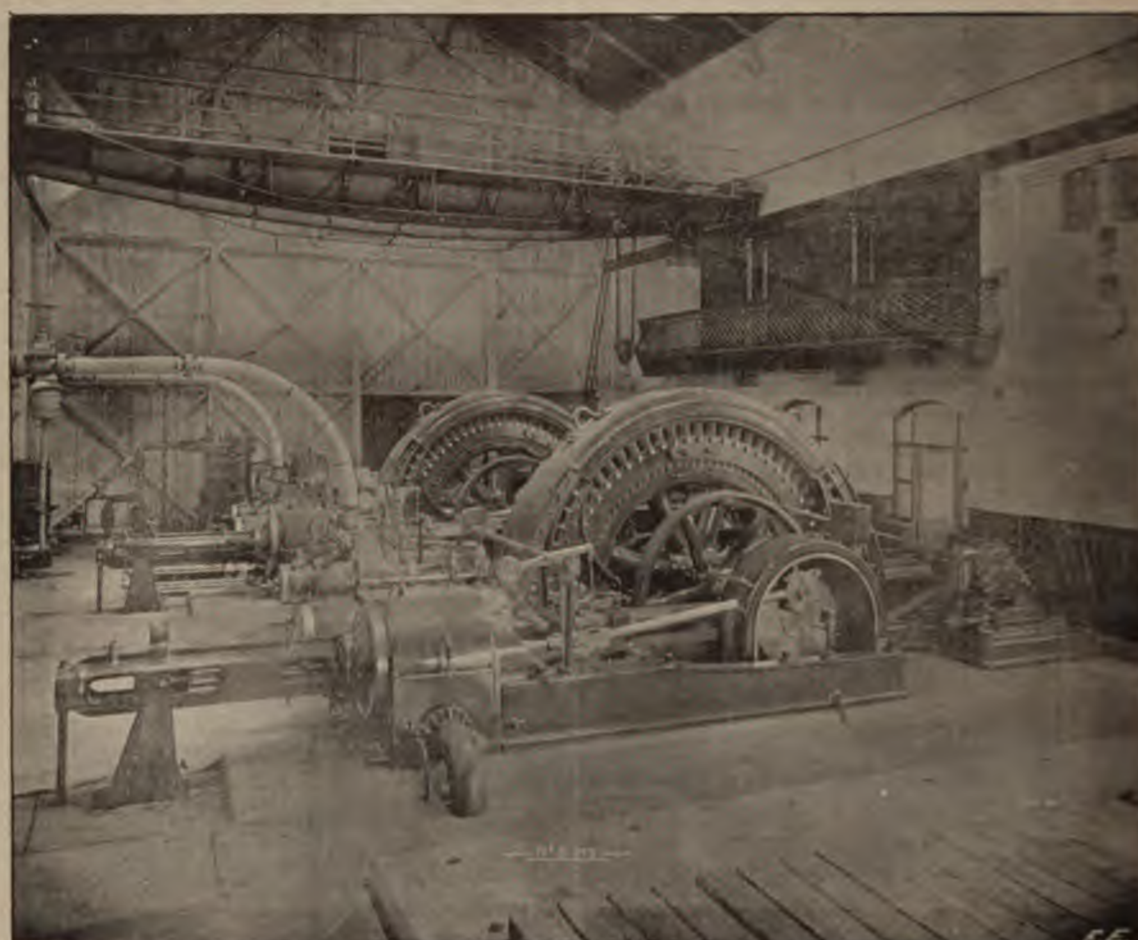


FIG. 2.—General View of the Engine-Room of the Electricity Works, Wakefield.

firm's engineers, the principle of which is that the piston ring has a spring behind it wound in a corrugated manner, the corrugations being caused by internal bosses in and out of which the spring is wound. The effect of this is that the flat portion of the spring bearing on the piston ring is always at a sustained definite and constant tension, thus causing the ring which it supports to keep the cylinder uniformly steam-tight. In addition to the spring just described, spiral springs are arranged enclosed in the hollow bosses of one of the rings, but so as to bear firmly on the blank boss of the neighbouring ring by means of which a spring bearing is obtained in both directions—viz., lengthways and across the barrel of the cylinder—the result being an effective steam joint and a consequent saving in the steam consumption. Two of the engines are fitted with piston valves, but the third engine is to be supplied with the firm's newest type of positive Corliss valve, together with new automatic expansion gear which has just been brought out by one of the firm's engineers, and which it is anticipated will show high results. The valves are arranged directly in the cover of the cylinder

ALTERNATORS.

These are made by Messrs. John Fowler and Co. under the Hall patents, and, like the engines, embody the latest construction based upon extended experience in high-tension work. Each of the larger alternators is constructed to give an output of 112 kw. at a speed of 112 revolutions per minute and with a periodicity of 60 as an ordinary working load, but on emergency these alternators are guaranteed to be capable of delivering 130 kw. for several hours if necessary. They run with one pole earthed. The field magnets of the alternator form the flywheel of the engine, and are placed between the high and low pressure cylinders, the foundation plate of which is arranged to take the alternator armature, which is slot or polar wound. The machines have a minimum insulation resistance of 50 megohms between the armature and core, and one megohm between the magnets and core. The insulation between the armature conductors and the frame is capable of resisting piercing by a spark of 4,000 volts alternating E.M.F. The machines repay a careful inspection as to their strong mechanical construction and durability, being

made for continuous running and capable of withstanding rough usage. This type of alternator has won for itself a very solid reputation for hard work and reliability. Since large alternators came into use, it has been found necessary to have them capable of running silently, or practically so, as far as annoyance to outside property owners is concerned; and these alternators have been brought up to these requirements by careful study and trial, and will be found to meet the utmost wishes of the fastidious. The machines run continuously in parallel with a low synchronising current, and can be put in parallel with the plant running at full load within two minutes. The firm have four 300-kw. alternators coupled direct to slow-speed vertical engines in Madrid, and two 150-kw. alternators coupled direct to slow-speed horizontal engines in Malaga, all running nightly in parallel. In order to provide for inspection and cleaning of the machine, the armature is arranged to rack open by means of a screw rack and gear. Should replacement of coils at any time be necessary, the coils are so constructed that in 10 minutes a new coil can be placed in position, which is no small advantage for the central-station engineeer. It has, however, been found in actual practice that these machines rarely require any such replacement.

The day-load plant (Fig. 3) consists of a 34-kw. alternator, driven by a Belliss vertical high-speed enclosed engine, running at 450 revolutions per minute. The alternator is of the same type as the larger machines, and, like

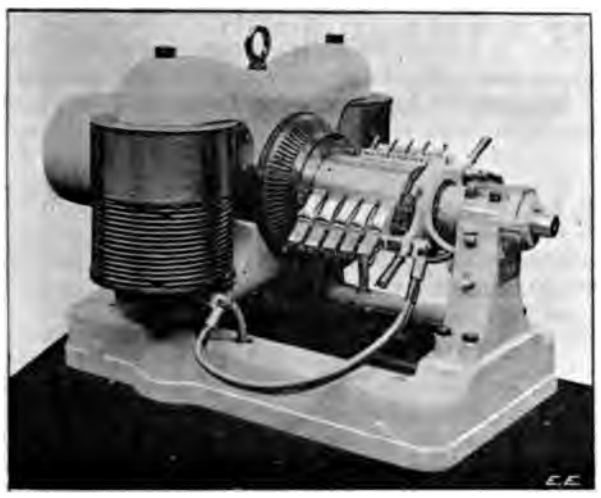


FIG. 3 —The Direct-Current Exciters, Wakefield.

hem, silent in running and perfect in paralleling capabilities. By means of this plant the larger plants can be shut down when the heavier load is off.

The engine-house sundries include an automatic waste-oil purifier worked by exhaust steam. It requires no chemicals, cloths, charcoal, or other filtering substances, being based upon the relative differences in the specific weights of oil and water. The oil runs through the centre tube below the water, passes round the steam coil, and, being thus somewhat diluted, drops the finest of its impurities. After going once more through the chamber and again up through it, and once more through water, it finally gathers above the water-line ready for use. The blow-off pipe answers as an outlet for any gases that may form. It will also prevent overflowing by discharging any rising or overheated oil back into the reservoir. The steam-pipe serves to thoroughly blow out and clean the whole apparatus from time to time. The purifier is made by Messrs. W. H. Wilcox and Co. A complete fire hydrant, with hose couplings, insulators, and leather buckets, manufactured by Angus and Co., provides against possible calamity. The workshop fittings comprise blacksmith's hearth and chimney, bellows, anvil, and complete set of tools for the same, lathe, fitter's bench, vice tools, files, punches, ratchet, brace, drills, and drill posts, etc., necessary for executing ordinary repairs.

Steam and Exhaust Pipes.

The steam-pipes are arranged with connections to separate branch pieces on engines and boilers, and consist of lap-welded steel manufactured by Messrs. Stewart and Clydesdale. The flanges are screwed and brazed. The tees are of cast iron, and the diameters of the main pipes and principal branches are as follows: main, 9in. diameter, branches to boilers 6in. diameter, and branches to engines 5in. diameter. The subsidiary steam-pipes are of wrought iron, and connect the feed pump, injectors, condensers, etc., with necessary valves and drains. All the steam-pipes are covered with sectional magnesia non-conducting lagging.

The exhaust pipes are of cast iron, 18in. diameter, and are capable of dealing with the exhaust up to 1,000 i.h.p. They are carried underground and connected to a single uptake pipe, so that the exhaust steam, in the event of the plant not working condensing, may be delivered into the atmosphere direct. The uptake pipe is carried outside the building, and to a height of 6ft. above the roof. The valves and connections are so arranged as to enable the engines to be worked condensing or non condensing at will. A system of drain pipes is arranged in the engine-room and boiler-house. The feed pipes are of cast iron in duplicate, and of 3in. bore, and are connected to pump, economiser, and injector. The blow-off pipes and drain are also of 3in. cast iron. Branch pipes ¾in. diameter connect the intake pipe with the engine sumps with a sluice valve at the end, the valve spindle being carried up so as to be operated from the floor level. A cast-iron feed-water tank is placed underground, the capacity being 3,000 gallons. All the steam and feed valves are of Hopkinson's patent parallel slide pattern.

Switchboard.

This is arranged on the well-known Lowrie-Hall system of plug switches and fuses. The switch parts and instruments are fixed on an iron framework consisting of H-iron uprights fixed top and bottom to channel-iron girders, the uprights being drilled for fixing the switch parts, which are all mounted on black enamelled slate slabs. The conductors are brought up to the switch parts at the back of the board through insulated collars fitted in drilled holes in the ironwork. The framework is supported by wrought-iron stays connecting the wall and the uprights, and the whole makes a non-combustible switchboard. The switchboard is divided into three parts: the centre portion dealing with the synchronising instruments, the left-hand portion with the distributing circuits, and the right-hand with the alternators. This arrangement of the consulting engineer allows for the indefinite extension of the switchboard from time to time, either in circuits or alternators, without disarranging the existing board. The exciter instruments, together with the hand regulating apparatus, are placed on the regulating table, which occupies a position in front of the board. The attendant sitting at this table has therefore also a clear view of the switchboard. Upon the regulating table are also fixed the transmitting portion of the signalling apparatus, consisting of switchboard and lamps connected in series with the engine-room indicator. This consists of two cast-iron boxes with ground-glass fronts arranged in separate compartments, each divided off from one another, and each being fitted with a lamp behind the ground-glass front. One of the boxes has its divisions marked with the numbers of the engine, the numbers being painted on the ground glass referred to. The other box has the driver's instructions painted on the ground glass, one word for each division—viz., "fast," "slow," "right," "stop." When the signal is desired to be given an electric bell is sounded, the attendant closes a switch belonging to the particular engine for which the signal is intended; this lights up the lamp immediately over the switch, and also the lamp in the particular compartment of the indicator whose glass front bears the engine number. He also closes the switch belonging to the particular word of instructions in the other box, and the lamp lights up in the same manner. The driver in the engine-room has therefore two illuminated signals, the one giving him the number of the engine which he is to operate, and the other instructing him to go either "fast," "slow," or to "stop." The entire switchboard at present provides for three circuits and four alternators. The connections between the alternators and circuits of the board are made by means of concentric cable, which are connected at the board by special concentric fittings mounted on porcelain, which

is again mounted on slate. All the current-carrying metal parts of the high-tension apparatus are mounted on porcelain, which in turn is mounted on the enamelled slate, and the high-tension switches are surrounded by slate guards to prevent accidental contact. The main fuses are of the latest type of Lowrie-Hall main station fuse, made by the addition of the firm's latest patent asbestos-sheathed fuse, by means of which, should the wire be suddenly melted with the current, the formation of an

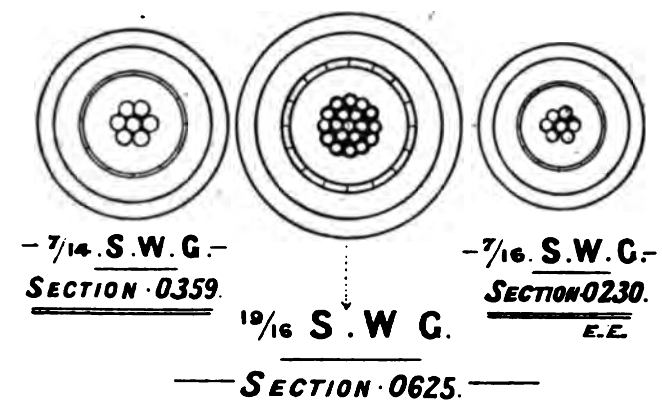


FIG. 4.—High-Tension Cables.

arc is entirely prevented by the damping action of the asbestos surrounding the naked fuse wire. The fuses are double-pole, mounted in massive slate base fitted with ebonite handles, enabling the fuses to be withdrawn quickly and safely. Two pairs of 'bus bars run the whole length of the switchboard coupling the alternators and the circuits, one side of each pair of bars being earthed. The voltage of the two 'bus bars is read from two Kelvin high-tension voltmeters. In addition to the above voltmeters the ampere-gauges employed are those of Lord Kelvin, manufactured by Messrs. White, of Glasgow.

The testing-room is equipped with the usual set of instruments, including a Thomson galvanometer fixed on a strong pillar to prevent vibration with a set of shunts, a Post Office bridge and reversing key, and a portable testing set. There is also a portable galvanometer, Kelvin watt-balance,

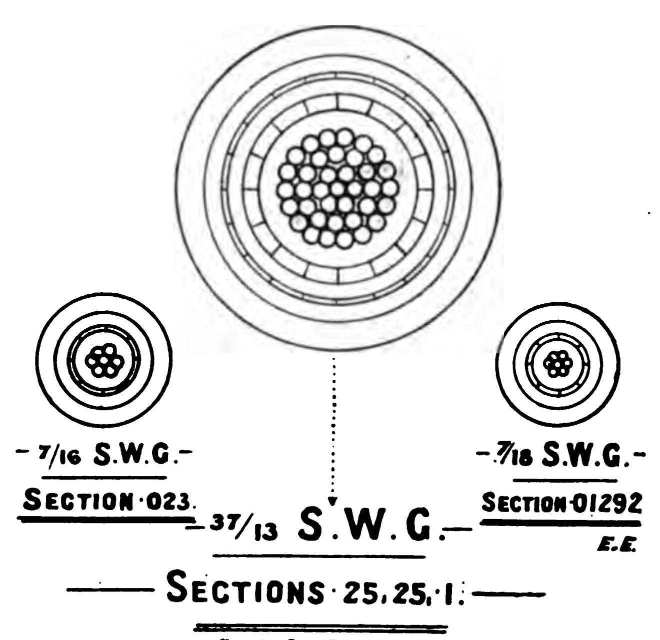


FIG. 5.—Low-Tension Cables.

100 Leclanché cells, and a carbon megohm. In order to provide a means of testing the output of the alternators before running on the load, a water resistance of a new pattern has been constructed by the firm which admits of the test being taken without any difficulty. It consists of a heavy cast-iron tank surmounted by a framework carrying the insulated electrode, which is drawn up or down by means of insulated pulleys. Hitherto this form of resistance has given trouble on account of the great amount of heat generated, causing a change in resistance, and where the water container has been of wood it has generally fired. These difficulties have been obviated by providing, first, the heavy container mentioned, and combined with this an outlet pipe, by means of which the water could be kept constantly flowing, thus avoiding the heat trouble.

THE MAINS.

The cables are throughout manufactured and laid by the British Insulated Wire Company, Limited, of Prescot, and are of their concentric type, insulated with their patent oil impregnated paper insulation and lead covered. The cables carrying current generated at the Calder Vale to the sub-station in Westgate have a further covering of jute yarn to serve as a protection against mechanical damage during drawing in. There are three of these cables between the works and the sub-station insulated to work at 2,000 volts, having a sectional area of ·062 square inch. Six-way stoneway casing has been laid the whole way between the works and the sub-station, except in places where the proximity of cellar roofs to the surface necessitated the use of iron pipes. Cast-iron pipes were also used for road crossings and for leading into the station. Boxes are placed about every 70 yards in the run of the conduits for the purpose of drawing in the high-tension feeders. These boxes are rendered with cement and covered with the British Insulated Wire Company's patent ventilating cover, whereby the conduits are ventilated, and at the same time it is made impossible for any exterior cause, such as a carelessly dropped match, to cause an explosion. The cover is also so arranged that it is impossible for water to get into the box by way of the ventilating cover. In addition to the three high-tension feeders, there is a ·023 square inch high tension concentric main running from the town sub-station and supplying the Ings-road Board Schools. There is also a ·062 square inch high-tension concentric main, similar to the high-tension feeders, run from the sub-station in three-way stoneware casings to the town hall for supplying the town hall and the County Council buildings. These high-tension cables were all tested between the inner and outer conductors with a pressure of 5,000 volts for a period of one hour, and between the outer conductor and lead with a pressure of 2,500 volts for one hour after laying and jointing. The current is transformed at the sub-station in Westgate from 2,000 volts down to 200 volts, and is distributed to consumers by lead-covered paper-insulated triple concentric cables, the conductors of which have a section of ·25 square inch by ·25 square inch by ·1 square inch respectively. These cables are protected by two steel tapes wound spirally so as to form a complete metal sheath. The arc lighting mains are armoured cables, and are connected to transformers in the base of the posts, which transform the current down to the voltage necessary for the lamps.

SUB-STATION.

The main sub-station bears out the modern character of the whole works. It is connected with the generating works by a B.I.W. patent air-space low-capacity paper insulated telephone cable, which is drawn into the stoneware casing alongside the high-tension feeders. The fuses at the station are of the massive main station type, and from these the connections pass on to main station switches and thence to the 'bus bars, through high-pressure switch fuses to the four 42 kw. Lowrie-Hall transformers. The low-pressure distributing board is fixed at the opposite side of the sub-station, and is arranged for three-wire distribution and six outgoing circuits. There are two sets of 'bus bars, each set connected to a pair of two 42-kw. transformers. The low-pressure switches connecting the transformers are of the triple-pole laminated lever type, similar to those manufactured by Messrs. Fowler for the Leeds electric tramways switchboard, and are of a fine substantial character.

For the past few weeks one of the larger sets of plant has been in operation, and connections have been made to the premises of many of the leading tradesmen and to the palatial buildings recently erected by the West Riding of Yorkshire County Council, as well as to the theatre. The supply has on all hands given great satisfaction, the steadiness of the light, due it is claimed by the contractors to the heavy flywheels on the generating plant, being specially noticeable.

THE COTSWORTH ARC LAMP.

On Monday last, at the invitation of Arthur Ormsby, Esq., of Merton Park, Surrey, some 50 or 60 members of the Press and other gentlemen interested in electric lighting, and with whom were to be seen a sprinkling of fair ladies, visited that well-known up-river pleasure resort, Tagg's Island, Hampton Court. The invitation was given on behalf of the Cotsworth Arc Lamp and Electric Lighting Syndicate to witness a practical demonstration of electric lighting by means of the Cotsworth arc lamp. The visitors were on arrival at Hampton ferried across to the island, where a garden party was held, a very good band being in attendance, which played at frequent intervals and during the cold collation, which was well served in the open space in front of this noted boating establishment. After the dinner a little speech-making was indulged in, but it was creditable to all concerned that the speeches were neither long nor dry. Colonel Brooke was to have occupied the chair, but, unfortunately, through sudden indisposition, was unable to be present. The chair was, therefore, occupied by Mr. R. Logan, one of the directors of the syndicate.

Mr. ORMSBY spoke of the pleasure it gave him to see so many friends there. He regretted the absence of Colonel Brooke, who would have been able to give far more details of the lamp, as he had thoroughly examined it. He would not go into details as regards the lamp, as only the technical portion of the visitors would be sufficiently interested to hear them. He referred gentlemen to Mr. Cotsworth, who during the evening would light up the lamps and would give any information desired. He stated that the proprietor, Mr. Tagg, was so pleased with the lamps in the hotel grounds that he had asked if he could purchase them outright.

Mr. H. G. COTSWORTH, in reply to the toast of the "Cotsworth Arc Lamp," said he did not claim to be an inventive genius. He had devised the lamp in its first stage about three years ago, and since had improved on it step by step. At least 100 lamps had been made, with successive improvements. As soon as the toast of "The Press" was proposed we decamped for the time being to inspect an electric launch belonging to the Immisch Company. A few friendly spirits had also been incited to slip away, and, under the guidance of Mr. H. S. Hodgson, we visited the charging station higher up the river, where the electricity is made and the cash received. The strong room for storing the profit impressed us, but it was difficult to get from Mr. Hodgson exactly how high a figure they charged per unit. The variation in the voltage used by different launches makes the charging with electricity a somewhat difficult or wasteful process, but the cash charges are not wasteful from the Immisch Company's point of view. The same launch took us back to Tagg's Island, where Mr. Costworth's lamps were then in full working order. The electricity was supplied from a set of accumulators in a barge moored to the island, and the lamps burned very steadily.

Leaving now the festivities and coming to the lamp itself, the feed mechanism of a series-wound lamp is shown in Fig. 1. This is intended for use on a constant-voltage system of mains with resistance in series. A gravity feed is employed. The lamp is focussed as a coil connects the two rods, R_1 R_1, passing over the brake wheel, W. This wheel is now made with a right-angle V groove round its periphery, against which the square rods, R_1 and R_2, rest. The action of the clutch in striking the arc is easily seen from the diagram. In lamps intended to burn in series the clutch is placed at the top of the brake wheel and actuated by a shunt coil. The carbons are, in that case, left apart after the lamp is trimmed. The simplicity of the lamp is its great feature, combined with very few working parts. Thus it should be a very cheap lamp to make. Another feature of interest is the globe-lowering gear. This is the subject of a special patent. The details of this are shown in Fig. 2. The two rods, K K, supporting the globe slide up two tubes, V V. At the top of these rods two small pistons are placed. Those on the down stroke are made nearly airtight, but on the up stroke the air pressure is automatically relieved by the use of a small cup leather, so in lowering the globe the catch is released by one hand, and then the globe gradually sinks without any jar or shock to the bottom of its travel. One hand, again, is quite sufficient to raise it up till it catches again at the top. The full view of the lamp is shown in Fig. 3. We understand that good financial support has been secured by the syndicate, and that these lamps will soon be on the market.

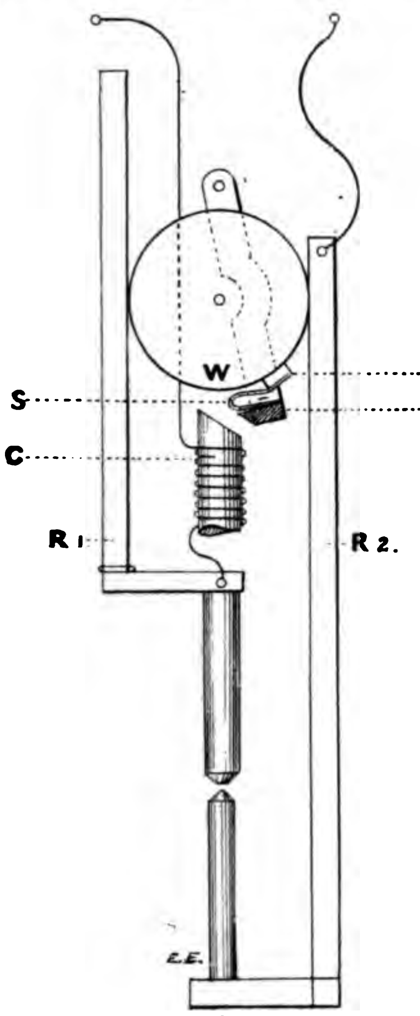


FIG. 1.


FIG. 3.

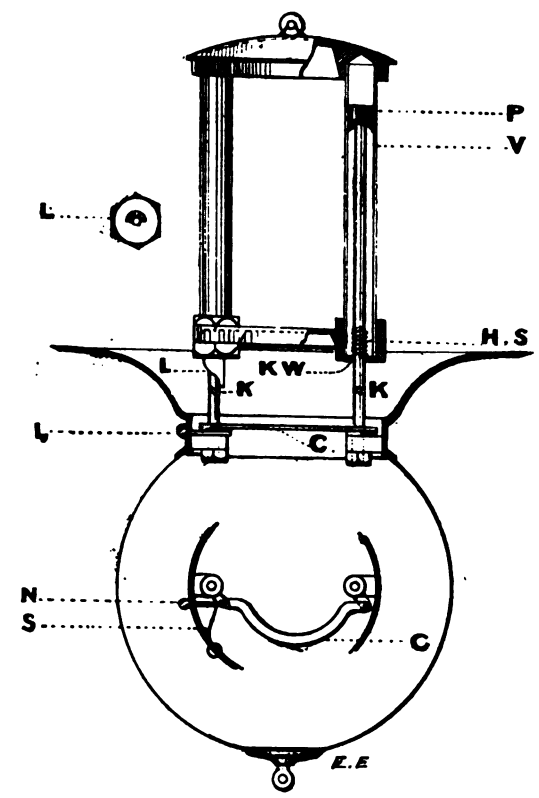


FIG. 2.

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THE BURNING QUESTION.

We hope before the year is out to have placed at our disposal one of the most recent—and from hearsay evidence one that represents all the latest improvements—installations of refuse destructors erected for the double purpose of burning refuse sanitarily and, as a by-product, raising steam. It is proposed to continue the experiments for at least seven consecutive days, and to have absolutely accurate accounts kept during that period of all the operations carried on at the works. While it is perfectly clear that this information when obtained is only accurate as regards that one town—for refuse is a very variable commodity—it will once and for all clear the atmosphere of much that is merely conjectural. The members of the corporation at whose request these experiments are to be carried out, are, like most of us, seeking definite knowledge. What exactly is it that engineers and corporations want to know about refuse destructors? It has been suggested to us that we should put this question fully and frankly to those interested in the matter, and ask them to reply, so that no real want should be left unconsidered during these trials. So far there seems to be three distinct classes under which destructors may be placed. The first includes those destructors which are required not only to destroy refuse, but also to burn the sludge from sewage tanks; the second are purely destructors of refuse; and the third are supplemented with apparatus for utilising any waste heat that may be available. Electrical engineers are concerned with the latter only. It is because we believe there is an utterly incorrect view taken by the majority of town councillors that we have entered upon this subject. Quite recently at a discussion upon the question of utilising waste steam from refuse destructors for tramway purposes, we were surprised to find engineer after engineer gravely quoting the average horse-power he estimated could be obtained from specified destructors. There was not one single word said to indicate storage of any kind, but it was assumed that the average horse-power available was a good basis upon which to make calculations. Given proper storage, of course our remarks upon this discussion will not hold. Without storage, the minimum horse-power available is the only basis upon which calculations can be founded, and unless this minimum available is greater than the maximum required at any particular time, it would be bad policy to rely upon steam thus obtained. Our reason for supposing storage to be outside the discussion is simple. To equip an installation with storage is more costly than to equip one without, and the estimated expenditure mentioned did not, and could not, include storage. This is only one point about which half-informed men too hastily jump at conclusions. At this time of day anyone who has had to do with tramway schemes of no very extensive scale knows that the demand of power fluctuates enormously, and it is only when dealing with very large schemes that the demand may be more or less averaged. It is

important, then, that these loose ideas should be met with more definite ones, stating exactly what may and what may not be expected. We therefore ask our readers interested in this subject to prepare and send to us a list of questions which it seems desirable should be authoritatively answered. It is probable that when one class of destructor has gone through this experimental course, the other classes will be put through their facings also, and so a tolerably correct indication be obtained to serve as a guide for future designers.

THE ROYAL SHOW.

The fifty-ninth country meeting of the above show opened at Four Oaks Park, near Birmingham, on Saturday last. Among the many interesting exhibits the self-moving vehicles received a great share of attention from visitors.

Amongst the electrical department exhibits we noticed a new high-speed vertical engine for driving dynamos, exhibited by MESSRS. RANSOMES, SIMS, AND JEFFERIES, LIMITED, Orwell Works, Ipswich.

MESSRS. TANGYES, LIMITED, Birmingham, again have a most imposing stand which consists of a good representation of their world-renowned manufactures. They show several oil-engines of Pinkney's patents, in motion, driving pumps, dynamo for electric lighting, sawbench, flour machinery, and one driving a boot-blacking machine. There is also on view a 6-b.h.p. portable oil-engine with Pinkney's patents fitted also with an improved apparatus for cooling the water for circulating purposes. The engine will give off this power in constant work, and is tested to about 25 per cent. more than this before it leaves the works.

MESSRS. MARSHALL, SONS, AND CO., LIMITED, of the Britannia Ironworks, Gainsborough, occupy as usual a prominent position in the section for machinery in motion. Prominent among the engines on their own stand is a high-pressure engine underneath a locomotive multitubular boiler of 16 n.h.p. This is a high-class engine and boiler throughout, showing the best possible finish in every detail. The engine is fitted with cross-arm quick-speed governors and equilibrium throttle valve, central bearing to crankshaft, and the boiler is provided with their extra large sized fire-box for burning wood refuse as fuel, and the whole would be of ample strength for 90lb. working pressure.

MESSRS. W. F. DENNIS AND CO., of 23, Billiter-street, London, E.C., make a good display with electric cables of various sizes and kinds.

MESSRS. W. H. WILLCOX AND CO., of Southwark-street, London, S.E., have various exhibits, comprising a general collection of engineers' tools and general engineers' stores, also lubricating oils. We noticed specially semi-rotary pumps, Penberthy injectors for ploughing engines, traction engines, road-rollers, etc. It is claimed that if an injector will work on a road-roller or traction engine satisfactorily, it will work on any fixed boiler. There is also belting, mountings, valves, boiler-cleaners, and boiler compositions for preventing incrustation, etc.

MESSRS. ROBEY AND CO., LIMITED, of Lincoln, exhibit a gas-engine fitted with patent self-starter and all modern improvements, specially suitable for all classes of machinery, having governor suitable for electric lighting; and an open-type high-speed vertical engine fitted with equilibrium governor. The cross-head of this latter engine is of special construction, with a steel gudgeon having a conical head, the piston rod being secured to the cross-head by a coned end and cotter. With this construction the removal of the piston is much simplified.

MESSRS. JOHN FOWLER AND CO., LIMITED, of Leeds, occupy two large stands among the machinery in motion. All the traction engines and road locomotives made by this noted firm have recently been redesigned, and many improvements in detail have been introduced. The following may be specially mentioned: improved governors and equilibrium throttle valve controlling the speed of the engine within 2 per cent., improved brake gear, giving the driver easy and perfect control.

MESSRS. JOHN LYSAGHT, LIMITED, of Bristol, have on view their noted specialities in galvanised and corrugated iron goods.

MESSRS. CROSSLEY BROS., LIMITED, of Openshaw, Manchester, make their usual big display of gas and oil engines, showing all the latest designs and improvements.

E.M.F. OF THE ARC WITH ALUMINIUM ELECTRODES.

It is known that an electrolytic cell having carbon and aluminium electrodes opposes the passage of current in the aluminium-carbon direction with an E.M.F. of 22 volts, while current passes in the other direction with only the opposition due to the resistance of the liquid and the polarisation E.M.F. Herr V. von Lanz describes in *Wiedmann's Annalen* his researches upon the arc with aluminium electrodes. This arc is established under an E.M.F. of 19 volts. Between electrodes of aluminium and carbon the current passes more easily from aluminium to carbon, an effect contrary to that noticed in the electrolytic cell. This arc may be used therefore for the rectification of alternating currents, but the efficiency of such a rectification would not be higher than about 6 per cent.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared, and should be written on one side of the paper only. We would call the attention of those sending in answers to the fact that the neatness of any sketches sent in is considered when marking the relative values of these answers. Questions may be sent at any time.

QUESTIONS.

74. In what way would you test lubricating oils, and how would you find out if they were animal, mineral, or vegetable?—I.

75. What periodic tests would you advise to be made on a set of accumulators, and what records kept in order to tell how the cells were being treated?—P. T.

ANSWERS.

Question No. 69. What are the relative advantages and disadvantages of a steam-pump and an injector for boiler-feed purposes?

Best Answer to No. 69 *(awarded* 10*s.)*.—It is assumed that consideration is only desired in connection with boilers for central-station purposes, and not for locomotives or portable boilers. To judge from the usual practice observed in works of this kind the two pieces of apparatus are apparently considered equally desirable, and are generally installed together whenever a duplicate feed plant is installed. As the direct-acting pump and the live-steam injector are perhaps the most efficient of their respective classes, only these types will be considered.

Steam-Pumps.—Advantages: (*a*) Can be used for much hotter feeds than the ejector, and therefore a steam-pump is more reliable than an injector, where a feed heater is installed, and there is not the failing of "losing water" at high temperatures. (*b*) The steam-pump is more useful than an injector for reducing steam in a boiler, as is sometimes desired. The injector returns a large proportion of the heat it uses to the boiler, thus requiring more water and energy to reduce steam. (*c*) Steam-pumps are capable of being put to a variety of uses which injectors are not suitable for, such as tank-filling, fire-extinguishing, etc. Disadvantages: (*a*) Steam-pumps take up much more room than injectors, have numerous moving parts, greater liability to get out of order, thus necessitating more

expensive maintenance. Valves often require readjustment. (b) Will not lift hot feeds; the supply must be at least on a level with the pump barrel when used for such purposes. (c) When used for cold feed, a foot valve and charging connection are often required. (d) Steam-pumps require constant attention when in use and want the glands repacking periodically. (e) More expensive both as regards cost and erection as compared with injectors.

Injectors.—Advantages: (a) Cheaper to purchase and erect than steam-pump of similar capacity, and in small sizes effects a great saving of coal when compared with a pump of similar duty. (b) Will lift its feed some distance when the temperature does not exceed 105deg. F. in cases of high-pressure steam. (c) No lifting or moving parts, nothing to get out of order, thus meaning low cost of maintenance. (d) Ready for immediate use, and feed can be adjusted to a great nicety. (e) Lighter, takes up less room, is quite as certain in its action, and as it is only in action when required it absorbs less power than a pump. (f) It is easy to see when the injector is working satisfactorily by watching the overflow and vibration caused by the passing steam and water through the feed pipes. Disadvantages: (a) No use where the feed water has a temperature higher than 105deg. F. for high-pressure and 135deg. F. for low-pressure steam plant. If these temperatures are exceeded, such a large amount of water is required to condense the steam that its velocity is too much reduced in driving forward the large volume of feed water. (b) Wasteful eddies are often formed in these instruments, thus absorbing energy to no useful end. (c) They are not so useful for reducing steam in a boiler as a steam-pump, and the range of usefulness is much more limited.

The injector, apparently, has greater advantages where cool feeds are used than the steam-pump, but the latter has such a much wider field of usefulness that it is highly improbable that the injector and mechanically-driven pump will ever cease to be installed together.—F. S. P.

Answer to No. 69 (*awarded* 5s.).—For boiler feed purposes the steam-pump is generally used, especially in power stations of any magnitude. There are many forms of pumps, likewise injectors. Of the pumps there are two main types, the direct-acting and rotative; the former, which is a duplex—*i.e.*, having two steam and water cylinders, the piston rod of one moving the valve of the other—is the greater favourite, as it will start with greater certainty and run slowly; but the great disadvantage of this pump is that it is a great steam consumer, probably more so than the injector. As it is desirable to save steam at every point in a station, this consideration leads to the adoption of the rotative type, where a rotative engine drives by gearing a crank which works the plungers of the pump. For economy the engine ought to be a compound one, as about 30 per cent. of steam consumption is saved. In this combination are the following advantages: reliability, economy, constant feed, a wide range of regulation, and the capability of dealing with hot feed water. This combination is a very expensive one, but this will not prevent its being adopted in stations. Where first costs have not so much weight as reliability and economical working, the expense must be gone to in order to gain any advantage over the injector. Of the injectors, I will take the exhaust injector first; this uses waste steam from the engine, and gives a feed temperature of about 190deg. F., but the advantage of this disappears entirely if the engines are condensing, as there is then no exhaust steam; and in the case of non-condensing engines, little advantage can be obtained if economisers are in use: they only feed against 75lb. to 80lb. per square inch unless helped by a steam jet, which would be necessary with high-pressure boilers. They also put oil into the boilers, and as the internal parts of most engines are lubricated, if much oil got into the boiler, it would damage the boiler plates, therefore exhaust injectors are not much used in power stations, though they are very economical and find a suitable field in some cases. Taking an injector, to be compared with the steam-pump, is the high-pressure type, automatic, by having a one-way valve opening outwards to the atmosphere from a chamber formed round a division or slit in the combining nozzle, including modifications in which the steam and water supplies are also adjustable, but simultaneously and in their proper ratio. Every boiler should have two injectors; for instance, all the feed water has to pass through a hole about $\frac{7}{16}$in. diameter, and the possibility of this hole becoming obstructed with wood, waste, etc., and getting choked up by scale, is sufficient explanation for this; the bodies or cones of such injectors are made to be easily removed for examination, and if both sets of injectors do not fail at the same time, no stoppage of the plant need arise from these causes. The injector, however, gives a constant feed, though the amount is not so easily regulated, the limit being about 50 per cent. for the regulated type and less for the others. A very general idea is that as all the steam is returned to the boiler, the injector is a very economical apparatus; this is not so, due to the fact that they will not take feed water of any temperature, 159deg. F. being the outside limit, which is a great disadvantage, hence the adoption of the pump.—T. J. A.

Answer to No. 69 (*awarded* 5s.).—The relative merits and demerits of pumps and injectors depend so largely on the conditions existing in each individual case that it is hard to lay down any definite law as to which is preferable. Of course the question of economy is one that naturally appeals first to the average steam user. In this it would appear that using a cold feed the injector gives a slightly better performance than the pump, but when any form of heater is used, raising the temperature of the feed, say, to 200deg. F., the feed pump is much more economical, as the following table will show:

A.	B.	C.
Direct-acting pump, without heater, water at 60deg.	1	—
Injector feeding at 150deg. without heater	·985	1·5
Injector with heater, raising water from 150deg. to 200deg.	·938	6·2
Direct-acting pump and heater, raising water from 60deg. F. to 200deg. F.	·879	12·1
Pump geared to main engine, and heater raising water from 60deg. F. to 200deg. F.	·868	13·2

A.—Temperature of water to injector or pump, 60deg. F.; rate of evaporation of boiler. 10lb. of water per pound of coal from and at 212deg. F. B.—Relative amount of coal required per unit of time, the amount for direct-acting pump feeding water at 60deg. F. being taken as unity. C.—Saving of fuel over the amount required when the boiler is fed with pump without heater.

The various other advantages and disadvantages of the two systems are set forth below.

Steam-Pump.—Advantages: They are somewhat more simple to manipulate, being quite easy to start and to keep constantly going at one speed, thus requiring comparatively little attention. In case of emergency, when there is no steam on the boilers with pumps of the direct-acting pattern, with the smaller sizes the boiler can be pumped up by hand. Disadvantages: Relatively to injectors, they take up a lot of room, and, as a rule, require some sort of foundation; their maintenance is heavy, requiring frequent reseating of valves, packing of glands, etc., and lubrication both in the cylinder and also of the moving parts; and, finally, when of the direct-acting pattern, do not always work so sweetly as could be desired, due to such defects as passing water in the pump cylinder, liability to jamb, having no rotating parts to give them a constant stroke, etc. They are greater in first cost than injectors.

Injectors.—Advantages: When no form of feed heater is used they form a very convenient method of raising the temperature of the feed, and, as shown above, under these circumstances are more economical than pumps. They are small, taking up little floor-space, and are generally of a shape and size convenient for affixing to the boiler front, immediately against the check valve, making a much more compact arrangement than with a feed pump situated some distance away. Their maintenance is small, requiring only occasional taking adrift and cleaning, and, finally, in prime cost they are low. Disadvantages: If any form of feed heater is used which the water goes through previous to the injectors then there is a great deal of difficulty to get the latter to work, and, in fact, in most instances it is quite impossible. Under certain conditions they are difficult to start, such, for instance, as with a leaky check, requiring skilled labour to manipulate them. When used in conjunction with a condensing system, if not carefully guarded

against they tend to spoil the vacuum by forcing a lot of air into the boiler, although this can be minimised to a great extent by an intelligent disposition of cocks.

Reviewing the above, it will be seen that both systems have several advantages, and it is usual with most steam-raising plant to suitably combine the two and realise these advantages, and also to efficiently guard against breakdown.—H. BELL.

Question No. 70.—Explain the working of a direct-current "booster," and show with diagram of connections and switch-gear how a "booster" may be used for charging the battery from the continuous-current public supply mains. If the voltage has to be "boosted" up 20 per cent., what efficiency would you expect from a given size of "booster"?

Best Answer to No. 70 (*awarded* 10*s.*).—A booster consists essentially of a direct-current transformer, the primary of which is run in this case off the supply mains, while the secondary, which is in series with the cells to be charged, raises the pressure above that of the supply mains by an amount equal to the excess of the battery pressure when fully charged over that of the mains. There are various forms on the market, all embodying the same principle—namely, that of a motor driving a dynamo of the requisite voltage, but the practical details are caried out in slightly different ways, as follows: (1) two separate machines, having their shafts rigidly coupled together; (2) one machine, with a double winding on the armature and a commutator at each end; (3) one machine, with a double winding on the armature and a duplicate magnetic circuit, this latter commonly called a variable ratio booster.

1. This arrangement has the advantage that the regulation of pressure can be effected by rheostats in the shunts of the machines, thus obviating the necessity of having resistance in the circuit of the primary armature to vary the voltage of the secondary. It is somewhat heavy in first cost, and takes up a great deal of room.

2. With this it is necessary to have a variable resistance in the circuit of the primary, since any regulation of the field necessarily affects both the primary and secondary, but in opposite direction, because increasing the resistance in the shunt will make the motor run faster, but it will also decrease the voltage of the generator, and thus practically no change will take place. One great advantage that it possesses is that armature reaction is minimised, and the machines will run with comparatively little adjustment of the brushes and consequently little attention.

3. This arrangement is perhaps the most elastic of all, it being possible with these machines to obtain a variation of from 40 per cent. to 50 per cent., while the E.M.F. on the other remains constant.

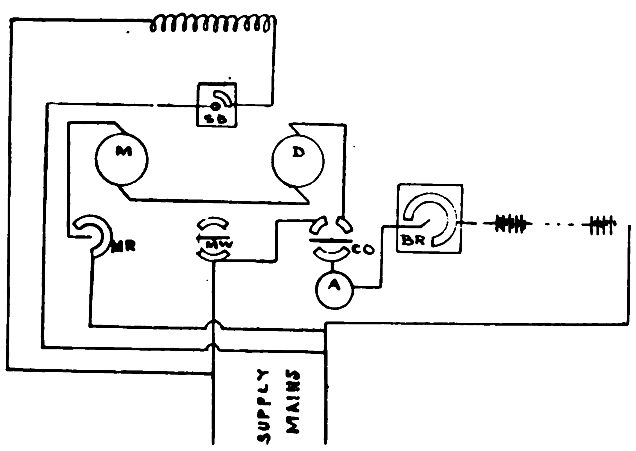


FIG. 1.

The general arrangement of connections and switch-gear are shown in Figs. 1 and 2. In Fig. 2 it will be seen that there is a motor-starting and regulating switch, M R, a middle-wire switch, M W, and a change-over switch, C O, for either charging or discharging, a concentric battery-regulating switch, B R, a shunt-break switch, S B, and an adequate number of fuses. Briefly, the operation of switching the machine in is as follows: The shunt-break switch is closed, and when the magnets are fully excited the middle-wire switch is closed, and the starting switch put on the first stop. The speed is then run up by taking out the starting resistance till the requisite voltage is obtained (determined by the voltmeter, V, which can be changed over from the battery to the machine terminal by a suitable two-way switch) when the change-over switch is closed on the charge position, and the charge finally adjusted by means of M R.

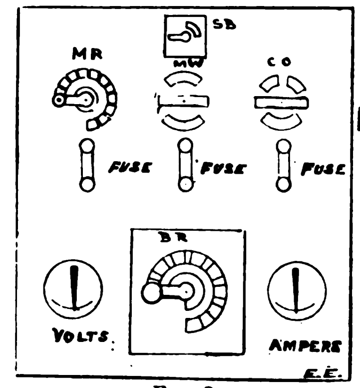


FIG 2.

As far as the question of efficiency is concerned, most machines that have been working for some time will probably not have a much greater efficiency than 85 per cent., but owing to the great improvements during the last year or so most makers will now guarantee an efficiency of from 91 per cent. to 93 per cent.—H. B.

Answer to No. 70 (*awarded* 5*s.*).—It is open to discussion whether the use of the name "booster" in the sense the above question uses it is correct. The American name "booster" has been given to a small dynamo used for the purpose of raising the voltage of any particular feeder, power line, etc., and as it essentially consists of a dynamo whose field and armature windings are in *series* with the feeder or main, and which automatically increases the pressure as the load increases owing to the greater current around the field. It is clear from this that to use such a machine for charging accumulators by private individuals from the public supply mains is out of the question, especially as no suppliers to the public of electrical energy would consent to the placing in *series* with their mains any private consuming device on the premises of a customer. For the same reason the German "Fernleitungs-dynamo," which consists of a motor in series with the mains, driving a generator whose armature is placed as a shunt across the mains, is ineligible for battery-charging.

Having regard to the rules and regulations issued by the various supply companies and corporations, the only machine which is adapted for the purpose required is the motor-generator or dynamotor, as it is variously termed. This machine usually consists of two distinct sets of coils wound on a common armature core, the two sets of coils terminating at two separate commutators, one at each end of the armature. The coils of the two windings alternate with each other, and revolve in a common field, which is usually placed as a shunt across the low-potential armature. The motor being supplied with current from the mains, its armature in revolving carries the generator armature coils with it. This in turn generates an E.M.F., and current depending upon the turns on the armature, the excitation, and the speed. The motor being in parallel or shunt with the supply mains, the conditions are in accordance with usual practice of current supply. These machines often consist of two precisely similar dynamos complete in themselves, which are mechanically connected as regards their armatures and mounted upon a common bed-plate, and in this form are used as balancing apparatus on a three-wire system. The first kind have an advantage over the latter, insomuch as owing to the reactions of the two sets of coils, they run sparklessly. These machines are built for transforming from a high to a low potential or *vice versâ*.

Fig. 2 shows diagrammatically two armature windings on the same core and shaft intended to revolve in a common field. Assuming that the battery requires 5,400 watts to be passed through it for a certain time in order to charge it, and assuming that the supply from the mains

is at 100 volts, then the motor or primary armature, whose commutator is marked P, would probably be wound for an

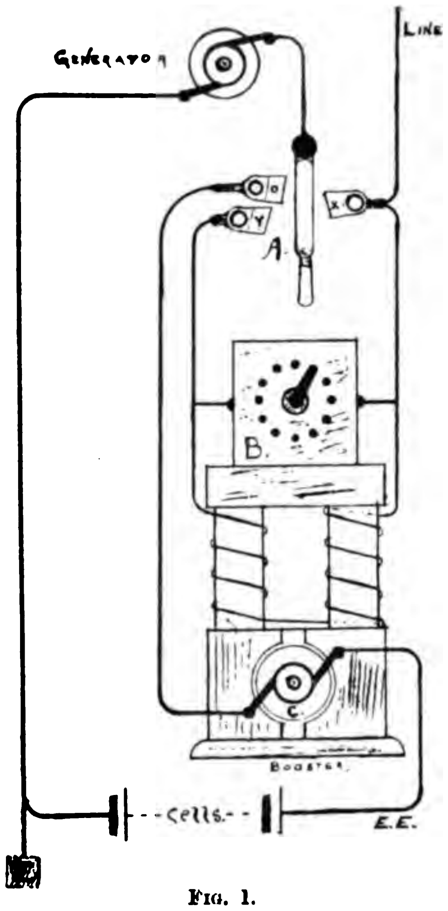
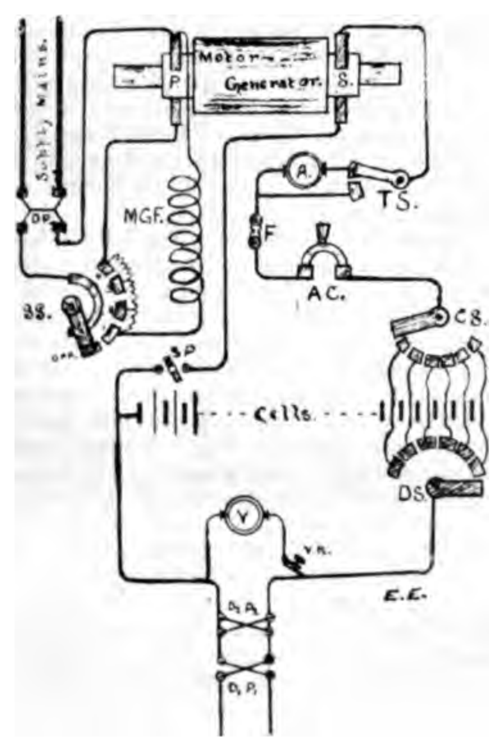


Fig. 1.

output of 60 amperes at 100 volts, thus allowing a small margin. The generator or secondary armature, whose



To Lamps.

Fig. 2.—D P, double-pole switch and fuse; D_1 P_1, double-pole fuse; D_2 P_2, double-pole switch; S P, single-pole switch; T S, two-way switch; F, fuse; A, ammeter; V, voltmeter; P, primary or motor commutator; S, secondary or generator commutator; M G F, field windings of motor-generator; S S, starting switch; A C, automatic cut-out; C S, charging switch; D S, discharging switch; V K, voltmeter key.

commutator is marked S, would be wound to give an output of upwards of 6,000 watts at 135 volts, say 44 amperes at 135 volts, both windings working in the same field. The current from the mains passes through the double-pole switch and fuse, D P; this switch should be of such construction that it would be impossible to close it unless the starting switch, S S, be on the contact marked "off," otherwise should D P be closed with the starting switch on 3 or 4, a direct short-circuit of the armature would be the result, probably totally destroying it. With S S on contact 1, the current divides, part going through the resistances connected to the contacts 2, 3, and 4 to the commutator and motor, P, part passing through the field winding, M G F, which, when the switch is in this position, gets the full pressure of the circuit and produces a strong starting torque. As the switch, S S, is moved over contacts 2, 3, and 4, the resistance which is being cut out of the motor circuit is being inserted in the field circuit, thus weakening the field and running the motor up to its highest speed. The generator side of the system requires very little explanation. It is a simple domestic accumulator circuit, in which T S is a two-way switch for short-circuiting the ammeter, A, whilst A C is an automatic cut-out which disconnects the battery from the dynamo should the E.M.F. fall below what is required to overcome the back E.M.F. of the cells whilst charging. The rest is self-explanatory. With a well-designed switch connected as is S S, probably the whole of the necessary regulation of the charging current could be effected by its intelligent use, together with varying the number of cells in charge. A variable resistance, capable of carrying the whole charging current, if inserted between S and T S, would effect the same purpose and might even be more desirable.

Fig. 1 shows a true "booster" dynamo whose magnet windings are in *series* with the line. Such an arrangement as is shown would be suitable for raising the pressure at a distant point on an electric tramway system, and could furnish current from the battery should occasion arise. By means of the switch, A, several arrangements can be effected. C is the "booster" dynamo, whilst B is a variable shunt across the series field winding, and by means of which the excitation may be adjusted. An efficiency of 85 per cent. on the double transformation may reasonably be expected in machines of good size, but in small machines this figure would probably not exceed 75 per cent.—Yankee.

LEGAL INTELLIGENCE.

THE SMOKE NUISANCE.

The Metropolitan Electric Supply Company, Limited, was summoned at Bow-street Police Court on the 22nd inst. for not complying with a magisterial order calling on it to abate a nuisance caused by black smoke being allowed to escape from a chimney in such a way as to constitute a public nuisance.

Mr. H. C. Jones prosecuted on behalf of the St. Giles's Board of Works.

Mr. Muir, who defended, admitted that black smoke had escaped from the shaft of the company's premises, but explained that owing to the coal strike in South Wales it was impossible to get the smokeless coal generally used. The company used the best coal now in the market, but to prevent smoke with this coal it would be bound to reconstruct its furnaces, which would take 10 or 12 months, and involve enormous expense. He quoted cases to show that a company bound by law to discharge a public duty (as this company was) was exempt from penalty if a nuisance was caused by so doing.

Sir James Vaughan said he was satisfied that the company had done all in its power to mitigate the nuisance, and he marked the summons "No conviction."

Mr. Jones, who said there were 30 other summonses against the company, then obtained leave to withdraw the same.

A similar batch of summonses against the Charing Cross and Strand Electric Supply Corporation, Limited, taken out by the St. Martin's Vestry, was also withdrawn.

SOUTHPORT ELECTRICITY WORKS.

The following is the annual report of the electrical engineer, Mr. C. D. Taite, upon the working of the Southport electricity works for the year ending March 31, 1898, together with an abstract of the accounts:

I have much pleasure in laying before you my second annual report on the working of the electricity estate. From both a financial and an engineering point of view, the results of the

period under consideration have been highly satisfactory. There have been no serious failures either at the generating station or on the mains, and over 100 new customers have been added to the latter, representing an increase of about 50 per cent. on those connected on March 31 of last year. During the year, various extensions have taken place in every branch of the undertaking, these extensions being rendered necessary by the rapidly increasing demand for electricity.

GENERATING STATION.

Boiler-House.—An additional boiler, manufactured by Messrs. Tinker, Shenton, and Co., has been installed, and has been working satisfactorily for the past eight months. Allowing for one boiler being shut down for cleaning, there is now sufficient capacity in the boiler-house to deal with a maximum demand of from 900 i.h.p. to 1,000 i.h.p. A further order for two more boilers has been placed with the same firm; when these two are installed the present boiler-house will contain the full number for which it was designed—viz., a range of six boilers. A large feed pump has been put down, capable of dealing with about 5,000 gallons of water per hour; it is of the well-known Worthington type. The economiser has been enlarged by the addition of 96 pipes, and the whole battery of pipes has been raised 2ft. in order to avoid the ream water which occasionally used to give trouble. Excellent duty is obtained from this adjunct of the boilers, the water, which is fed into the economiser at an average temperature of about 60deg. F., coming out at the top at about 270deg. F., this result being obtained without any perceptible interference with the chimney draught. All the steam-pipes, including valves and flanges, have been covered on an improved method; the non conducting material is silicate of cotton, and this is held to the pipes by a sheet-steel covering; the loss by radiation has been largely reduced. A duplicate supply of water has been furnished by connection with the waterworks company's mains.

Engine-Room.—The engine-room plant has been increased by the addition of a 500-h.p. engine, direct coupled to a 300-kw. alternator; the combination is similar in type to the two 250-h p. sets laid down in 1895, but is of a much more massive design. It was completed in the second week in December, its erection being delayed owing to the strike in the engineering trade; the delay would have been still more serious had not your own staff undertaken the work of erection, the contractors retaining all responsibility. If any other course had been adopted it would, in all probability, have been necessary to decline to connect additional consumers, as a great number of other towns had to do. Fortunately, by working day and night, and by putting extreme pressure on the contractors, the plant was completed in time to meet all demands. It is now working satisfactorily and with economical results, and that it is capable of doing its work is shown by the fact that it has frequently run on the town with an overload of from 15 to 20 per cent., and during the official trials it worked up to as much as 30 per cent. overload. The older plant has been kept in perfect working order, and its reliable character was thoroughly demonstrated during the strike referred to above, when for several weeks in succession the whole of the plant, consisting of five engines and alternators, was run night after night without the slightest hitch or difficulty. The total power now installed is 1,250 i.h.p. The rectifiers continue to give very little trouble.

DISTRIBUTION.

The cables continue to prove themselves most reliable, not a single fault having occurred on any of the main cables during the year. As I had cause to remark in my report last year, some other types have given very serious trouble in many towns; in several installations the cables are the weak point, and while it does not do to be too confident, it is very satisfactory to note that in the towns where the greatest trouble has been experienced new cables have been put down of the type which the Southport Corporation were the first to adopt four years ago, and with which all the extensions have been carried out, and in at least one case a guarantee (under penalty) of not less than 10 years has been given. The transformers have been equally satisfactory, no faults having occurred. A great advance has been made by the adoption of sub-stations for the transformers where the demand is heavy, and of pillar boxes where the demand is not sufficient to warrant the cost of a sub-station; the switch-gear is now quite under control and easily accessible, and it is a comparatively easy matter to arrange a duplicate supply of feeders to each sub-station. This work will be carried out during the approaching summer. Another feature of the year has been the adoption of a pressure of 210 volts in the outlying districts, in place of the previous pressure of 100 volts; a large number of residential houses have been changed over to the higher pressure, with satisfactory results. The practical result, as far as the Corporation is concerned, is a large saving in the cost of mains, while the consumer benefits by the more even pressure obtained. During the year distributing cables have been laid in the following streets and roads: Forest-road (part), Chambres-road, Lethbridge-road, Curzon-road, St. Luke's-road (part), Shakespeare-street, Virginia-street (part), Duke-street (part), Scarisbrick-street, Knowsley-road (part), Leyland-road (part), Preston-road (part), Park-avenue (part), Park-crescent (part), and Princes-street (part). It has been found to be a matter of considerable difficulty, owing to the large increase of load on No. 2 main, to keep a constant pressure in all parts of the town; with the addition, however, of the two new feeders which are now being laid, together with the boosters or regulating transformers, it will be possible to raise or lower the pressure on one feeder independently of the other feeders, thus almost entirely eliminating the difficulty referred to above.

Street Arc Lighting.—The arc lamps in Lord-street and the Promenade continue to work satisfactorily.

Wiring.—With the beginning of the year the new hire-purchase system of wiring houses came into vogue. Since that date 13 installations have been entrusted to the supervision of your staff, the total value of the work carried out being £590. 7s. 4d. When the system was first introduced much difficulty was experienced in getting some of the wiring contractors to understand that the specifications issued were intended to be carried out, but by duly enforcing the various clauses, and by striking off those contractors who for a variety of reasons proved themselves unable to efficiently carry out the work entrusted to them, it has been possible to raise the standard of wiring above the rather low ebb to which it had fallen. I am of opinion that when the scheme comes to be more widely known it will be highly appreciated and largely used by private householders, to whose advantage it is to have the work carried out once for all in a thoroughly workmanlike and efficient manner. Already, since March 31 last, a number of additional applications for wiring have been received.

Criticism of Annual Returns.—From the balance-sheet attached, it will be observed that the net profit on the year's working is £643. 16s. 9d., as against a loss on the previous year's working of £471, showing an improvement in the right direction of £1,114. 16s. 9d. The amount paid in interest and sinking fund was £2,854, as against £2,459 of the previous year, the gross profit being £3,498 compared with a gross profit of £2,058 for the year 1896-7. The output of the works has increased at a very satisfactory rate, the units sold to ordinary consumers showing an advance of over 92 per cent. on the units sold during the previous 12 months, the actual figures being 291,277, as against 151,095. The total units sold have increased from 245,515 to 376,490, the total income has increased at the same time from £4,426 to £6 350, while the total working costs have only risen £484—viz., from £2,368 to £2,852—that is to say, the additional 130,975 units have been generated at an additional cost of £484, or ·88d. per unit. The wisdom of reducing the price to 4d., after two hours' consumption, to 2d. per unit is amply demonstrated, not only in the increased revenue, but also in the reduced costs per unit sold. The basis of the demand indicator system is to provide for the stand-by charges out of the revenue obtained from the first hour's daily average consumption of each consumer, as on this basis only can all classes of consumers pay their fair share of these charges. Up to the present, however, it is found that 7d. for the first hour's consumption does not quite cover all the stand-by charges, hence it has been necessary to retain 4d. for the second hour's charge before reducing to 2d. for the remainder. The stand-by charges are roughly taken to include total charges to revenue account, minus total works costs. These charges are represented by a sum of £3,668 in the case of Southport, while the running costs amount to only £2,038, or 1·30d. per unit sold. On a revenue of 2d. per unit there is a profit of ·70d. on every unit sold at the 2d. rate, but on the first hour's consumption, although a revenue of 7d. per unit is obtained, there is a loss on every unit sold, because 7d. does not cover the stand-by charges as well as the running costs. The amount paid to sinking fund account during the year was £1,438; this sum, added to £1,586, the amount paid up to March 31, 1897, makes a total of £3 023 which the electricity estate has already contributed towards its own purchase. In other words, not only has the estate paid all interest on money borrowed, and met all liabilities (with the exception of a sum of £204, being part of the amount disallowed by the Local Government Board on preliminary expenses and chimney account), but it has also set aside towards repayment of its own loans a sum of £3,023, without any expense to the rates of the town. An examination of the analysis of the accounts shows that a reduction of ·35d. per unit sold has been made in the works costs, and a reduction of ·49d. in the total working costs, or, if interest and sinking fund charges be included, as perhaps they should be (the cost of electricity being regulated as much by the capital charges as by the running costs), the total reduction in the cost of each unit sold is 1·07d.—viz., 4·71d. to 3·64d.—or over 20 per cent. The increased output is chiefly responsible for these reductions, as expenses do not increase at anything like the same rate as the output. I have no doubt that for the next few years further slight reductions will continue to be shown; they would, however, be much more marked if it were possible to employ the plant to some advantage in the daytime. Any step which will advance the economical use of electricity for power or domestic purposes, as opposed to lighting, will do more to reduce the cost of electricity to the community at large than the most rigid economy can ever hope to do. Southport now holds second place as regards economy of production amongst the 28 municipalities that have adopted a high-tension system of generation, and whose results are published. As regards coal consumption, Southport holds the premier position, bracketed with Bolton. There are, however, two companies—viz., Leeds and Sheffield—who, with outputs more than double that of Southport, have obtained better results. Their total working costs, exclusive of capital charges, are 1·50 and 1·53 respectively. Negotiations are now in hand for municipalising both these undertakings. In each case the municipalities have offered more than double the par value of the share capital, thus demonstrating their appreciation of the immense value of the monopoly.

Units absorbed in mains, transformers, etc., have increased largely during the year. That is only what was to be expected, as the number of transformers in use have largely increased, and they have to be energised day and night. In addition, the main feeders have been very fully loaded, and the loss of pressure due

to this fact amounts to as much as 12 or 14 per cent. at top load. When the new cables are connected up, this loss will be curtailed, and the adoption of a 200-volt distribution, in place of house-to-house transformers, should prevent increase in transformer losses.

In conclusion, I should like to draw your attention to a feature which does not appear in any balance-sheet or schedule, but which nevertheless appears to me so be one of the most satisfactory details of the year's work. I refer to the number of consumers who, having once put in the electric light, have extended its use after a short trial, not only in the original premises in which they first installed it, but very frequently in additional premises altogether and in their dwelling-houses. No less than 44 consumers extended their lighting last year. This fact points to a decided appreciation of a pure and healthy light, and speaks well for the regularity of the supply.

REVENUE ACCOUNT.

Expenditure.		£ s. d.
Stock, March 31, 1897		214 10 6
Generation of Electricity.		
Coal, including carriage		631 9 1
Oil, waste, water, and engine-room stores		205 13 9
Wages at generating station		946 3 5
Repairs and maintenance: buildings, £27. 13s. 11d.; engines and boiler, £66. 1s. 6d.; dynamos, etc., £45; sundry work, £194. 6s. 2d.	333 1 7	
		2,116 7 10
Distribution of Electricity.		
Wages to linesmen, etc.	40 6 8	
Repairs, maintenance of mains	34 3 4	
Incandescent lamps	70 0 4	
Repairs, maintenance, and renewals of transformers, meters, switches, etc., on consumers' premises	19 14 3	
		164 4 7
Public Lamps.		
Attendance and repairs	218 17 0	
Renewals	77 17 5	
		296 14 5
Rents, Rates, and Taxes.		
Rent payable	95 0 0	
Rates and taxes	92 4 8	
		187 4 8
Management Expenses.		
Salaries—engineer's department	230 0 0	
Ditto clerical staff	84 11 3	
Ditto general office	45 0 0	
Stationery and printing	81 11 8	
General establishment charges	155 1 11	
Cooking apparatus	0 12 1	
		596 16 11
Special charges—insurances		12 5 6
Redemption Fund.		
Interest on loans	1,416 5 11	
Sinking fund	1,438 4 6	
		2,854 10 5
		6,442 14 10
*Balance—surplus		643 16 9
		£7,086 11 7
Deficiency brought forward and accrued since commencement of supply		£169 6 10
Net surplus since commencement of supply		474 9 10

Income.	£ s. d.
Sale of current per meter at 7d. per B.T.U.	3,913 3 2
Ditto at 4d. ditto	1,451 2 8
Ditto at 3d. ditto	1 9 9
Ditto at 2d. ditto	566 14 10
Ditto under contract	3 11 6
	5,936 1 11
Less discounts, £272. 19s.; and bad debts and allowances, £25. 16s. 3d.	298 15 3
	5,637 6 8
Street-lighting, £840; and rental of meters and transformers (arcs), £129. 11s. 9d.	969 11 9
Premiums	12 10 0
Stock in hand, March 31, 1898	242 7 0
Recharges—generation account	224 16 2
	£7,086 11 7

* N.B.—This surplus is being appropriated to wipe off part of the £678 disallowed by the Local Government Board on chimney and preliminary expenditure account.

STATEMENT GIVING DETAILS OF OUTPUT.

Units generated	532,862
Units sold { Ordinary consumers	291,277
Units sold { Public lighting	85,213
Consumed at works and testing	10,162
Units absorbed in mains, transformers, etc.	146,210
Percentage loss	27·4
Maximum load (units per hour)	404
Number of consumers	338
Number of 8-c.p. lamps connected	26,012

COMPANIES' MEETINGS AND REPORTS.

ELECTRIC AND GENERAL INVESTMENT COMPANY, LIMITED.

Directors: George Herring (chairman), J. B Braithwaite, jun., Emile Garcke, B. H. Van Tromp.

Report of the directors to be submitted to the ninth ordinary general meeting of the shareholders to be held at Winchester House, Old Broad-street, E.C., on Tuesday, June 28 1898, at 3 p.m.:

The profit and loss account shows a gross profit on the transactions of the year of £31,946. 13s. 8d., and, after deducting all general charges and the interim dividend already paid on the ordinary shares, there remains a net balance of £25,719. 1s. 10d. available for distribution. The directors recommend that this sum be dealt with as follows: Ordinary shares—to the payment of a further dividend at the rate of 30 per cent. per annum for the six months ended May 31, 1898, £3,000; to the payment of a bonus of 10 per cent. for the year ended May 31, 1898, £2,000. These payments, with the interim dividend of 10 per cent. previously paid, will make a total distribution of 35 per cent. for the year upon the capital paid up on the ordinary shares. Founders' shares—to the payment of a dividend of £30 per share for the year ended May 31, 1898, £3,000; to the payment of a bonus of £20 per share for the year ended May 31, 1898, £2,000. Ordinary shares reserve fund—to the payment to the trustees of such fund of £7,859. 10s. 11d. Founders' shares reserve fund—to the payment to the trustees of such fund of £7,859. 10s. 11d. Total. £25,719. 1s. 10d. The trustees for the founders' shares reserve fund propose to distribute to the holders of such shares a sum of £20 per share out of the proceeds of investments sold and dividends received in respect of the fund, making a total distribution of £70 on each founders' share. The directors retiring this year are Mr. George Herring and Mr. B. H. Van Tromp, who being eligible, offer themselves for re-election. The auditor, Mr. G. T. Rait, also retires, but offers himself for re-election. It is proposed to make the dividends payable on June 28, 1898.

Dr. BALANCE-SHEET, MAY 31, 1898.	£ s. d.
Capital subscribed—20,000 ordinary shares	100,000 0 0
100 founders' shares	500 0 0
Capital called up—£1 per share on 20,000 ordinary	20,000 0 0
£5 per share on 100 founders'	500 0 0
	20,500 0 0
Provision for contingencies, May 31, 1897, £15,248. 17s. 1d.; less 10 per cent. directors' additional remuneration thereon, as per articles of association, £1,524. 17s. 10d.	13,723 19 3
Sundry creditors	6,557 9 0
Unclaimed dividends	5 1 8
Balance of profit and loss account	25,719 1 10
	£66,505 11 9

Note.—There is a liability amounting to £8,944 in respect of calls that may become due on securities held by the Company.

Cr.	£ s. d.
Investments at cost	46,325 6 9
Sundry debtors	1,409 2 2
Cash at call	10,177 3 2
Cash in hand and at bankers	8,593 19 8
	£66,505 11 9

PROFIT AND LOSS ACCOUNT, YEAR ENDED MAY 31, 1898.

	£ s. d.
General charges, including directors' fees, and additional remuneration as per articles of association, legal charges, advertising, printing, auditors' fee, etc.	4,227 11 10
Interim dividend paid for the six months ended Nov. 30, 1897, at the rate of 20 per cent. per annum	2,000 0 0
Net profit available for division	25,719 1 10
	£31,946 13 8

	£ s. d.
Interest, dividends, commissions, and sundry profits	31,946 13 8
	£31,946 13 8

FOLKESTONE ELECTRICITY SUPPLY COMPANY, LIMITED.

The report of the directors of this Company, presented at the second ordinary general meeting of shareholders on the 21st inst., states that the issue of capital in March last was very largely oversubscribed. As stated in the prospectus, out of 10,000 shares of £5 each, the nominal share capital, 4,500 shares, or £22,500, were applied for before the issue of the prospectus, and applications were subsequently received for 10,515 shares, making a total of £75,075 applied for. Under the contract with Messrs. Edmundsons' Electricity Corporation, Limited, the works to be carried out by them have to be completed by July 1, 1898, and the directors state that Messrs. Edmundsons are making very satisfactory progress with their contract, and the station and works at Shorncliffe are

being rapidly pushed forward by the contractors. Contracts for lighting the Pavilion Hotel, the West Cliff Hotel, and other large establishments have been secured, and at the present moment applications have been received for light quite up to the expectations of the directors. There is, in addition the contract with the Folkestone Corporation for street-lighting.

BIRMINGHAM ELECTRIC SUPPLY COMPANY.

A special meeting of the shareholders of the Birmingham Electric Supply Company, Limited, was held on the 17th inst. at Birmingham, Mr. H. Buckley presiding, to consider the proposed sale of the undertaking to the Birmingham Corporation. The provisional agreement providing for the sale of the Company's undertaking and assets to the Corporation of Birmingham at the price and upon the terms stated was approved, and the directors were authorised to carry the agreement into effect. A sum of £2,000 was voted to the directors for their services.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Tunbridge Wells.—The Corporation invite tenders for the wiring of the new baths. Specifications, etc., at the Borough Surveyor's Office. Tenders by 27th inst.

Hammersmith.—The Vestry invite tenders for the supply of eight 25-kw. transformers. Further particulars appear in our advertising columns. Tenders by July 4.

Shanghai.—The Municipal Council invite tenders for the supply of various plant to electric light station. Further particulars appear in our advertising columns. Tenders by Aug. 10.

Edinburgh.—The Town Council invite tenders for the supply of copper strip for electric conductors. Specifications, etc., may be obtained from the Resident Electrical Engineer, 5, Dewar-place. Tenders by June 30.

St. Pancras.—The Vestry invite tenders for condensing plant, steam-pipes, etc., for the Regent's Park Generating Station, 47, Stanhope-street, N.W. Further particulars appear in our advertising columns. Tenders by July 12.

Sofia.—Tenders are invited for telegraph and telephone material. The estimate is £2,845 8s. Five per cent. deposit is required. Particulars may be obtained from the Permanent District Commission. Tenders by July 2.

Belfast.—Tenders are invited by the Belfast Harbour Commissioners for the extension of their electric lighting station, Abercorn Basin. Specification, etc., at the office of the harbour engineer, Mr. G. F. L. Giles. Tenders by July 4.

Wimbledon.—The District Council invite tenders for the installation of the electric light mains and fittings in the new depôt buildings in Queen's-road, Wimbledon, for particulars of which refer to our advertisement columns. Tenders by 27th inst.

Brussels.—The Belgian Government will shortly invite tenders for the introduction of electric traction on their line from Mons to Boussu. The estimate is £26,000, £9,600 of which is for rolling-stock. The line has a length of six miles, exclusive of branches.

Stavelot (Belgium).—The Municipal Authorities invite tenders for the installation and working of an electric plant for light and power for 30 years. Conditions, etc., may be obtained for 2s. 8d. from the Town Clerk, at Stavelot. The deposit is £120. Open until Aug. 2.

Madras.—The Secretary of State for India in Council announces that the time allowed for the receipt of tenders by the Chief Engineer for Irrigation, Madras, for the utilisation of water power of the Periyar Lake has been extended from Oct. 31, 1897, to July 1, 1898.

Hull.—The Corporation invite tenders for wiring and the supply of fittings for the East Hull Baths (the contract will include 10 arc lamps and 106 incandescents). Forms of tender, etc., may be obtained from Mr. A. E. White, Town Hall, Hull. Tenders before 10 a.m. on July 1.

West Hartlepool.—The Town Council of West Hartlepool invite competitive plans, designs, and tenders for the erection of refuse destructor, boilers, etc., adjoining the electric light station, Burn-road. Conditions, etc., can be obtained upon application to Mr. J. W. Brown, borough engineer. Tenders by 4 p.m. on July 27.

Leeds.—The City Council invite tenders for two engines and dynamos of about 1,000 h.p. each and for 50 electrical tramcars. Particulars, etc., may be obtained from the City Engineer, Municipal Buildings, Leeds, on deposit of £10. 10s., or from Dr. J. Hopkinson, 26, Victoria-street, London, S.W. Tenders by June 29.

Heckmondwike.—The Heckmondwike Industrial Co-operative Society, Limited, invite tenders for an electric light installation (about 500 lights), including generating plant for their premises. Specifications, etc., may be obtained from Mr. Walter Leake, 51, Victoria street, Manchester, on deposit of £3. 3s. Tenders by 10 a.m. on June 30.

Bootle (Lancs.).—Tenders are invited by the Corporation for the erection of an electric light station on their land in Pine-grove. Specifications, etc., may be obtained at the office of Mr. J. A. Crowther, borough engineer, on and after 17th inst., on payment of £2. 2s., which will be returned on receipt of a bona fide tender, with quantities fully priced out. Tenders by noon on 28th inst.

London, N.E.—Tenders are invited by the Bethnal Green Board of Guardians for supplying the necessary plant and installing the electric light at their new infirmary, Palestine-place. Specifications, etc., can be obtained from the architects, Messrs. Giles, Gough, and Trollope, 28, Craven-street, Charing Cross, W.C., on payment of £5. 5s., to be returned on receipt of a bona fide tender. Tenders by 10 a.m. on 28th inst.

Cardiff.—Tenders are invited by the Corporation for the construction, supply, delivery, and fixing of two water-tube boilers with superheaters, each to evaporate about 6,500lb. of water per hour, and one 300-kw. direct-driven steam alternator. Specifications, etc., may be obtained from Mr. Neville Appelbee, borough electrical engineer, Cardiff, upon deposit of £1. 1s., which will be refunded on receipt of a bona fide tender. Tenders by 9 a.m. on 28th inst.

London, S.E.—The Vestry of St. Mary, Newington, invite tenders for the construction, supply, and erection of boilers, pumps, steam and water mains, water tank, surface condenser, fuel economiser, and sundry ironwork for their electric lighting generating station in Penrose-street, Walworth. Specifications, etc., may be obtained from Messrs. Kincaid, Waller, and Manville, 29, Great George street, Westminster, on payment of £5. 5s. Tenders at or before noon on July 1.

London, S.W.—Tenders are invited by the London County Council for works in connection with the construction, delivery, and erection complete of two sets of three-cylinder compound pumping engines and accessories in a new engine-house now being built at the Barking outfall works, near Beckton, North Woolwich. Specifications, etc., may be obtained from the Engineer's Department, County Hall, Spring-gardens, S.W., upon payment of £3, to be returned to bona fide tenderers. Tenders by 28th inst.

RESULTS OF TENDERS.

Walsall.—The Town Council have accepted the tender of Mr. A. Lynex, at £88, for laying the foundations for the new engine and dynamo at the generating station.

Yarmouth.—The tender of Messrs. Gray and Palmer, at £73. 15s. 10d., has been accepted for the installation of the electric light in the new wards at the isolation hospital.

Bristol.—The City Council have accepted the tender of D. Parsons and Co., at £1,467, for providing lamp-posts for an installation of the electric light; and that of Willans and Robinson, at £2,255, for providing an engine at the electric lighting works.

Hull.—The following tenders have been accepted by the City Council for the construction of electrical tramways in Hessle-road: Siemens Bros. and Co., electrical equipment; Société Anonyme des Acierie d'Angleur, rails, fishplates, etc.; Jarrahdale Jarrah Forests and Railway, Limited, and Millar's Karri and Jarrah Forests, Limited, hardwood; Nichol, Morecambe, paving to tramways; Beecroft and Whiteman, Hull, sawing hardwood.

London, S.E.—The Vestry of St. Mary, Newington, have received the following tenders for the supply and fixing of engines, generators, and public lighting plant at the new electric lighting station in Penrose-street:

Sharp and Piper	£9,575
Siemens Bros. and Co., Limited	9,375
Brush Electric Company	9,090
Johnson and Phillips (recommended for acceptance)	8,975
Crompton and Co.	8,802
Fowler and Co. (one section only)	5,200

London, S.W.—The following tenders have been received by the London County Council for the supply of engines, dynamos, etc., in connection with the installation of the electric light at the Crossness outfall works:

W. R. Renshaw and Co., Stoke-on-Trent	£4,497	10	0
Calvert and Co., Manchester	4,600	0	0
Scott, Anderson, and Beit, Sheffield	4,750	0	0
Safety Concentric Wiring Company, Limited, Victoria-street	4,990	0	0
Laing, Wharton, and Down, Limited, New Bond-street	5,455	0	0
Edmundsons' Electricity Corporation, Limited, Westminster	5,530	0	0
J. Fowler and Co., Limited, Leeds (for two dynamos and accessories only)	860	0	0

London, S.W.—The following tenders have been received by the London County Council for the supply of cables, wires, etc., in connection with the installation of the electric light at the Crossness outfall works:

Fowler-Lancaster, Limited, Birmingham	£1 560	0	0
National Electric Free Wiring Company, Limited	2,630	0	0
J. H. Pickup and Co., Limited, Queen Victoria-street, E.C.	2,712	19	7
Scott, Anderson, and Beit, Sheffield	2,780	0	0
Calvert and Co.	2,800	0	0
British Insulated Wire Company, Limited, Prescot	2,893	0	0
Allingham and Tennell, Leytonstone, E	2,943	14	0
H. J. Rogers and Co., Blomfield-street, E.C.	2,950	0	0
Safety Concentric Wiring Company, Limited	3,250	0	0
Laing, Wharton, and Down, Limited	3,484	0	0
A. H. Wood, Victoria-street, S.W.	4,880	0	0
J. Jenkins and Sons, Camberwell-road, S.E.	5,050	0	0
T. H. Taylor, West Kensington	5,800	0	0
G. Stegmann, Clapham Junction, S.W.	6,225	0	0
Sax, Slatter, and Co., Limited, Sloane-street, W.	6,500	0	0
Walsall Electrical Company, Limited, Walsall	6,912	10	0

Dublin.—The following tenders have been accepted by the Town Council: Callender's Cable and Construction Company, at £12,505. 13s. 2d., for the supply and laying down of concentric cables, the company binding themselves to maintain the whole of the concentric mains, together with the boxes and accessories as supplied and laid by them for a period of 12 months free of cost to the Corporation; also the offer of the same firm to maintain the cables for a further period of 10 years, on consideration of an annual payment to them by the Corporation at the rate of 10s. per £100, or ½ per cent. on the invoiced value of the work; and Messrs. Johnson and Phillips, at £2,996. for transformers, with the addition of £100, approximately, for cartage and fitting up.

BUSINESS NOTES.

Liverpool.—The first rail of the electric tramways was laid on the 22nd inst.

Western and Brazilian Telegraph Company.—The receipts for the past week were £2,932.

Doncaster.—The Board of Trade has issued a provisional electric order to the Corporation.

Burton-on-Trent.—The Town Council are going to expend £11,000 on electric light extensions.

Norwich.—The Norwich Electric Tramways Bill has been read a third time in the House of Commons.

Hackney.—On Monday last the Vestry considered the desirability of providing an electric light installation.

Barmouth.—The District Council have agreed to accept an offer to provide the town with a refuse destructor and the electric light.

Barking.—The Local Government Board have sanctioned the District Council's application for a loan of £15,000 for electric supply purposes.

Richmond.—The proposal to run an electric tramway from Kew to Hampton Court, through Richmond and Petersham, has been abandoned.

Islington.—The London County Council have agreed to lend the Islington Vestry £2,950 for purchase of premises so as to extend their electric lighting station.

Walsall.—Mr. Councillor Cope has been added to the Electric Lighting Committee. The engineer has been instructed to order the pipes required for the new condensing plant.

Bristol.—The Electrical Committee's report as to increase of plant, and a resolution as to the extension of the area of supply, were adopted by the Town Council on the 21st inst.

Appointments Vacant.—We refer readers to our advertising columns for vacancies at Dartford for engine fitter, at Salford for a cable jointer, and also for a foreman for small works in the country.

Ryde.—The Pier Company are making preparations for the season by improving their electric railway. They are also constructing a covered station at the pier head. These improvements will cost £14,000.

Limerick.—The plans of the proposed Limerick Electric Tramways Company, Limited, have now been lodged by Mr. Fitt, solicitor. The plans will, it is stated, be considered at the Corporation meeting to-day.

Yarmouth.—A conference which has been held by the Electric Lighting Committee and a deputation from the Yarmouth and Gorleston Tramway Company as to the working of the trams by electric traction has been adjourned.

Colne.—The preamble of the Colne Corporation electric lighting order to supply electricity within the borough at a proposed expenditure of £10,000 was passed by the Select Committee of the House of Lords on the 22nd inst.

Ipswich.—The Town Council have empowered the Electric Lighting Committee to take the necessary steps to carry out the powers conferred on the Council by the provisional order for the supply of electricity within the borough.

Huddersfield.—The Tramways Committee have decided that the new rails at present being manufactured for them are to be drilled so as to be applicable for electric traction when such a change might be considered necessary and desirable.

New Arc Lamp.—We are informed by Mr. G. Braulik, sole agent for Messrs. Korting and Mathiesen, that the latter now manufacture a continuous current arc lamp which burns three in series on 110 volts with a resistance, and also double-carbon lamps.

Personal.—Mr. F. Alan Wilkinson, at present engaged as superintendent of mains to the Bournemouth Electric Supply Company, has been appointed inspector of works to the St. Pancras Vestry's electricity works. There were in all 47 applicants for the position.

Glasgow.—The Electricity Committee have now placed the contract for the excavation and concrete work for the electric station at Port-Dundas, as well as the contract for the mason work at Pollokshaws. They have resolved to push on the erection of these works without delay.

Alloa.—A new scheme for electric lighting has been discussed by the Burgh Commission. It is intended to erect 18 arc lamps, instead of 34, as previously proposed. The estimates are £236. Notice has been given to move at the next meeting that a provi[illegible] order be applied for.

Halifax.—It is expected that the Government inspection of the Halifax electric tramways will take place next Monday, and that if all turns out satisfactorily, the cars will commence running by the end of the month.

Kensington.—The following members have been appointed a general committee to deal with the clerk's report on the question of electrical energy and the electric light: Mr. F. C. Frye, Mr. Harland, Major Isaacs. Messrs. Blott, Hillyer, Whittaker Thompson, Rawlings, and R. A. Robinson.

Kidderminster.—At the monthly meeting of the Town Council, a letter was read from the secretary of the Kidderminster and Stourport Electric Tramway Company intimating their purpose to lay down five additional "turn-outs"—two in Kidderminster, two in Stourport, and one between the two towns.

Saltburn.—At a special meeting of the Urban District Council on the 16th inst. the report of Mr. Burstall on the electric lighting of the town was considered. The general feeling appeared to be that it was not favourable for the Council to embark on any scheme if the Assetts Company proceeded with their undertaking.

Obituary.—We regret to announce the decease of Mr. William Rickard, the founder and sole proprietor of the Ashbourne-road Mills, Derby, which took place at Derby on Tuesday, the 14th inst. We are informed that the business will continue to be carried on under the same management as heretofore.

Bromley.—At the last meeting of the Rural District Council the committee reported that a formal notice had been received from the Chislehurst Electric Supply Company, together with plans showing the disturbances to be made in the roads, and they recommended that they be referred to the Chislehurst Parish Council for report. This was agreed to.

Swinton.—The Clerk (Mr. James Berry) reported at the monthly meeting of the Council that he had informed Mr. L. R. L. Squire, of Swinton Cottage, Swinton Park, that the Council could not allow the Salford Corporation to supply electric light to Swinton Cottage, but that the question of electric light supply was one which the Council hoped shortly to take into consideration.

Long Eaton.—After considerable discussion the District Council have granted the application by the Co-operative Society to lay wires in the street from the old gasworks to the new premises in Main-street. During the debate it was suggested that if the society had the consent of the Council to put down wires in the streets, there was no reason why the Council should not be customers to have the streets lighted.

Kenilworth.—At the last meeting of the Urban District Council the clerk read a letter sent from London, asking him to furnish the names of the members of the Council who had to do with the lighting of the town. The Chairman said he saw no objection to the clerk filling in the information. He thought it would be a very great benefit to the town if a public body would take it into their heads to light it with electricity.

Blackpool.—The Mayor (Councillor R. B. Mather, J.P., C.C.) last week invited the whole of the Corporation, the Corporation employés, the police force (as much as could be spared), to accompany him and the Mayoress on a trip to the Isle of Man. The party numbered 700 in all. Amongst the items of special interest was a visit by special electric car to Laxey, in order to inspect the generating station of the Isle of Man Tramway and Electric Power Company.

Geneva.—The Swiss Electrical Trust, already referred to by us, has now been started with a capital of £1,000,000. £600,000 of which has been taken over by the Banque de Paris et des Pays Bas, and the remainder by the Union Financière. A *Financial News* correspondent says that not only Switzerland, but France, will be included in the field of its operations. In order to preserve its Swiss character the offices are to be in Geneva, but they will be conveniently near to France.

Leeds.—The Bill to confirm the provisional orders granted by the Local Government Board to the Corporation of Leeds for power to create sufficient stock to acquire the undertaking of the Yorkshire House-to-House Electricity Company having been referred to a Select Committee, objection has been taken on behalf of the Corporation to the right of the electricity company to be heard before the committee. The question will therefore have to be decided by the Court of Referees.

Dundee Institute of Architecture, Science, and Art.—The annual general meeting will be held on the 30th inst. at 2.30 p.m. A competition is announced for a design for a public tramway shelter, combining ladies' and gentlemen's retiring-rooms, with bandstand above, not to exceed 40ft. by 40ft; square or other regular figure. Plan, elevation, and section to ⅛in. or ¼in. scale. Conditions, etc., may be obtained by applying to the hon. secretary, Mr. John James Henderson, 8, Bank-street, Dundee.

Telephones.—The London County Council's report (which has been sent to the vestries) of the proceedings of the conference between local authorities of other towns and a committee of the Council, to discus the reference of the question of the telephone service to a Select Committee, states that the conference expressed the opinion that the telephone service ought not to be left permanently in the hands of a private company, and that municipal authorities should be empowered to provide such service.

Poplar.—At the last meeting of the Board of Guardians a letter was received from the District Board of Works stating that the Board had resolved to put in force the provisional order obtained in 1893 for the purpose of supplying the Poplar district with electricity for lighting and other purposes, and that when in a position the Board would be prepared to supply electrical energy to the

Guardians for the buildings under their control on most favourable terms. A motion refusing to accept the District Board's offer was agreed to.

New Firm.—We are informed by Messrs. A. and W. Hopkins, manufacturers of electrical supplies and fittings, that they have taken Mr. Montague H. Galsworthy in as partner in their fittings manufactory, carried on at 7, Hill's-place, Oxford-circus, W., and that the business will in future be carried on under the name of the London Electrical Fittings Company, and under the same management as at present. The accessories supply business will be carried on as heretofore, under the name of A. and W. Hopkins, at 30, Parliament-street, Westminster, S.W.

Ashton.—Mr. Clirehugh has reported to the Town Council that upon making enquiries he had been informed that the makers would commence delivery of the boilers in five weeks, and complete in about seven weeks; that one of the dynamos would be delivered at the engine builders at the end of July to be tested; that one engine and dynamo would be running at the end of August, at which time the committee would be enabled to supply electricity to the tramways company, and that the erection of the lamp pillars would be commenced just after Whitsuntide.

City Electric Lighting.—The City Corporation at its meeting yesterday discussed Mr. Brooke Hitching's motion, previously referred to by us, in favour of a reference to the Streets Committee (or to a special electric light committee of 12 members) "to consider and report as to the desirability of approaching the directors of the City of London Electric Lighting Company, Limited, with a view to acquiring the whole or part of their undertaking by friendly purchase, and empowering the committee to ascertain on what terms, if any, the directors would sell the undertaking."

Yarmouth.—During the Eastern Counties' district meeting of the Incorporated Association of Municipal and County Engineers, held in Norwich and Yarmouth, a visit was paid to the electric light works at the latter town. Previous to inspecting them, Mr. Cockrill explained the methods of construction in vogue for the wall of the fish wharf, showing how the concrete had been faced with granite. At the electric light works the plant proved of great interest to the assembled company, and a rather lengthy stay was made. The flat concrete roof of the coal store came in for a measure of approbation.

Stoke Newington.—At a meeting of the Vestry held on June 21 a circular letter was read from the Vestry of Marylebone in reference to the Bill for confirmation of provisional order granted to the Vestries of Bermondsey and Marylebone stating that notice had been given by electric light companies to reject the Bill on the ground that local authorities should not be permitted to enter into competition with private companies already supplying electricity in their districts; requesting the Vestry to desire their M.P. to support the Bill on the ground that if the said motion be carried it would reverse the policy of Parliament laid down in the Electric Lighting Act of 1888.

Manchester.—The Electricity Committee of the Corporation at its last meeting received a deputation from the Salford Corporation, who attended to confer as to an arrangement for the uniformity of the pressure of electrical power to be supplied in the city and the borough when electricity becomes the motive power on the tramways system. It has already been decided by the committee that, so far as Manchester is concerned, the pressure shall be fixed at 400 volts. It is probable that the deputation will recommend the Salford Town Council to adopt the same basis so as to secure the desired equality of power over the area of the two municipalities.

Whitby.—The electric light has been installed at the new hotel on the West Cliff. The plant was erected by Mr. Wilson Hartnell, M.I.M.E., Kirkstall-road, Leeds, and the laying down of the machinery and the fitting of the light personally superintended by Mr. E. Howbry, the firm's representative. There are two dynamos of 110 volts, giving 330 lights each, worked by steam-engines of 35 h.p. each. In the coffee-room there is an electric fan, which makes 610 revolutions a minute, and is an ingenious contrivance for abstracting the foul air. A passenger-lift, capable of carrying nine persons at a time, is also worked by electricity. The total number of lights is 520, of 16 c.p.

Johnstone.—On Wednesday last a conference took place in the Municipal Chambers between the Town Council and the representatives of the electric tramway company. The deputation gave valuable information to the Council relative to the proposal to put down an electric tramway system connecting with Paisley and Glasgow. The promoters propose to lay down a track, 8ft. wide, at their own expense, which they will also maintain during the existence of the lease, at the expiry of which the Council are to have the option of purchasing at a valuation. It is understood that, if the necessary powers are granted in Johnstone, the company may consider the advisability of extending the system to Kilbarchan.

New Tramways for West London.—The Select Committee of the House of Commons engaged in considering the scheme of the London United Tramways Company for the working of their existing tramway lines by electricity, and for certain important extensions, has thrown out the Acton and Hanwell part of the scheme, but assented to the remainder, deciding, however, that the electrical system to be adopted should be subject to the consent of the local authority. Mr. Earle appeared at the last meeting for the Middlesex County Council, asking to be heard on the subject of interference with the main roads of the county of Middlesex, but the committee, not desiring to sanction a dual authority, rejected Mr. Earle's application.

Barmouth.—At the meeting of the District Council on Tuesday a letter was received from Mr. David Davies enquiring what the Council intended doing with reference to his application for a provisional order enabling him to supply the town with electric light, etc. The terms were agreed upon by which Mr. Davies was to take the refuse of the town at a figure to be agreed upon for a term not exceeding five years, the Council reserving the right to terminate the agreement on giving three months' notice should the refuse destructor which he will use prove a nuisance, Mr. Davies also to have the use of lamp-posts at present used by the Council at a payment of 1s. each per annum.

Southend.—The members of the Tradesmen's Association and friends had an enjoyable outing to Margate on Wednesday. On return home a meat tea was partaken of at the Victoria Hotel. During the speeches which followed the Mayor said he was enabled to tell them that next week Southend Town Council would be asked to accept the principle of electric trams. This was not to stave off a competitive scheme, but so that they might go to Parliament and obtain their consent to develop tramways along the roads ready for them, and to continue that work when necessary. Councillor Martin said the Electric Lighting Committee had decided to lay down plant sufficient, not only for lighting, but for trams. Within 18 months he promised them illumination by means of electricity.

West Derby.—At the June meeting of the Parish Council a letter was read and plans submitted from Messrs. F. J. Leslie and Co., in which they stated that their clients, the Lancashire Light Railways Company, Limited, were applying for powers to construct a light railway between Liverpool and Prescot, to be worked by electricity, the intention being to unite by a light railway or tramway the St. Helens tramway, which terminates at Prescot, with the Liverpool tramways. The Council was asked to support the proposed tramway. It was resolved that the clerk write to Messrs. Leslie and Co., stating that while the Council could see no objection to the proposal, they would like a little further information as to the uses to which the tramway would be applied—if for goods or passengers, or both.

Fire.—A very destructive fire burst out on the morning of the 16th inst. at 19 and 21, Heddon-street, Regent-street, involving the destruction of the works, offices, etc., of Messrs. Davies, Kent, and Stewart, manufacturers of electrical accessories, etc. The fire spread rapidly, and Commander Wells, R.N., assisted by Superintendent T. Smith, ordered a large force to the scene, and set 19 steamers to work. The morning had far advanced, however, before the fire was overcome. There were some very narrow escapes from serious injury. A huge telephone derrick, weighing 40 tons, with about 1,600 wires, on the top of the burning building suddenly collapsed, and the mass crashed into the roadway. Messrs. Davies, Kent, and Stewart have, in consequence of the destruction of their premises, removed to 17, Berners-street, with works at 41, Berners-mews, Oxford-street, W.

Cardiff.—At a meeting of the Electric Tramways Committee on Saturday last it was resolved that the deputation appointed some time since to visit various centres and inspect methods of electric traction and report to the committee be instructed to proceed on their tour of inspection forthwith. The deputation consists of the Mayor, Alderman Carey, Councillor Hallett, the borough engineer, and electrical engineer. The tramways company wrote, asking whether the Corporation would again consider the question of giving the necessary permission in order that the tramlines in certain parts of the town might be doubled. They pointed out that there would be an all-round advantage in carrying out the work as soon as possible. The committee decided to postpone the question until they had settled whether the overhead system or conduit system for the proposed electric tramways should be adopted.

Greenock.—The Greenock and Port-Glasgow Tramways Company are considering the advisability of introducing electric tramcars on their line. Their present lease of the line will terminate about two years hence, and in the event of its renewal it is not unlikely that they will apply for parliamentary powers to run electric cars.—The Police Board have decided that the Board's workmen shall open up the pavement, form trenches, construct the necessary manholes, and restore the pavements and street surface, charging the Telephone Company with the cost of the work, under the conditions of the agreement entered into between the company and the Board of Police; also that the company submit a complete plan of the proposed route showing the position of all distributing poles, manholes, junction boxes, etc., with a specification of the work which they propose should be done for them by the Police Board.

Ilkeston.—At the monthly meeting of the Town Council the Town Clerk gave an exhaustive report upon the working of the tramways in Dover, and the following resolutions were carried: "That it is desirable an application should be made to the Board of Trade for a provisional order, authorising the construction of tramways, under the Tramways Act, 1870, and that after the proper notices have been given, pursuant to Part 3 of Schedule A to the said Act, a special meeting of the Town Council should be held on July 12 to pass a statutory resolution approving of the intention to make such application"; "that it is desirable an application should be made to the Board of Trade to grant a provisional order authorising the supply of electricity, under the Electric Lighting Acts, 1882 and 1888, and that, after the proper notices have been given, as required in the said Acts, a special meeting of the Town Council should be held on July 12 to pass a statutory resolution approving of the application being made"; and "that the General Power Distributing Bill be opposed by this Corporation."

The Electrical Company.—We were invited to see some electrical novelties at the Charing Cross-road address of this firm on Tuesday last, and learnt, amongst other things, that the firm had a most successful year's work from April 1, 1897, to March 31, 1898. The net profit earned in that time amounted to about £2,364. Out of this a 10 per cent. dividend has been declared and £750 carried forward. About £490 was distributed as directors' fees and bonus to employés. During the year the trade and the gross profits have increased by 50 per cent. over those of the previous year. Amongst the articles of new design shown us was a horizontal projector with an automatic feed gear at the back. We also noticed a novel combination of arc and incandescent lamps. The electrolier in question contained four 50-volt incandescent lamps, used with resistance in series with the arc. We were much pleased with an alternate-current arc lamp shown us, and also with an alternate-current meter, both of which we hope to describe fully in another issue.

Metropolitan Railway.—The Bill promoted by the Metropolitan Railway Company for power to acquire lands for further ventilating their system is under the consideration of a House of Lords Committee. The promoters are represented by Mr. Littler, Q.C., Mr. Balfour-Browne, Q.C., and Mr. Freeman, Q.C. The whole matter has been before the House of Lords, and a Departmental Committee at that time came to the conclusion that the most satisfactory method of dealing with the ventilation of the Metropolitan tunnels would be by the adoption of electric traction. In view of the probable adoption of electric traction in the near future, the committee, as a temporary measure, recommended the construction of additional openings, which would be found useful even when the line was worked electrically. The time had not yet arrived when it would be wise to substitute electric traction for the present means of locomotion. Colonel Bell, the chairman of the Metropolitan Company, said arrangements had been concluded with the District Company for electrical experiments which would occupy at least 12 months.

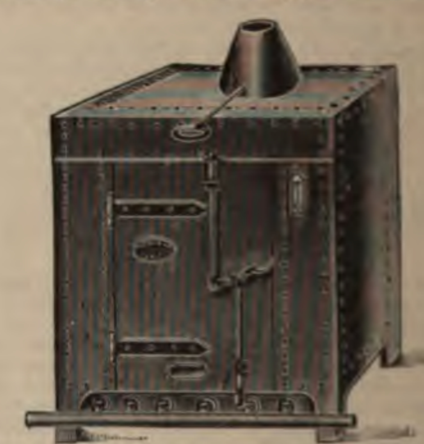
Kennington.—At yesterday's meeting of the Vestry the following report was submitted by the General Purposes Committee: "In pursuance of the agreement entered into between the Vestry and the City and South London Electric Supply Corporation, Limited, as to the erection of the dust destructor (which agreement provides, among other things, that the Corporation shall erect 'a refuse destructor of the most approved sanitary type at the time of its construction, to be approved by the Vestry'), plans were submitted at the previous meeting of the committee of the destructor proposed to be constructed by Messrs. Manlove, Alliott, and Co., in Bengeworth-road, this being the site approved by the Vestry on May 27, 1897. Messrs. Manlove, Alliott, and Co. have constructed, amongst others, the new destructor at Shoreditch, and a sub-committee has been appointed to go to Shoreditch to inspect the same. The sub-committee reported at the present meeting that the Shoreditch destructor appeared to be most efficient, and that if the plans as submitted were adhered to, the Lambeth destructor should be equally satisfactory. The committee therefore recommend that the plans submitted by Messrs. Manlove, Alliott, and Co. be approved."

Hastings.—The Town Council have sanctioned several extensions of low-tension armoured cables, to be laid under the footway about 2ft. from the kerb, and about 1ft. 6in. underground, by the Hastings and St. Leonards-on-Sea Electric Light Company, Limited. The Electric Light Committee have reported that, in accordance with the terms of the order made at the last meeting of the Council on their report recommending that Mr. P. M. B. Grenville should be instructed to make the report, "by a competent engineer and valuer," upon the works comprised in the undertaking of the Hastings and St. Leonards-on-Sea Electric Light Company, Limited, including particulars of the age, condition, efficiency, etc., of the several works and plants required by the Local Government Board in connection with the application of the Council tor sanction to borrow the sum of £58,000 required for the purchase of the undertaking, they had fully considered the matter, and now recommend that Prof. Henry Robinson, F.R.S., M.I.C.E., of 13, Victoria-street, Westminster, be instructed to make the necessary report, they having ascertained that he is prepared to do so for a fee of 100 guineas, which is the same as that proposed to be paid to Mr. Grenville, and that the company be requested to afford the professor all necessary facilities for the purpose. The report has been adopted.

Swansea.—The Surveyor to the County Council reported last week that he had received notice of the intention of the tramways company to commence the works necessary for the repair and renewal of the tramways on or after the 25th inst., and, in accordance with his recommendation, it was resolved to request the company to lay all single lines of tramways in the centre of the roadways, and that with regard to existing passing places, where there is not sufficient width of road on either side of the rails to admit of these being placed in a central position, the company be asked to lay the loop line on that side of the road where, in certain cases, no footpath exists. The surveyor further reported that the work of relaying the tramways was commenced on the 2nd inst., and he was directed to arrange for the proper supervision of the work without addition to his present staff. He was also instructed to require the company to pitch, in line, full 18in. outside the rails. Referring to the minute forbidding projections over footpaths over 3in., it was said there was a by-law which said there should be no projections affixed to any wall. It was also pointed out that the sills of the houses projected 3in. and the plinth about 2in., and it was questioned whether the law prohibited a man using projections to that length. The minute referring to this *matter was expunged*, and the minutes as amended were adopted.

Heysham.—At the last meeting of the Council, Mr. Parkinson, the electrical engineer, presented a report upon his tests of the steam dynamos, etc. It was resolved that a copy of the report be sent to Mr. Parker. It was resolved that Messrs Thomas Parker, Limited, be allowed to deliver the steam dynamos and exciter, which Mr. Parker had tested, and which he had reported as so being in accordance with the contract, subject, however, to the question of compensation standing over. Mr. Thomas Parker, contractor for the electric light plant, stated that the committee might expect to have the arc lamps lighted in a fortnight, and the general supply to the town in a month. The Local Government Board having sanctioned the borrowing by the Council of the sum of £8,821 for electric light purposes, being the sum of £10,000 applied for, less a deduction of £1,144. 10s., the sum awarded to the Council in respect of defective cables, and £34. 10s. for articles not forthcoming in connection with the purchase of the portion of the plant of the Morecambe Electric Light and Power Company, Limited, for which the Local Government Board sanctioned a loan of £3,900 on Sept. 20, 1897, the committee recommended that the loan should be obtained from the Public Works Loan Commissioners. Mr. Parkinson stated that the following additional persons would be required to form the staff at the electric light works—viz.: assistant electrical engineer, wages about 42s. per week; engineer and switchboard hand, 30s.; engine driver, 28s. to 30s.; battery man for three sub-stations, 30s.; two trimmers (each), 25s.; fireman, 25s.; labourer, 25s. It was resolved that Mr. Parkinson be authorised to engage such staff as and when required. The committee is to meet every Wednesday at the electric light station. The electrical engineer was authorised to confirm the orders for machinery already given out.

Catalogue.—We have received an illustrated catalogue from Messrs. A. Hall and Walker, Limited, Coventry, showing various improved stoves for enamelling, lacquering, and drying, specially adapted to the requirements of electrical engineers, japanners, etc. These stoves have a long range of temperature, and can be regulated from 60deg. F. to 600deg. F. They will enamel slate switchblocks, distributing boards, ironwork on dynamos, resistance frames, lamp fittings, etc., and are also arranged for drying coils for transformers, field magnets, arc lamps, and armatures complete.



All stoves in this list are self-contained, and, being built in sections, are easy to handle in transit, and present no difficulty when having to pass through narrow doorways. At the bottom of each door of these stoves is a mica sight hole, through which the flames can be observed without the wasteful practice of opening the door. There are also stoves heated by petroleum oil for localities where gas is not obtainable.

Dublin.—A special meeting of the Municipal Council was held on the 17th inst. for the purpose of considering a report of the committee of the whole house on the consideration of tenders for the supply, laying down, and maintenance of electric mains and apparatus in connection with the loan of £20,000. Before the special meeting of the Council was proceeded with the following notice of motion was submitted: "That in consequence of the answer given in the House of Commons by the Chief Secretary for Ireland respecting the decision of the Board of Works on the application of the United Tramways Company for a passage through the Phœnix Park to connect their lines between Parkgate-street and North Circular-road, the resolution of the Council passed at the last monthly meeting be reconsidered." The report of the Electric Lighting Committee was adopted, also a resolution: "That the tender of the Callender Cable and Construction Company for the supply and laying down of concentric cables for the sum of £12,505. 13s. 2d. be accepted, the company binding themselves to maintain the whole of the concentric mains, together with the boxes and accessories as supplied and laid down by them for a period of 12 months, free of cost to the Corporation, and also to maintain the cables for a further period of 10 years in consideration of an annual payment to them by the Corporation at the rate of 10s. per £100, or ½ per cent. on the invoiced value of the work, and that the law agent prepare the necessary contract deed." From correspondence published in the *Mail*, it appears that the tramway company has agreed to substitute side poles for centre poles in various streets. They also state that they are obliged to follow that course should the Corporation direct them to do so, and it is suggested that the Council should direct the tram company to in future adopt the side-pole system throughout the city.

The New Arc Works at Chelmsford.—Messrs. R. E. Crompton and Co.'s new electrical engineering works at Chelmsford were visited on Saturday by the directors of the company and their friends. Representatives of the Press were also invited, at least, so the *East Anglian* says, to whom we are indebted for this report. The party was a fairly large one, and included a number of ladies. The buildings, which were erected soon after the disastrous fire at the old Arc Works at Moulsham, are close to the Great Eastern Railway on the down side. Externally, they have nothing to boast of from an architectural point of view. The works cover an area of between eight and nine acres, the main shop occupying over three acres. This building is very loftily, well lighted, and ventilated, and at any time can be easily extended towards Chelmsford. It is probable that before long such an extension will be made. It is principally used as a fitting shop and for the manufacture of armatures. The various machines, etc., were inspected by the party, and the huge electric overhead travelling cranes came in for a large share of attention. Adjoining this main building is the smiths' shop, and close at hand are other shops, where the different processes of the manufacture of electrical machinery are carried on. The company has its own water supply and sewage works, the sewage being electrically treated. A large reservoir has also been constructed on the lower portion of the grounds. The drawing and other offices front the Writtle-road, and are erected for every convenience and comfort. When the party arrived at the works a new electrical locomotive for the City and South London Underground Railway was being tested, and, naturally, was an object of much interest. The obvious impression gained was that when all underground railways are supplied with these locomotives, underground travelling will be a far pleasanter experience than it is now. Over 300 men are employed at the new works, and over 200 at the old Arc Works. The annual sports of the Arc Works, which were held on the club's own ground in Wood-street on the same day, attracted a larger attendance than usual. The racing was also much more interesting. The course was lined with Venetian masts, and suspended between these were bright streamers and bannerets, giving an attractive look to the ground. This and other decorative work was carried out by Messrs. H. and T. C. Godfrey, of Chelmsford. There were 19 events, including four championship races.

Dundee.—A statutory meeting of the Dundee Town Council as a Gas Commission was held in the town hall on the 15th inst. As regards the electricity department, the revenue, including a large balance of £1,328. 4s. 3d., less a charge of £381. 6s. 7d., the remaining balance due to the gas department, was stated to be £7,553. 17s. 8d., and the expenditure £7,039. 6s. 7d., showing an estimated surplus of £514. 11s. 1d. The Treasurer said he had provided in the year's expenditure for a contribution of £1,000 towards the formation of a contingent fund for the electrical department. The end sought was to provide against any unforeseen changes involving unusually heavy expenditure without rapid or serious additions to the rates charged. Up till then the electricity department had been in debt to the gas department, but it had discharged its obligation, and was now bearing its full share of the general expenses. The figure of £1,000 might seem to some unduly large, but he had chosen it for two reasons—first, because the electrical department had been in existence for five years, and accordingly £1,000 represented only a contribution of £200 per annum, but the main reason was to give as much stability as possible to their finance. It was a maxim of sound finance to combine the most careful provision for all charges with a constant endeavour to foster increased consumption, and hence it was with much pleasure that the committee were able to ask the Council first to lower the ordinary charges from 4½d. to 4d. per Board of Trade unit, and, second, to offer an electric supply for motor purposes at 2½d. per Board of Trade unit. This second proposal was practically a new movement, susceptible of great development, and which would, he hoped, at no distant date yield a large revenue. The report was agreed to, and a resolution passed that the price of electrical energy to ordinary consumers, otherwise than by agreement, and otherwise than for motive power per quarter, should be as follows: for any amount up to 20 units, 6s. 8d.; for each unit above 20 units, 4d., subject in all said cases to a deduction or discount at the rate of 5 per cent. to all such consumers who pay their accounts within 28 days after the accounts are rendered. It was also moved that the public electric lamps should be charged at the rate of £20 each per annum for those burning the whole night, and £10 for those burning part of the night, and, further, that electrical energy be supplied for motive power at the rate or price of 2½d. per unit if taken through separate meter, but if not taken through separate meter at the ordinary rate. This was agreed to.

Sheffield.—The report already referred to by us from the expert who was asked to report on the proposal to utilise compensation water for electric generation read as follows: "97, Queen Victoria-street, London, E.C., June 2, 1898. Dear Sir,—In terms of your instructions, my Mr. Lowe visited your existing waterworks, and I have now the pleasure to report on the advisability of utilising the compensation water from the waterworks for generating electricity for the city of Sheffield. Damflask reservoir: This reservoir, being used solely for compensation water, its use would not at present interfere with the supply to the town, but would necessitate buying out or compensating the 11 mills situated on the River Loxley. The difference in level between the sill of overflow at Damflask to the level of the river at Malin Bridge is 277ft. in a distance of 3¼ miles, but seeing that in dry seasons the dam would be drawn down, and taking into consideration the fact that it will be necessary to maintain the head constant, so as to give a regular speed to the dynamos, it would be well to deduct the depth of the reservoir—viz., 85ft.—which would reduce the working head to 190ft. The compensation available from this source is 25½ cubic feet per second, or 1,530 cubic feet per minute for 12 hours per day for six days a week, but I assume that the tramway would require power for 16 hours per day and seven days per week, consequently the available quantity of water per minute would be reduced in order to meet the requirements of a greater number of working hours—viz., 112 per week, as against 72 at present—consequently the quantity of water available per minute for 112 hours per week would be 950 cubic feet. The existing 24in. pipes would not be suitable for passing this quantity of water, as the loss through friction would be too great; it would, therefore, be necessary to lay a new pipe line 30in. diameter, which would pass the 950 cubic feet of water per minute at a velocity of 3½ft. per second, and would occasion a loss of head due to friction equal to 35ft., which would reduce the working head to 155ft. Under this fall of 155ft. and 950 cubic feet per minute, 198 h.p. could be obtained for a working day of 16 hours for seven days per week. It will, therefore, be seen that to develop this power would necessitate laying down about 3¼ miles of 30in. pipes, at a cost, roughly speaking, of about £18,000, in addition to which there would also be the cost of the turbine—say, £500—and also the expense of compensating or buying the mills on the River Loxley. Rivelin reservoir: In this instance the difference in level between the depositing pond and the river at Malin Bridge is 304ft., and the quantity of water 14 cubic feet per second, or 840 cubic feet per minute. The pipe line required to pass this water would be 28in. diameter, and would cause a frictional loss of 44ft., thus reducing the working head to 260ft. The 840 cubic feet of water under this head of 260ft. would develop 330 h.p. Of course, in this instance there will also be the expense of compensating or buying the mills on the River Rivelin, and the pipe could be estimated at a cost of about £20,000, with an additional £450 for the turbine itself. Redmires reservoir: I do not think anything could be done with this source of supply, as nearly the whole of the water is required to supply the high service of the town. With regard to making independent stations between Dale Dyke and Damflask, and Dale Dyke and Strines, owing to the low fall and unreliable supply of water, this would not be practicable, besides which there would be a considerable loss of energy in transmitting the electricity to the town. If I can render any further service in the matter it will afford me much pleasure.—Yours faithfully, F. NELL."

PROVISIONAL PATENTS, 1898.

JUNE 13.

13161. Improvements in or connected with electric switches. Harry Sydney Verity, Plume Works, Aston, Birmingham.

13194. An improved system of and appliances for outdoor electric lighting. George Wilkinson, 73, St. Stephen's-road, Upton Park, London. (Complete specification.)

13208. Improvements relating to electric arc lamps. Walter John Hubert Jones, 18, Southampton-buildings, Chancery-lane, London.

13209. Bromo-electric process for the extraction of fine or refractory gold or other metals. William Herbert Hyatt, 67, Wellesley-road, Gunnersbury, London.

13210. Improvements in and relating to electric heaters. Robert Lundell, 77, Chancery-lane, London. (Complete specification.)

JUNE 14.

13258. An improved system of electrical communication for use in telephony, telegraphy, and the like. Alexander Timothy Brown, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

13261. Improvements in and relating to the outer cells or containing vessels of electric batteries. Hermann Jobben, 1, Broad-street-buildings, Liverpool-street, London.

13273. Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

13274. Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

13299. Improvements in electrical starting and steering apparatus applicable to electric launches and the like. Henry William Headland, jun., Samuel Clark, Walter Papineau, and Alfred Ambrose Harris, 77, Chancery-lane, London.

13300. Improvements in or connected with screens, shades, or covers for electric lights. Charles Clarke Bruff, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

13304. Improvements in electric arc lamps. Arthur Marshall Arter, 46, Lincoln's-inn-fields, London.

13308. An electro-thermic incubator. Arthur Edwin Greville, 18, Southampton-buildings, Chancery-lane, London.

13312. Improvements in electric incandescent lamps. Otto Henry Michaelson, 53, Chancery-lane, London.

13316. Improvements in or relating to telephone installations. Joaquin Llorente Lara, 111, Hatton-garden, London. (Complete specification.)

JUNE 15.

13325. Improved means for ventilating enclosed or partially enclosed electric motors. Wilson Hartnell, Volt Works, Kirkstall-road, Leeds.

13393. Improvements in electrolytic apparatus especially intended for use in the electrolytic decomposition of solutions of alkaline chlorides. Josiah Rigby Wylde, Josiah Wyckliffe Kynaston, and the United Alkali Company, Limited, 47, Lincoln's-inn-fields, London.

13399. Method of combined application of continuous and alternating currents for exciting magnetic fields and combination apparatus for producing by this method electrical energy and mechanical power. Max Deri, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JUNE 16.

13404. Pliable support for electric incandescent lamps or other light articles. John Dugdill, Firs House, Failsworth, near Manchester.

13468. An improved system of telephony. Llewellyn Traherne Bassett Saunderson, 53, Chancery-lane, London.

13477. Commutator brush holders and brushes for electric motors or dynamo-electric machines. Edward Hibberd Johnson and Robert Lundell, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

13478. Improvements in or relating to apparatus for controlling electric currents of high tension and great quantity. Edward Hibberd Johnson and Robert Lundell, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JUNE 17.

13497. Improvements in telephone magneto boxes. Arthur Gregg, 6, Chichester-street, Belfast.

13527. A new or improved terminal for electrical connections. Peter Charles Middleton, 7, Staple-inn, London.

13557. An improvement in telephone cables. Llewellyn Traherne Bassett Saunderson, 53, Chancery-lane, London.

13569. Improvements in jointing electric cables. John Henry Barker, 18, Southampton-buildings, Chancery-lane, London.

JUNE 18.

13586. Improvements in electric cables. Gerard Carlyle Allingham and William Fennell, Harrow Green, Leytonstone-road, London.

13610. An improvement in advertising electric signs. John Lawson Johnston and Bovril, Limited, Birkbeck Bank-chambers, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1897.

12039. Means for regulating the voltage of dynamos. The Société Générale des Industries Economiques. (Date applied for under International Convention, March 20, 1897.)

12820. Transforming continuous electric currents. Müller and Tudor.

12942A. Electrical igniting apparatus for explosion engines and for other purposes. Johnson. (Date claimed under Patents Rule 19, May 25, 1897.)

12945. Electric arc lamp. Fesquet and Keys.

13154. Attachments for operating telephone call-bells. Libbey.

13735. Primary batteries. Rowbotham.

14252. Mechanism for electric traction systems in which the electric current is supplied to the cars or locomotives from studs, sections of rails, or the like laid in the road. Thompson and Walker.

14395. Automatic time meter for telephonic conversations. Bösl.

15099. Apparatus for controlling and governing electric motors. Belfield (Davis.)

15850. Apparatus to be employed in connection with the electro-deposition of metals. Brooks and Holt.

16443. Incandescence electric lamp sockets and holders. Bevis and Fletcher.

17158. Electric batteries. Rowbotham.

19424. Electrical glow light. Nernst.

29595. Electric heaters or rheostats. Kraemer.

1898.

2025. Rheostats for regulating the current used in electroplating and other processes. Thompson. (Zucker and Levett and Loeb Company.)

4287. Electric arc lamp. James.

4910. Primary batteries. Koenig.

7193. Primary batteries for producing electric currents, also applicable for the purification of water. Boult. (Cerpaux and Wilbaux.)

7575. Electric furnaces for manufacturing calcium carbide. Thompson. (Wilson, Muma, Unger, Schneckloth, Brosius, and Kuchel.)

9047. Hanger for trolley wires of electric railways. McCallum.

9531. Incandescent electrical devices. Wise. (Hubert.)

TRAFFIC RECEIPTS.

Liverpool Overhead Railway.—The traffic receipts for the week ended June 19 were £1,440, as compared with £1,389 in same week of 1897, being an increase of £51.

Birmingham Tramways.—The traffic receipts for the week ending June 18 were £3,744. 10s. 2d., as compared with £3,541. 3s. 9d. for same week in 1897, being an increase of £203. 6s. 5d.

Dover Tramways.—The traffic receipts for the week ending June 18 were £152. 6s. 8d. The total receipts for the year 1898 are £2,851. 2s. 6d. The mileage open at present is 3 miles.

Bristol Tramways.—The traffic returns for the week ending June 17 were £2,835. 12s. 4d., compared with £2,441. 6s. 4d. for same period of last year, being an increase of £394. 6s. 0d.

South Staffordshire Tramways.—The traffic returns for the week ending June 17 were £608. 10s. 10d., as compared with £591. 6s. 9d. in same week of 1897. The aggregate receipts for the year are £14,481. 0s. 11d., as against £14,685. 19s. 2d. in the same period of the previous year.

City and South London Railway.—The returns for the week ended June 19 were £974, compared with £1,093 for same week of 1897, being a decrease of £119. The total receipts for the half-year amount to £25,532, compared with £25,308 for the same period last year, being an increase of £224.

Dublin S.D. Tramways.—The traffic receipts for the week ending June 17 were £748. 2s. 5d., as compared with £814. 0s. 9d. in the corresponding week in the previous year, being a decrease of £65. 18s. 4d. The number of passengers carried was 110,303 in 1898 and 121,265 in 1897. The aggregate returns up to date are £11,711. 12s. 6d., as compared with £12,362. 6s. 4d. last year, being a decrease of £650. 13s. 10d. The mileage open is the same as last year—viz., 8 miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday.
Birmingham Electric Supply Company	5	10-10½
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	16-16½
—— 6 p.c. Cm. Pf., 30,001-40,000 (iss. at £2. 10s. pm., all pd.)	7	10½-11
Brush Company, Ordinary	2	1½-2
—— Non. Cum., 6 per cent. Pref.	2	2¼-2¾
—— 4½ per cent. Debenture Stock	100	110-114
—— 4½ per cent. 2nd Debenture Stock	100	101-104
Callender's Cable Company, Debentures	100	110-113
—— Ordinary	5	10½-11½
Central London Railway, Ordinary	10	9½-10½
——	6	5½-6½
—— Pref. Half-Shares	1	1¼-1½
—— " "	5	4¼-4¾
Charing Cross and Strand	5	11-12
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	7½-8½
—— 4½ per cent. Debentures	100	115-117
City of London, Ordinary	10	25-26
—— Prov. Cert. 90,001-100,000	5	17½-18½
—— 6 per cent. Cumulative Pref.	10	15-16
—— 5 per cent. Debenture Stock	100	127-131
City and South London Railway, Consolidated Ordinary	100	68-71
—— Ordinary	2	1½-1¾
—— 4 per cent. Debenture Stock	100	126-128
—— 5 per cent. Pref. Shares	10	15-16
—— " " " '96	10	13½-14½
County of London and Brush Provincial Co., Ordinary	10	12-13
—— " " "	4	6-7
—— 6 per cent. Cum. Pref.	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
—— 5 per cent. Debentures	—	88-93
Crystal Palace District, Ordinary 5 per cent. Stock	100	125-130
—— Preference 5 per cent. Stock	100	143-145
Edison and Swan United Ordinary	3	3½-3¾
—— 5 per cent. Debentures	5	4-5
—— 4 per cent. Deb. Stock, Red.	100	103-105
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	3	3½-4½
Electric Construction, Limited	2	2¼-2¾
—— 7 per cent. Cumulative Pref.	2	3¼-3¾
—— 4 per cent. Perp. 1st Mort. Deb.	100	106-108
Elmore's Copper Depositing	1	[illegible]
Elmore's Wire Company	2	[illegible]
W. T. Henley's Telegraph Works, Ordinary	10	21½-22½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	8-9
—— 7 per cent. Preference	5	9½-10½
India Rubber and Gutta Percha Works	10	21-22
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	13-15
—— 6 per cent. Pref.	5	8-8½
London Electric Supply, Ordinary	5	3½-4
Metropolitan Electric Supply, Limited, Ordinary	10	14-15
—— 4½ per cent. First Mortgage Debenture Stock	100	117-121
National Telephone, Ordinary	5	5½-5¾
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	5¼-5¾
—— 3½ per cent. Deb. Stock, Red.	100	101-106
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1¼-1½
—— £5 Shares	5	7½-8
—— £4½ shares	4	6½-7
Oriental Telephone and Electric Company	1½	[illegible]
Royal Electrical Company of Montreal	—	143-145
—— 4½ per cent. First Shares Mortgage Debentures	100	102-106
South London Electric Supply, Ordinary	2	2-2½
St. James's and Pall Mall, Limited, Ordinary	5	13-16
—— 7 per cent. Pref.	5	9-10
—— 4 per cent. Deb. Stock, Red.	100	107-110
Telegraph Construction and Maintenance	12	35-38
—— 5 per cent. Bonds	100	103-106
Waterloo and City Railway, Ordinary	100	116-119
Westminster Electric Supply, Ordinary	5	14½-15
Yorkshire House-to-House	5	[illegible]

THE

ELECTRICAL ENGINEER

A JOURNAL OF ELECTRICAL ENGINEERING,

WITH WHICH IS INCORPORATED

"ELECTRIC LIGHT."

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New Series—No. 1, Vol. XXI.

LONDON, JANUARY 7, 1898.

PRICE 3D.
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CALENDAR FOR 1898.

	JANUARY.						FEBRUARY.						MARCH.						APRIL.					
SUNDAY	...	2	9	16	23	30	...	6	13	20	27	...	...	6	13	20	27	...	...	4	11	18	25	...
MONDAY	...	3	10	17	24	31	...	7	14	21	28	...	...	7	14	21	28	...	...	5	12	19	26	...
TUESDAY	...	4	11	18	25	...	1	8	15	22	...	...	1	8	15	22	29	...	...	6	13	20	27	...
WEDNESDAY	...	5	12	19	26	...	2	9	16	23	...	...	2	9	16	23	30	...	...	7	14	21	28	...
THURSDAY	...	6	13	20	27	...	3	10	17	24	...	...	3	10	17	24	31	...	1	8	15	22	29	...
FRIDAY	...	7	14	21	28	...	4	11	18	25	...	...	4	11	18	25	...	...	2	9	16	23	30	...
SATURDAY	1	8	15	22	29	...	5	12	19	26	...	...	5	12	19	26	...	...	3	10	17	24	...	...

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Gwynne and Co., Brooke-street Works, Holborn

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...ng, Mendham, and Co., Bristol.
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King, Major H., Isfield Place, near Uckfield, Sussex.
Kingsbury, J. G., 79, Coleman-street, E.C.
Koerber, A., 44, Frith-street, Soho-square.
Kolle, H. W., 27, Charterhouse-square, E.C.
Larkie, Wm., 75, Waterloo-street, Glasgow.
Laing, Wharton, and Down, 82A, New Bond-street, W.
Langdon, W. E., M. R. Co., Derby.
Laurence, Scott, and Co., Norwich.
Lavender, Jno., 41, Halliwell-lane, Cheetham Hill, Manchester.
Lee, J. H., Town Hall, Southampton.
Lewis, F. Harman, Town Hall, Wolverhampton
Lewis, J. Slater, Salford Rolling Mills, Manchester.
Lock, W. B., 15 and 16, Norfolk-street, King's Lynn.
Lodge, Prof. O., Waverley-road, Liverpool.
Lorrain, J. G., Norfolk House, Norfolk-street W.C.
Lowdon, David, Barry Graving Dock, Barry near Cardiff.
Lucas, Owen, and Pyke, Albany Buildings, 39 Victoria-street, S.W.
Lundberg, Gus. C., Bradbury-street, Kingsland, London, N.
Maclean, M., University, Glasgow.
Macmoldrow, W. G. P., Liverpool Corporation
Mapple, Edgar, Blackpool Corporation.
Marryat, Lillywhite, and Co., 57D, Hatton garden, E.C.
Marshall, A. W., 190, Loughborough-road Brixton.
Massingham, H. G., Bridge-street, Taunton.
Mather and Platt, Salford, Manchester.
Mather, T., City and Guilds of London Institute, Exhibition-road, S.W.
Maurice, W., Swanwick Collieries, Alfreton.
Mavor, H. A. 56, George-street, Glasgow.
Mayson, C. M. Electric Light Station, Whitehaven.
McLachlan F. L. 86 Brighton-road Stoke Newington.
M'Cowan, V. A. H. Town Hall Belfast.
McLean, J. H., Oxford Electric Lighting Company, Oxford.
Metzger, G. F., Dorchester-street, Bath.
Mosses and Mitchell, 68, Chiswell-street, E.C.
Moulton, J. F., 11, Queen's Bench-walk, E.C.
Mountain, A. B., Borough Electrical Engineer, Huddersfield.
Mountain, W. C., Close Works, Newcastle-on-Tyne.
Munro, Jno., 23, Duppas-hill-terrace, Croydon.
Murray, E. T. Ruthven, Guildhall, Worcester.

Neale, J., North Staffs Railway Co., Stoke-on-Trent.
Newington, F., Electric-st. Station, Edinburgh
Newington, S. W., Oldham Corporation.
Newton, F. M., Newton Electrical Works, Taunton.
Nuthall, B., Ivy Side, King's-road, Kingston-on Thames.

Osler, F., and Co., 100, Oxford-street, W.

Parker, T., Manor House, Tettenhall, near Wolverhampton.
Parsons, Hon. C. A., Heaton Works, Newcastle-on-Tyne.
Paxman, J. N., Colchester.
Pell, B., 5, Granville-park, Blackheath.
Perry, Prof. J., 31, Brunswick-square, W.C.
Pickstone, M. T., Salford Rolling Mills, Manchester.
Pilling, J., Electricity Works, Bolton.
Pitkin, J., 56, Red Lion-street, Clerkenwell.
Portheim, R. S., Salford Rolling Mills, Manchester.
Preece, W. H., G.P.O., E.C.
Preller, Dr. C. S. Du Riche, Loch Broom House, 18, Margaret-street, Cavendish-square, W.
Pritchetts and Gold, 11. Hart-st., Bloomsbury.
Probert, L., General Post Office, E.C.
Proctor, H. Faraday, Central Electric Lighting Station, Temple Backs, Bristol.
Putland, E. E., Electric Light Works Aberystwyth.

Quin, R. C., Corporation Electricity Works, Blackpool.

Radcliff, W., St. Heliers, Torquay.
Ramsay, Prof. Wm., University College, Gower-street, W.
Ramsden, F. L., Electric Light Works, Burton-upon-Trent.
Ranken, A. W., Electric Light Station, Great Yarmouth.
Ransomes, Sims, and Jefferies, Ipswich.
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Rettie, Chas., 18, Geraint-street, Liverpool.
Rickard, Wm., Derby.
Rider, J. H., Plymouth Corporation.
Rigg, J. H., 43, Skinner-lane, Leeds.
Rimington, E. C., Lenton House, The Park, Norwood.
Robertson, G. H., 30, Hemstall-road, West Hampstead, N.W.
Robertson, H. J., Thornloe, Oban.
Robey and Co., Globe Works, Lincoln.
Robinson, Hy., St. Pancras Vestry, N.W.
Robinson, Wm., University College, Nottingham.
Rogers, H. J., Watford Engineering Works, Watford.
Rooper, W. O., Mill-street, Stafford.
Rosling and Appleby, Trafalgar Works, Bradford
Royce, T. H., and Co., Cooke-street, Hulme, Manchester.
Ruddle, M., Dublin Corporation.
Russell, C. N., Shoreditch Vestry, E.
Russell, N. Scott, 30, Coleman-street, E.C.
Russell, S., Silvertown Co., E.
Ruston, Proctor, and Co., Lincoln.

Salomons, Sir D., Broomhill, Tunbridge Wells.
Sankey, Capt., Ferry Works, Thames Ditton.
Saunders, J., and Co., Bute-street, Cardiff.
Sayers, W. B., 56, George-street, Glasgow.
Scott, W. H., Gothic Works, Norwich.
Scott, Ernest, Scotville, Gatmore-gardens, Wimbledon-park.
Scott and Mountain, Close Works, Newcastle-on-Tyne.
Sellon, J. S., The Hall, Sydenham, S.E.
Sellon, R. P., 49, Queen Victoria-street.
Siemens Bros., 12, Queen Anne's-gate, S.W.
Sisling, W. B., Laurence, Scott, and Co. Norwich.
Smith, W., 101, St. Martin's-lane, W.C.
Smythe, R. G. 12, Idol-lane, Great Tower-street, E.C.
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Stewart, J. E., Derby Corporation.
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Swan, J. W., 58, Holland-park, W.
Swinton, A. A. Campbell, 66, Victoria-st., S.W.

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Talbot, Herbert, Guildhall, Nottingham.
Tangyes, Limited, Birmingham.
Tasker, Sons, and Co., Sheffield.
Tatham, S. R., 26, Thurloe-place, South Kensington.
Taylor, J., Telegraph Mfg. Co., Helsby.
Teague, F., Town Hall, Paisley.
Thomas, Wm. J. Rawlinson, The Council House, Birmingham.
Thompson, Prof. S. P., Morland, Chislett-road West Hampstead.
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Traill, W. A., Portrush, co. Antrim, Ireland
Travers, G. Gasworks, Cork.

Unwin, W. C., 7 Palace-gate-mansions, S.W
Upward, A. R., 150, Holland-rd., Kensington
Usher Thos. G., Norfolk-street, Sunderland.

Varley, A. F., P. O. Telegraphs, Telegraph street, E.C.
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Veale, J. E., St. Austell, Cornwall.
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Voysey, A. A., City Commission of Sewers Guildhall, E.C.
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Wallace, R. W., 21, De Vere-gardens, Kensington, W.
Wallis-Jones, R. J., 29, Great George-st., S.W.
Walsall Electric Co., Walsall.
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Webb and Son, Stowmarket.
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Willans and Robinson, Rugby.
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Wilmhurst, T. P., Halifax Corporation.
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Yeatman, F. F., The Island, Reading.
Yorke, R. F., The Red House, Barham Canterbury.
Young, G., Burleigh Lodge, Trinity, Edinburgh.
Young, W., Aylesbury, Bucks.

Dunham, C. R., 331, Gray's-Inn-road W.C.